Global Academic Journal of Economics and Business

Available online at https://www.gajrc.com
DOI: https://doi.org/10.36348/gajeb.2026.v08i06.023

OPEN ACCESS



ISSN: 2706-9001 (P)
ISSN: 2707-2584 (O)

Review Article

Integrated Project Controls and Cost–Schedule Performance in Saudi Regional Development Megaprojects: A Critical Review and Conceptual Framework

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Article History
Received: 18.09.2026
Accepted: 10.11.2026
Published: 18.11.2026

Abstract: Saudi regional development megaprojects combine ambitious investment programmes with interfaces spanning infrastructure, tourism assets, utilities, contractors and public authorities. Such conditions expose limitations in isolated cost reporting and conventional schedule surveillance. This critical integrative review examines how integrated project controls may influence cost and schedule performance, which mechanisms plausibly generate improvements, and why implementation frequently falls short. The synthesis draws on peer-reviewed research published between 2020 and 2025 and distinguishes directly observed associations from conceptual propositions. Evidence is organised around baseline integrity, integrated work and cost structures, earned value and duration measurement, uncertainty management, digital interoperability, and governance of corrective action. Studies suggest that better outcomes depend less on dashboard production than on the timely conversion of credible information into authorised interventions. Interdependencies, contractual fragmentation, shifting scope and inconsistent progress measurement weaken this conversion. A proposed control-to-outcome framework explains how common data definitions, analytical diagnostics, cross-package coordination and decision rights interact. The review identifies methodological deficiencies in causal identification, longitudinal measurement and the evaluation of regional development benefits. Practical recommendations emphasise auditable baselines, integrated forecasting, explicit escalation thresholds and independent validation. These findings inform project management consultants, programme sponsors and policymakers seeking proportionate controls for Saudi development programmes without assuming that digitalisation alone guarantees delivery performance.

Keywords: Integrated Project Controls, Regional Development, Saudi Arabia, Megaprojects, Cost Performance, Schedule Performance, Programme Governance.

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1. INTRODUCTION

Regional development is delivered through interdependent projects rather than through a single construction contract. Cultural destinations, transport links, utilities, hospitality facilities and public space must reach usable states in compatible sequences. The schedule of an individual building therefore describes only part of programme readiness. An apparent saving in one package can generate more expensive delay elsewhere, while

accelerated construction can conceal unrecognised changes, weakened productivity or deferred commissioning. Saudi Arabia's large development initiatives make these problems consequential because capital commitments must be coordinated with public expectations and wider economic objectives. Under Saudi Vision 2030, these programmes are intended to diversify the economy and create new tourism, cultural and urban destinations, so delivery slippage carries programme-wide and reputational consequences beyond individual contracts (Kingdom of Saudi Arabia, 2016). This review addresses delivery performance without equating the completion of physical assets with the realisation of long-term development benefits.

Cost and time outcomes remain central indicators, but neither explains how a project reaches them. Overruns may arise from inadequate scope definition, late decisions, procurement exposure, design development, productivity losses or incorrect forecasts; meta-analytical evidence ranks several of these among the most frequently reported causes of construction delay worldwide (Sanni-Anibire *et al*., 2022). International megaproject research further indicates that such overruns are systematic rather than exceptional (Flyvbjerg, 2014). Conversely, apparent adherence to a baseline may reflect aggressive rebaselining or selective progress measurement rather than genuine control effectiveness. Evidence from Saudi construction identifies persistent weaknesses in cost control, schedule credibility and the management of client interfaces (Jawad and Ledwith, 2021; Aldossari, 2024, 2025). The appropriate research question is consequently not whether a project uses project controls software, but how coordinated control practices alter information quality, decision timing and remedial capability.

Integrated project controls are understood here as the coordinated governance and operation of scope, work breakdown structures, cost accounts, scheduling, risk, change control, forecasting and performance reporting. This definition is consistent with the integrated, cyclical view of cost and schedule control in the Total Cost Management Framework (AACE International, 2015) and with established earned value management system guidelines (SAE International, 2019). Integration requires compatible definitions and decisions across these domains. It differs from the simple consolidation of reports prepared by separate disciplines. For instance, a schedule delay is actionable only when its affected quantities, resource implications, contractual responsibility and forecast cost consequences can be traced. Organisational research suggests that management controls operate through their interaction with complexity, competence and decision-making arrangements rather than as self-contained techniques (Maqsoom *et al*., 2020; Le and Sutrisna, 2023).

The contribution of this review is to connect those mechanisms with Saudi regional development delivery, where multiple packages must remain aligned with common programme milestones. Its emphasis is critical rather than celebratory: integration introduces effort, data dependencies and governance demands, and poorly implemented controls may increase administrative burden while leaving decisions unchanged. The review therefore evaluates not merely the presence of control tools but the conditions under which they can affect measurable performance.

2. AIM, OBJECTIVES AND RESEARCH QUESTIONS

The aim is to critically synthesise recent evidence on the mechanisms through which integrated project controls influence cost and schedule performance in Saudi regional development megaprojects, and to formulate a context-sensitive framework for assessing implementation quality.

Four objectives guide the analysis: first, to distinguish the principal organisational and technical components of integration; second, to assess how baseline management, progress measurement and forecasting shape performance information; third, to examine the moderating effects of uncertainty, contractual interfaces and decision rights; and fourth, to identify research designs and practical controls capable of testing or strengthening the proposed mechanisms. The study asks three questions. RQ1: Which integrated control practices have the clearest theoretical or empirical connection with cost and schedule outcomes? RQ2: How do multi-contractor interfaces and programme governance enable or constrain these connections? RQ3: Which measurement and study design improvements are necessary to establish causal rather than merely associative claims?

3. REVIEW METHODOLOGY

A structured, critical integrative review was selected because the question spans empirical construction studies, methodological research, programme governance and digital production control. It seeks explanatory synthesis rather than a pooled intervention effect. Relevant publications from January 2020 to December 2025 were identified through targeted examination of peer-reviewed journal literature and backward and forward citation tracing from recent project controls studies (e.g., Alotaibi *et al*., 2025). Search concepts included "project control system", "earned value", "earned duration", "cost overrun", "schedule performance",

"construction megaproject", "Saudi Arabia", "baseline", "BIM interoperability", "change order" and "project governance". Concept combinations distinguished Saudi-specific findings from transferable international methods. Foundational standards and seminal works published before 2020 are cited only to define established concepts, such as total cost management, earned schedule and earned duration, and are not treated as part of the evidence base.

Eligibility required a publication date within the defined interval, a traceable scholarly source and relevance to construction or closely related project production and control. Preference was given to studies reporting explicit methods, observable project outcomes or clearly specified control processes. Publications focused exclusively on unrelated financial trading, purely architectural aesthetics or generic motivational success factors were not treated as direct evidence. The review retained selected international studies when they clarified mechanisms insufficiently evaluated in Saudi samples. Citation tracking was used to connect schedule and cost monitoring research with behavioural and organisational work. The evidence base comprises thirty DOI-bearing peer-reviewed studies published within the review period, and each identifier was checked against the corresponding publisher record to confirm traceability.

The analytic unit was the reported relationship or conceptual mechanism, not the publication as a homogeneous vote for or against integration. Studies were coded narratively by context, control intervention, outcome definition, temporal design, confounding factors and limits of inference. Findings were compared in six themes: baseline integrity, joint cost and schedule measurement, anticipatory risk management, digital information integration, multi-party governance and corrective action learning. Contradictions were retained where association, mechanism and causal identification diverged. No screening totals, inter-reviewer agreement statistics or meta-analytic effect sizes are claimed because a reproducible database export and independent full text coding exercise were not performed. Accordingly, the analysis is presented as a critical narrative synthesis rather than an exhaustive systematic review.

Evidence strength was interpreted conservatively. Cross-sectional surveys can establish perceived or reported associations but cannot isolate the effect of adopting controls from pre-existing organisational maturity. Predictive accuracy in retrospective datasets does not necessarily establish that managers subsequently acted on forecasts. Case-based technical demonstrations establish feasibility, not portfolio-wide economic benefits. As a result, recommendations are framed in terms of plausible pathways and observable verification tests rather than guaranteed savings.

4. Integrated Controls as an Operational System

The first requirement of integration is a coherent control architecture. An integrated master schedule provides activity logic and dependencies; a cost breakdown provides budget accountability; work and organisational breakdown structures determine what each team owns. These structures must be connected through stable control accounts and explicit coding conventions. Without a common dictionary, a progress update may be valid locally yet impossible to reconcile with programme cost reporting. Construction production studies emphasise that control methods often remain fragmented between planning levels and organisational units (Dallasega *et al*., 2021; Jawad *et al*., 2022). The distinction matters in megaprojects because interface delays cannot be reliably allocated where packages use incompatible milestones or reporting periods.

Baseline integrity precedes useful variance analysis. An approved baseline should express realistic scope, production assumptions, access constraints, procurement lead times and commissioning sequences. It must also record assumptions and the authority responsible for changes. A cost baseline derived from immature quantities is not rendered reliable by frequent dashboard refreshes. Similarly, a schedule with artificial logic, excessive constraints or unsubstantiated float cannot provide a credible critical path. Saudi construction evidence connects managerial competence and project controls discipline with the reliability of implementation, yet the strength of causal effects remains uncertain (Jawad and Ledwith, 2021; Aldossari, 2024). This suggests an assurance mechanism: baseline reviews should explicitly test logic integrity, estimate maturity and cross-package dependencies before performance reporting begins.

Integration also requires a temporal bridge between planning horizons. Annual programme milestones, contractor look-ahead plans and daily commitments represent different decision scales. When short-term activities do not map to the accepted master schedule, reliable frontline progress can coexist with inaccurate programme completion forecasts. Amer *et al*., (2021) demonstrate the feasibility of linking planning descriptions with language processing methods, while Lin and Golparvar-Fard (2021) show how visual production information can strengthen proactive control. Neither result eliminates the need for accountable

human validation of changes, because automated alignment can confuse similar activities or overlook contractual distinctions.

A practical definition of maturity must therefore emphasise control continuity: a variance detected in field reporting should propagate through an approved account, a verified schedule dependency, a risk or change record and a documented response. The presence of software modules alone is insufficient. Mature integration can also be deliberately selective. Applying detailed quantity-level integration to every minor work package may consume more resources than it saves; critical interfaces and high-uncertainty packages justify the greatest analytical effort.

Integration also depends on how performance periods are closed. When contractor submissions arrive after the programme reporting cut-off, the apparent distinction between planned and actual production becomes partly a timing artefact. A disciplined month-end process should record cut-off dates, late evidence, disputed quantities and subsequent adjustments. This is important when procurement milestones are reported as earned construction progress even though equipment has not arrived or been installed. Common coding standards must consequently be supported by common measurement rules and independent reconciliation. At portfolio scale, the intended benefit is consistent interpretation, not perfectly uniform work practices across every discipline. Controls can permit justified local variation while protecting the integrity of programme-level comparisons.

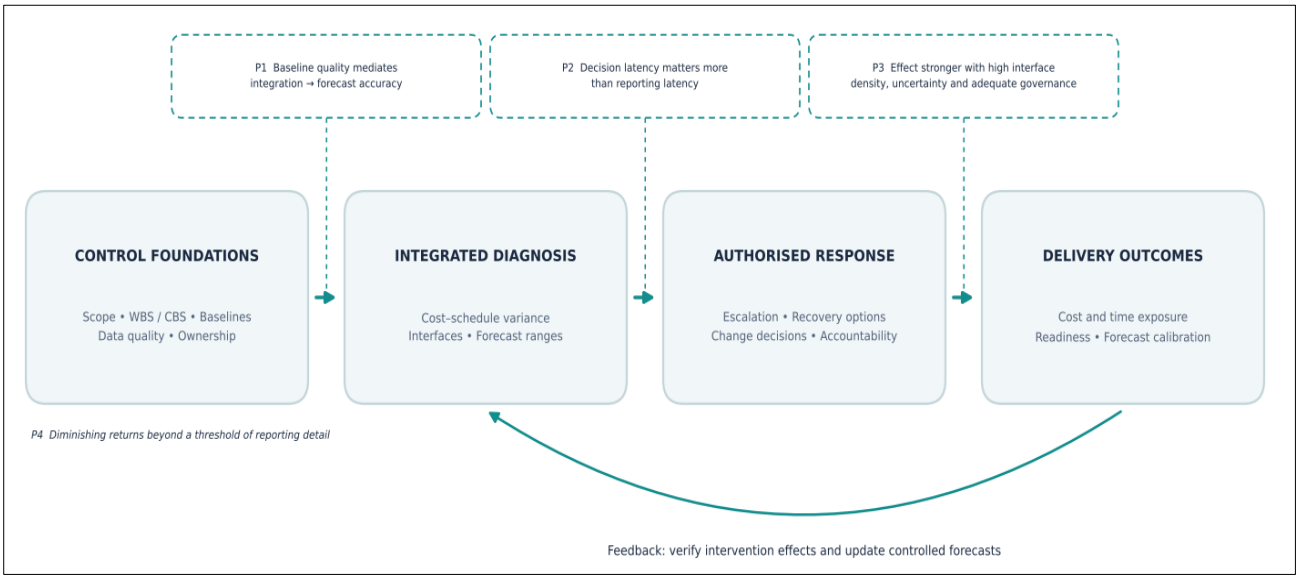


Figure 1: Conceptual pathway connecting integrated controls with programme performance. Original synthesis; arrows denote proposed mechanisms, not estimated causal effects. Labels P1–P4 indicate where the testable propositions in Section 9 apply.

5. Cost and Schedule Measurement

The principal attraction of earned value management is its consistent comparison of planned value, earned value and actual cost. Cost performance indices and schedule performance indices are useful early diagnostic signals, particularly when they are based on trustworthy quantities and independently verified physical progress. Yet a favourable index may conceal a future interface failure, and a deteriorating index may simply reflect temporary mobilisation effects. Multivariate monitoring research supports analysing cost and duration indicators jointly rather than treating each as an isolated alarm (Votto *et al*., 2020). Such monitoring is more informative when control limits are chosen in relation to forecast uncertainty instead of arbitrary monthly targets.

Schedule measurement presents a separate difficulty. Value-based schedule indices can lose interpretability late in projects, and aggregated milestones may hide local sequence instability. Earned schedule (Lipke, 2003) and earned duration (Khamooshi and Golafshani, 2014) approaches, together with short-horizon production reliability, provide complementary information about work continuity and likely completion. Nguyen *et al*., (2023) examine prediction of percent plan complete from time-series characteristics, supporting the use of operational trends alongside conventional baselines. Ezzeddine *et al*., (2022) examine the momentum of construction performance, reinforcing the importance of trajectory rather than one-period status. Neither method should be used as a substitute

for critical path review, procurement tracking or the diagnosis of unresolved constraints.

Cost and schedule interactions are asymmetric. Accelerating a delayed work package may increase labour, overtime and equipment expenditure, but can protect overall programme value when it prevents downstream shutdown. Delaying a non-critical package may lower short-term expenditure while creating later interface risk. Corrective action research demonstrates that constrained budgets shape which schedule interventions are feasible (Song *et al*., 2020). Consequently, variance dashboards should connect available float, recovery cost, completion date exposure and benefits at risk. Directors need the marginal cost of alternative actions, not only historical deviation percentages.

Forecasts should be treated as scenario estimates with provenance. A credible estimate at completion separates committed costs, productivity assumptions, approved changes, unresolved claims and risk allowances. Schedule forecasts should distinguish probabilistic completion ranges from a deterministic target date. The useful output is not a single authoritative figure but an auditable explanation of how assumptions change outcomes. Evidence on construction performance prediction identifies analytical opportunities while also exposing the danger of interpreting fitted models as interventions (Assaad *et al*., 2020; Rezakhani, 2022). Independent challenge of assumptions remains essential where reported performance has contractual or reputational consequences.

Consider a hypothetical tourism precinct where two packages report equal schedule performance indices. The first has stable design, reliable access and verified quantities; the second has unapproved design changes, expiring supplier quotations and an unresolved utility connection. The same index does not imply the same probability of completion or the same remedial requirement. The example illustrates why control reviews should combine numerical diagnostics with exposure registers and professional judgement. Forecast meetings should distinguish data errors from genuine deterioration and should document what would falsify the current recovery assumption. The value of a control system lies partly in making these uncertainties explicit before they become unavoidable costs.

Table 1: Main mechanisms, indicators and interpretative cautions from the reviewed literature

Control mechanism	Observable indicators	Expected value	Principal limitation
Baseline integrity	Estimate completeness; logic checks; change history	Comparable starting point	Risk of strategic rebaselining
Joint diagnostics	CPI; duration trends; critical paths; productivity	Early exposure signals	Lag and aggregation bias
Interfaces and risk	Shared handover dates; risk triggers; lead times	Programme exposure visibility	Correlated uncertainties
Digital interoperability	Mapped control accounts; version provenance	Faster reconciliation	Data quality dependencies
Governance and action	Decision ownership; escalation age; closure evidence	Timely response	Endogeneity and incentive effects

6. Uncertainty, Changes and Cross-Package Dependencies

Regional development programmes face correlated uncertainty. Utility access, permitting, design decisions, long-lead materials and contractor capacity can affect several packages simultaneously. Summing isolated package contingency allowances may underestimate shared exposure or double count the same programme risk. Integrated controls therefore require an interface register and a risk structure that traces common causes across cost accounts and activities. Research on schedule buffers demonstrates how activity dependencies alter required protection against uncertainty (Xiao *et al*., 2021). A regional programme should extend this reasoning to interfaces between construction packages, public infrastructure and commissioning authorities.

Changes constitute a second integration test. A design instruction may appear in a commercial ledger weeks before its schedule implications are evaluated, while a site team may resequence work before contractual entitlement is agreed. Such latency creates divergent versions of programme reality. Saudi evidence describes the material role of change orders in project performance (Alkhalifah *et al*., 2023), and causal analysis of delay factors in Iran shows how interrelated delay causes reinforce one another (Jahangoshai Rezaee *et al.,* 2021). Effective integration places each material change in one controlled record linking scope, responsible party, estimated cost, schedule logic, approval status and

residual risk. Pending decisions must remain visible rather than disappearing because entitlement is disputed.

Risk management also needs a dynamic response process. A register updated at monthly meetings is unlikely to capture fast-moving constraints or emerging combinations of threats. Risk triggers should be attached to schedule and cost forecasts, with ownership assigned to people authorised to intervene. In the literature on cost risks, categories alone do not explain outcomes unless their routes into project decisions are understood (Annamalaisami and Kuppuswamy, 2021). Programme teams should therefore identify which assumptions would fail first and determine the latest safe decision date for mitigation.

This approach has limits. Detailed integration can create spurious precision when upstream data remain uncertain. For example, assigning an exact completion probability to a scope that has not been approved can legitimise a fragile baseline. Sensitivity analysis is more honest when evidence quality is weak. The central competence is disciplined interpretation: disclose the confidence attached to each forecast, identify dependencies that may invalidate it and explain whether management has practical response options.

A useful interface assessment classifies each dependency by criticality, uncertainty and ability to influence its owner. High-criticality dependencies with little local control should be escalated at programme level, even when they are outside the contracting organisation's formal scope. Low-criticality issues can remain within package management, reducing overload at executive meetings. Review frequency should reflect the pace at which intervention options disappear rather than a fixed administrative calendar. Interface registers are most informative when linked to dated evidence of readiness: approved designs, access permits, completed utilities, test results and accepted handovers. The record should also show where progress claims rely on future assumptions.

7. Digital Integration and Information Credibility

Digital tools can reduce reporting latency, but their value depends on semantic and organisational interoperability. Building information models, field progress records, planning systems, commercial databases and dashboards often describe different objects at different levels of detail. A shared file repository does not automatically resolve these differences. Research on common data environments identifies persistent challenges in practical implementation, including fragmented practices and governance of information responsibilities (Jaskula *et al*., 2024). Studies of digital adoption similarly emphasise that implementation evolves with contractor capabilities and organisational processes rather than with software acquisition alone (Murguia *et al*., 2023).

Digital progress capture is most useful when observed quantities can be mapped to contractual scope and recognised progress rules. Automated vision techniques can supply additional evidence for installed work, but field exceptions, occlusion and incomplete models require validation (Pal *et al*., 2023). Digital data also create version risks: an attractive executive visualisation may be built from an obsolete baseline or a provisional variation log. A programme-wide information standard should specify source system, update frequency, approval state, data owner and quality checks for every high-impact metric.

Interoperable systems can strengthen decisions when they minimise the time between a material event and its management interpretation. The relevant performance metric is therefore decision latency, measured from detection to authorised response, rather than the number of dashboards produced. Digital controls need exception rules that avoid overwhelming executives with low-significance fluctuations. Visual interfaces should expose assumptions, drill-down paths and uncertainty bands rather than hiding them in polished summaries. Technical demonstrations of proactive controls support this direction (Lin and Golparvar-Fard, 2021), but direct evidence of sustained savings in Saudi regional programmes remains limited.

Data governance is a non-negotiable constraint. Contractors possess differing commercial incentives, and access to unvalidated information can create claims exposure or inaccurate attribution. A practical control design separates data submission, technical verification, approval and public reporting. Integration should make information traceable without assuming that all parties may edit the same records.

The development of automated narrative reporting introduces a further distinction between explanatory convenience and analytical evidence. Language generation systems may accurately rephrase an approved variance table yet invent causal explanations when prompted to interpret incomplete data. A responsible workflow would confine automation to traceable source records, require the explicit identification of uncertain statements and prohibit unsupervised changes to the approved baseline. Human review should test whether the narrative matches the underlying

quantities, schedule logic and commercial status. Such controls are relevant even when generative systems are not part of the formal project controls architecture, because executive decisions increasingly rely on concise textual summaries that can obscure the assumptions behind apparently precise numbers.

8. Governance, Behaviour and Corrective Action

Technical controls affect delivery only through organisations capable of acting upon them. Escalation routes, decision thresholds and sponsor authority determine whether identified deviations become recovery measures. Research on project control determinants highlights the influence of managerial structures and human coordination on operational control effectiveness (Alotaibi *et al*., 2025; Maqsoom *et al*., 2020). Evidence from construction projects in developing countries similarly emphasises the role of management practices in project success (Amoah *et al*., 2021). Accordingly, integrated reporting should link every red-rated exception to an accountable owner, deadline, decision requested and subsequent verification outcome. A report lacking these elements may document deterioration without altering it.

Multi-contractor environments require governance that distinguishes local optimisation from programme-level benefit. A contractor may rationally prioritise its own contractual milestones even when another sequence would reduce total programme delay. Interface governance should establish shared access windows, handover definitions, dispute resolution channels and incentives for cooperation. Research into megaproject stakeholder management identifies the risk associated with complex relationships and competing interpretations of success (Mashali *et al*., 2023), while case evidence from a record-breaking megaproject highlights the contribution of coordinated organisational arrangements to delivery success (Zhu *et al*., 2020). Central oversight must therefore reconcile commercial incentives with critical programme dependencies rather than merely aggregate contractor submissions.

Behavioural effects deserve equal attention. Teams may under-report bad news when performance ratings are punitive, and excessively centralised approval can discourage timely corrective action. Construction team studies connect teamwork, project knowledge and operational productivity, although they do not identify a universal control configuration (Loganathan and Forsythe, 2020; Yap *et al*., 2022). Effective governance combines independent assurance with constructive challenge. Near-miss schedule events should trigger learning rather than automatic blame, and forecast adjustments should be evaluated for explanation quality as well as numerical accuracy.

Control maturity is demonstrated by the closure of feedback loops. For each material deviation, programmes should be able to reconstruct when it emerged, who recognised it, what options were considered, what action was authorised, whether execution occurred and whether the forecast improved. Lessons learned research in Saudi construction supports systematic organisational learning (Almunifi and Almutairi, 2021). Without a similar audit trail, claims that integration improves performance may amount to post hoc attribution rather than evidence of effective management.

Decision rights should also be calibrated to reversibility. A minor resequencing choice can often be delegated to a package team; a change affecting shared access, public opening dates or major claims may require programme authority. Excessive escalation delays reversible decisions, whereas insufficient escalation allows local actions to create wider costs. The practical response is a tiered decision matrix linked to estimated cross-package impact and time sensitivity. Assurance should examine whether delegated choices actually stay within their authorised boundaries. This approach treats governance as part of operational control rather than as a separate ceremonial layer of reporting.

9. Critical Synthesis and Proposed Framework

Across the evidence, an explanatory pattern emerges: inputs make good control possible, but they do not themselves deliver performance. Standardised breakdown structures, reliable baselines, qualified analysts and interoperable tools improve information quality. Joint cost and schedule diagnostics then identify exposure, while governance determines the speed and quality of response. Figure 1 depicts this sequence, including the feedback from authorised action to new forecasts. The framework draws conceptual support from studies of project control system determinants and cost-control enabling factors but is proposed here as an analytical synthesis, not an empirically estimated model (Alotaibi *et al*., 2025; Le and Sutrisna, 2023).

The framework implies four testable propositions. First, baseline quality should mediate the relation between technical integration and forecast accuracy. Second, reporting latency should matter less than decision latency where management action requires complex approvals. Third, the relationship between integration maturity and programme outcomes should strengthen when interface density and uncertainty are high, provided governance capacity is adequate. Fourth, integration

may exhibit diminishing returns: beyond a threshold, additional reporting detail can divert resources from intervention. The propositions differ from simple technology success claims because each specifies an observable mechanism and a context-dependent prediction.

Table 1 contrasts mechanisms and evidence limits, preventing a mistaken equivalence between measurement accuracy and delivery improvement. Table 2 turns these findings into practical assurance questions. Together they establish a distinction between leading indicators of control quality, such as baseline completeness or unresolved decision age, and lagging outcomes, such as final cost growth and schedule overrun. Programme sponsors should monitor both. A weak outcome can coexist with capable controls when external shocks dominate, just as a favourable outcome may occur despite weak controls when scope and conditions are unusually stable.

An evaluation design should therefore compare comparable packages over time while explicitly adjusting for baseline maturity, size, procurement method, design change, market conditions and interface intensity. When integration is introduced progressively, difference-in-differences or matched longitudinal comparisons may help assess whether outcomes change relative to untreated packages. Such strategies require scrutiny of parallel trends and treatment selection; statistical significance alone cannot establish operational importance. The preferred outcome measures are final adjusted cost growth, schedule growth against an independently preserved original baseline, forecast calibration, intervention lead time and the closure rate of material interface risks. Figure 2 arranges these requirements into a four-stage assurance hierarchy, from data integrity to programme assurance, and Table 2 translates each stage into review questions and acceptable evidence.

Answers to the Research Questions

In relation to RQ1, the practices with the clearest connection to cost and schedule outcomes are baseline integrity, joint cost–schedule diagnostics and single controlled change records, although most supporting evidence is associative rather than causal (Sections 4 and 5). In relation to RQ2, multi-contractor interfaces weaken these connections when packages use incompatible coding, milestones or reporting periods, whereas explicit decision rights, interface registers and tiered escalation strengthen them (Sections 6 and 8). In relation to RQ3, causal claims require frozen original baselines, recorded intervention dates, longitudinal package-level data and quasi-experimental designs such as difference-in-differences with explicit tests of parallel trends (Sections 9 and 11).

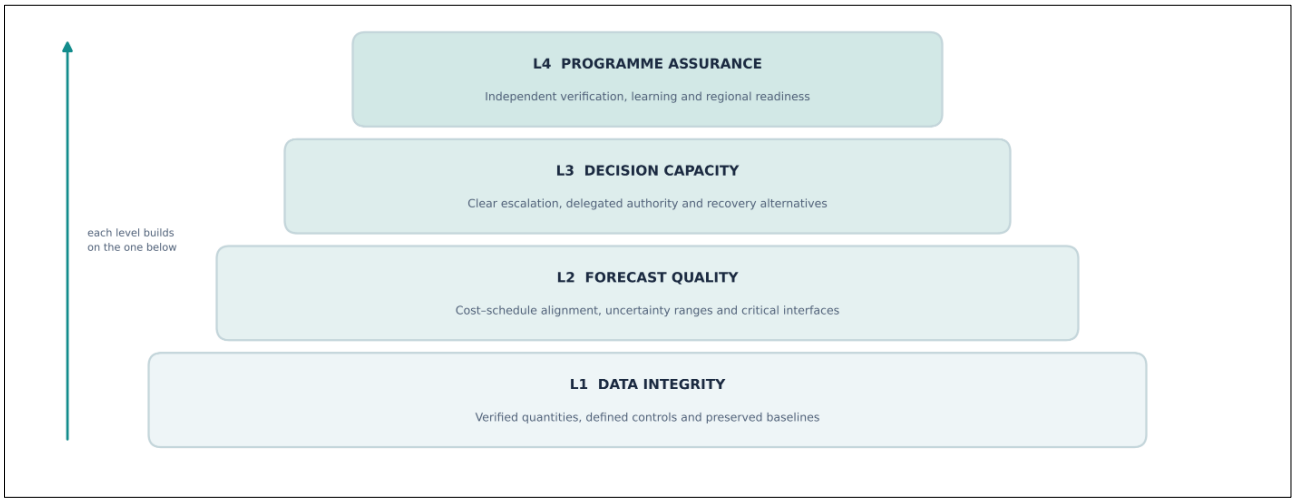


Figure 2: Four-stage assurance hierarchy for regional development programmes. Original conceptual diagram; stages are proposed rather than empirically ranked

Table 2: Programme assurance questions and evidence required for effective integrated control

Assurance domain	Key review question	Acceptable evidence
Baselines	Are cost and schedule anchored to the same approved scope?	Signed assumptions; cross-referenced account and activity maps
Progress	Does reported achievement represent verified physical work?	Field records; independent quantity review; reporting cut-offs
Interfaces	Can shared constraints be traced to programme milestones?	Interface register; dependency logic; verified handover criteria

Assurance domain	Key review question	Acceptable evidence
Decisions	Did significant warnings lead to authorised interventions?	Decision logs; action dates; comparative recovery scenarios
Outcome review	Did actions improve forecast reliability and delivery?	Frozen baseline; forecast error series; independent close-out analysis

10. Implications for Saudi Regional Development

For programme sponsors, the initial priority should be an integrated coding and assurance charter that defines control account ownership, reporting thresholds and baseline change authority. The next priority is a cross-package dependency model focused on public infrastructure interfaces, access constraints and readiness for operations. This is not merely a stronger reporting function: it is a decision architecture that clarifies which entity can resolve each critical constraint. Regional development benefits will remain exposed if individual projects reach nominal completion while connectivity, utilities or operating prerequisites are incomplete.

Project management consultants should establish a consistent monthly reconciliation between physically verified progress, recognised value, current commitments and forecast schedule logic. Exceptional variances need written causal diagnoses and quantified options for recovery. For significant risks, the board should receive competing scenarios showing additional expenditure, likely completion effects and residual uncertainty. The review does not justify universal numerical claims about cost savings; each programme should assess its own baseline of intervention effectiveness and data quality before attributing improvements to integrated controls.

Policymakers and asset owners can facilitate integration through information requirements embedded in procurement documents, standard definitions for handovers and independent assurance at major decision gates. Contracts should encourage early disclosure of emerging issues without compromising accountability. Benchmarking must distinguish projects with different maturity, physical conditions and scope volatility. International evidence can inform control design, but imported templates should be tested against the institutional interfaces, climate exposures, permitting structures and accelerated timelines of Saudi development programmes.

11. Limitations and Future Research

This review is limited by its targeted search procedure, the uneven geographic distribution of available studies, heterogeneity in outcome definitions and partial reliance on secondary descriptions. The bibliography is traceable through scholarly identifiers, yet a comprehensive database audit and duplicate independent screening have not been undertaken. Some reported effects concern project control perceptions rather than objective final accounts. International case studies provide conceptual insight but cannot be treated as direct estimates for Saudi regional programmes. Moreover, the reviewed works predominantly evaluate projects or organisational units, whereas development success involves interdependent asset systems and benefits realised after handover.

Future research should publish longitudinal project-level datasets with frozen original baselines, transparent rebaseline histories, measured intervention dates and separate records of approved and disputed changes. Multilevel models could distinguish contractor, package and programme effects. Quasi-experimental evaluations of common data environments or integrated cost and schedule governance should report implementation fidelity and negative as well as positive outcomes. Qualitative process tracing could reveal why apparently accurate warnings fail to trigger action. A final priority is to connect construction completion to regional readiness and public value without collapsing distinct causal pathways into a single composite performance score.

12. CONCLUSION

Integrated project controls can support better cost and schedule performance when they establish credible baselines, connect operational evidence to commercial and schedule consequences, and enable timely decisions across organisational boundaries. The literature does not support a simple claim that integrated software or more frequent dashboards automatically produces superior delivery outcomes. Information reliability, interface governance, uncertainty treatment and corrective action authority constitute the plausible mediating mechanisms. For Saudi regional development megaprojects, the appropriate measure of effectiveness is therefore not the sophistication of the control platform but whether credible warnings lead to proportionate interventions while preserving accountability. The proposed framework offers a focused agenda for programme assurance and causal evaluation. More longitudinal Saudi evidence is needed before precise claims about performance improvements can be defended.

DECLARATIONS

Author Contributions: [Author name]: conceptualisation, methodology, analysis, writing – original draft, writing – review and editing.

Funding: This research received no external funding. [Confirm.]

Conflict of Interest: The author is employed as a project controls professional by a project management consultancy engaged on Saudi development programmes. The views expressed are the author's own and do not represent those of the employer or its clients. [Confirm wording and any employer/client approval requirements.]

Data Availability: No new data were created or analysed in this study.

Use of Generative AI: [Describe any AI tools used, e.g., for language editing or structuring, in line with the target journal's policy.] The author reviewed and edited all content and takes full responsibility for the manuscript.

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