

Integrating Stage-Gate Governance, Digital Project Controls and Risk Management to Improve Execution Readiness in Saudi Mining Projects under Vision 2030.

Abstract:

Execution readiness requires mature engineering, credible delivery plans and accepted residual risks. This integrative review proposes a framework connecting stage-gate governance, digital controls and risk management for Saudi mining projects under Vision 2030. Targeted scholarly searches and official reporting inform the analysis. A gate evidence register links requirements to controlled documents, schedules, costs, risk owners and approval conditions. Mandatory constraints remain separate from general maturity assessments. Digital reporting supports traceability, while independent review challenges investment assumptions. Three tables specify evidence, readiness domains and pilot measures; a conceptual diagram explains the proposed relationships. Published Ma'aden revenue figures provide context rather than evidence of effectiveness. The paper proposes longitudinal validation using authorized project records. Its contribution is an operational account of how project information can support defensible investment decisions. The framework remains untested; improved delivery outcomes cannot yet be claimed.

Keywords: mining capital projects; stage-gate governance; execution readiness; digital project controls; risk management; Saudi Vision 2030

1. Introduction

Saudi mining investment requires evidence that technical scope, infrastructure, contracts and operating assumptions can be delivered together. Vision 2030 identifies mining as a diversification priority (Saudi Vision 2030, 2024), but strategic relevance alone does not establish execution readiness. Investment gates must translate policy objectives into specific, testable delivery commitments.

Readiness depends on interacting uncertainties. Geological interpretation affects resources, metallurgical testing affects process selection, and infrastructure constrains construction and operations. Advanced drawings cannot compensate for an unresolved water supply agreement. The assessment must therefore examine dependencies across the project rather than count completed engineering documents.

Governance oversees investment choices; management organizes delivery. Musawir et al. (2020) identify a need for context-specific governance, while Samset and Volden (2016) distinguish strategic investment success from tactical performance. Execution gates should test both investment validity and deliverability, retaining the ability to revisit earlier authorization.

Scheduling, enterprise, document and reporting systems can connect governance to delivery evidence. Their coexistence does not guarantee consistency. Chen et al. (2025) emphasize sociotechnical integration in digital transformation. Readiness assurance must establish how information is produced, checked and interpreted before relying on dashboard summaries.

The paper addresses a practical research gap between broad governance principles and operational readiness assessment. It asks how stage-gate authority, digital controls, and risk analysis can function as one decision process without imposing excessive administration. The proposed contribution is a traceable evidence architecture, a constrained readiness assessment, and an explicit validation strategy.

2. Aim and research questions

The study develops a literature-informed execution-readiness framework. Its objectives are to identify integration mechanisms, define observable evidence, preserve critical constraints, allocate responsibilities and propose empirical validation. The contribution is conceptual; it does not measure achieved improvement in Saudi mining projects.

Four questions guide the synthesis: what makes a gate substantively effective; how can digital controls supply credible readiness evidence; how should unresolved risks affect authorization; and what evaluation design could test integration? Each question connects a management practice to a decision mechanism rather than assuming checklist completion demonstrates viability.

75 **3. Review methodology**

76 An integrative review addresses the topic’s overlap between governance, investment definition,
77 digital transformation and mining risk. Snyder (2019) emphasizes transparent review purposes and
78 methods. This study develops a testable framework; it does not claim exhaustive systematic
79 coverage, bibliometric representativeness or a statistical meta-analysis.

80 Targeted web searches on 11 October 2026 combined mining projects, stage-gate governance,
81 front-end definition, digital controls, earned value and risk management. Publisher records and
82 official sources were prioritized. Authenticated Scopus and Web of Science searches were not
83 conducted, and subscription restrictions limited some full-text appraisal.

84 Sources were retained for relevance to authorization, planning maturity, information integrity,
85 mining uncertainty or sector context. Scholarly publications informed mechanisms; official reports
86 supplied descriptive context. Promotional claims were excluded. Foundational sources were
87 retained alongside recent studies because publication date alone does not establish conceptual or
88 methodological quality.

89 Evidence was organized into authorization, front-end definition, information integrity, uncertainty
90 and handover. Reported findings were separated from proposed applications. Restricted sources
91 supported only claims visible in accessible material. No screening counts, interviews or
92 performance estimates were invented. These access limitations constrain the review’s
93 methodological depth.

94 The synthesis connects governance authority, digital evidence and mining risk through proposed
95 readiness rules. Table 1 summarizes central evidence streams and limitations. The framework is an
96 original analytical proposition, rather than an established company procedure or an integration
97 model already tested by the reviewed studies.

98 **Table 1 Evidence sources and their analytical limits**

Source	Role in synthesis	Limit
Musawir et al. (Musawir et al., 2020)	Governance and strategic alignment	Broad project contexts
Samset and Volden (Samset and Volden, 2016); Babaei et al. (Babaei et al., 2021)	Front-end definition and interconnected issues	Transfer to mining requires testing
Cooper (Cooper, 2008)	Staged commitment and scalable gates	Originally product development
Chen et al. (Chen et al., 2025)	Sociotechnical digital integration	Not Saudi mining outcome evidence
Aramali et al. (Aramali et al., 2022)	Earned value system practice	Does not validate readiness model
Faúndez and Guzmán (Faúndez and Guzmán, 2025)	Mining cost and delay drivers	Not a Saudi-specific estimate

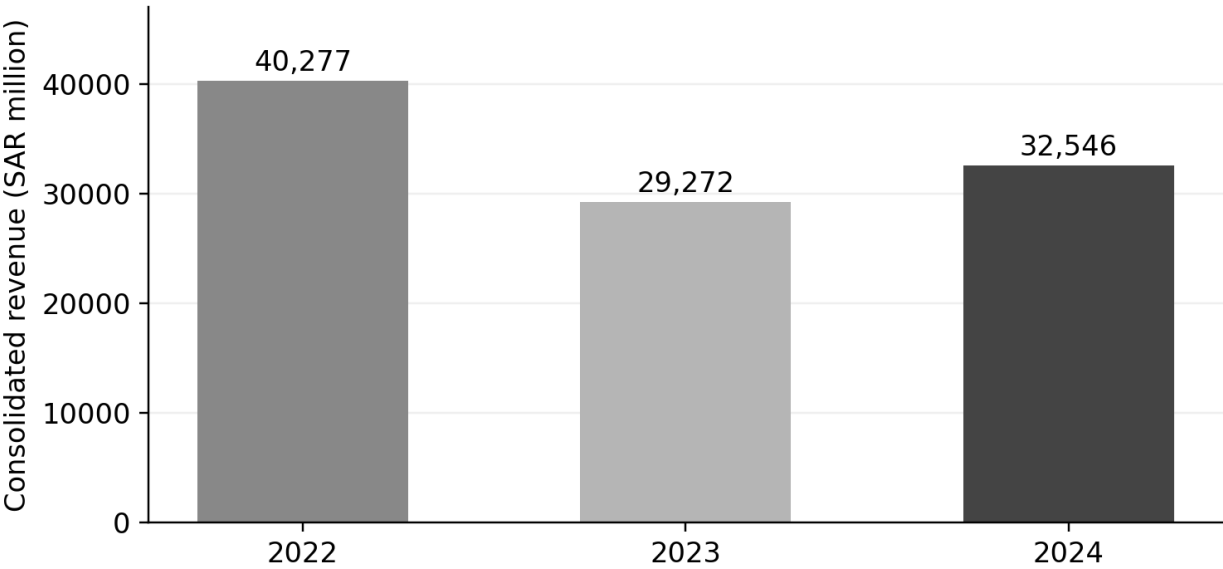
Source	Role in synthesis	Limit
Official reports (Saudi Vision 2030, 2024; Ma'aden, 2025)	Policy and corporate context	Descriptive rather than causal

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100 **4. Saudi mining context and investment discipline**

101 Potential mining-project benefits include capacity, downstream integration, supplier development
102 and technical employment. Each requires an owner, baseline and realization period. A business
103 case should explain the mechanism generating these benefits and how unresolved constraints affect
104 their credibility; merely mentioning Vision 2030 is insufficient.

105 Ma'aden reported consolidated revenue of SAR 40,277 million in 2022, SAR 29,272 million in
106 2023 and SAR 32,546 million in 2024 (Ma'aden, 2025). Figure 1 reproduces these values. Revenue
107 reflects markets, volumes and portfolio composition, so it cannot establish project readiness or
108 governance effectiveness.



109

110 Figure 1 Published Ma'aden consolidated revenue in 2022–2024, in SAR million (Ma'aden, 2025). Contextual
111 financial data only; not evidence of governance effectiveness.

112 Investment justification and execution assurance require connected evidence. Commercial
113 sensitivity tests value under changing assumptions; delivery assurance tests scope, schedule,
114 contracts and resources. A project can satisfy one assessment while failing the other. The gate
115 record should preserve both conclusions rather than equating policy relevance with executable
116 investment.

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118

119 **5. Literature synthesis**

120 **5.1 Stage-gate governance and front-end definition**

121 Stage-gate governance structures commitment around maturity assessments. Cooper (2008)
122 emphasizes meaningful gate decisions, scalability and avoidance of bureaucracy in product
123 development. Mining application requires adaptation to resources, process performance,
124 infrastructure and procurement. The transferable principle is evidence-informed commitment, not a
125 universal deliverable list.

126 Front-end maturity concerns whether technical assumptions, estimates, schedules and benefits
127 describe the same project. Samset and Volden (2016) distinguish strategic and tactical success;
128 Babaei et al. (2021) identify interconnected infrastructure front-end issues. These perspectives
129 motivate consistency checks but do not establish Saudi mining effect sizes.

130 A gate weakens when approval is assumed before review. Each unresolved condition needs an
131 owner, due date, affected commitment and closure consequence. Reviewers must distinguish
132 manageable execution conditions from gaps undermining authorization. The distinction is a
133 proposed safeguard, not a measured company characteristic.

134 **5.2 Digital controls and information credibility**

135 Common identifiers should connect scope, schedule, cost, procurement, documents and risks. This
136 enables reviewers to trace an indicator to its evidence and detect inconsistent representations.
137 Without reconciliation, digital consolidation can conceal mismatches. Ownership and revision
138 control should therefore precede automated scoring or predictive analytics.

139 Aramali et al. (2022) review the relationship between earned value research and industrial practice.
140 Readiness assessment should verify budgets, progress rules and cost collection before relying on
141 performance indices. Favorable ratios cannot compensate for unresolved technical constraints or
142 inconsistent contractor measurement practices.

143 Cost performance index equals earned value divided by actual cost; schedule performance index
144 equals earned value divided by planned value. Neither directly establishes completion-date
145 confidence or investment viability. Gate reviewers should verify measurement rules, cost
146 recognition and change treatment before approving the baseline.

147 Dashboards should expose overdue conditions, obsolete revisions, unsupported progress and
148 incompatible procurement dates. Missing information must remain visible. An absent approval
149 differs from approval of an obsolete document: both require attention, but different responses.
150 Reviewers need access to source explanations rather than colors alone.

151 **5.3 Risk integration and mining uncertainty**

152 Faúndez and Guzmán (2025) distinguish price, quantity and time drivers of mining cost deviation.
153 Readiness assessment should similarly separate scope maturity, market exposure and duration-
154 related costs. Contingency can appear sufficient while omitting engineering quantity growth or
155 procurement exposure, so its underlying assumptions require review.

156 Schedule risk analysis should test logic, duration ranges and correlated dependencies using
157 evidence on equipment, methods, access and commissioning. A delayed utility may affect several

158 systems simultaneously. Model assumptions require challenge; acceptable completion confidence
159 should reflect economics and risk appetite rather than a universal threshold.

160 Each material risk needs a cause, affected deliverable, consequence, response, owner and residual
161 exposure. Mitigation requires evidence: identifying a supplier is weaker than obtaining a qualified
162 offer with credible delivery capacity. Reviewers should assess response maturity rather than count
163 risks labelled mitigated.

164 Some uncertainty can be accepted through contingency and accountable response plans. Critical
165 technical, legal, environmental or safety gaps may require resolution before commitment.
166 Mandatory constraints must remain separate from maturity scores, preventing strong financial or
167 schedule results from compensating for an unresolved authorization requirement.

168 Governance research locates investment oversight at several organizational levels. Too and Weaver
169 (2014) connect portfolio choice, sponsorship, PMO oversight and project management, while
170 Biesenthal and Wilden (2014) emphasize the multilevel character of governance. Applied here, this
171 requires escalation rules that distinguish package decisions from investment decisions.

172 Stakeholder relationships also shape evidence acceptance. Derakhshan et al. (2019) identify
173 limitations in the treatment of external stakeholders; Müller et al. (2014) examine organizational
174 enablers and flexibility. Together, these perspectives support involving responsible suppliers and
175 specialist reviewers while retaining clear approval authority.

176 Benefits should remain connected to investment decisions throughout delivery. Musawir et al.
177 (2017) examine governance, benefit management and project success. A digital control record
178 should therefore connect material changes to the investment thesis. Vial (2019) further emphasizes
179 organizational changes surrounding digital transformation, supporting attention to incentives and
180 working practices.

181 Digital twins require precise definition. Kritzinger et al. (2018) distinguish digital models, shadows
182 and twins by integration, while Jiang et al. (2021) distinguish twins from BIM and cyber-physical
183 systems. A periodically refreshed dashboard should consequently be described by its actual
184 capabilities rather than automatically labelled a digital twin.

185 Boje et al. (2020) outline semantic construction digital-twin research, and Opoku et al. (2021)
186 review construction applications across lifecycle phases. These sources support investigating
187 connected representations of scope and progress. They do not establish that a twin reduces Saudi
188 mining overruns or that every capital project requires one.

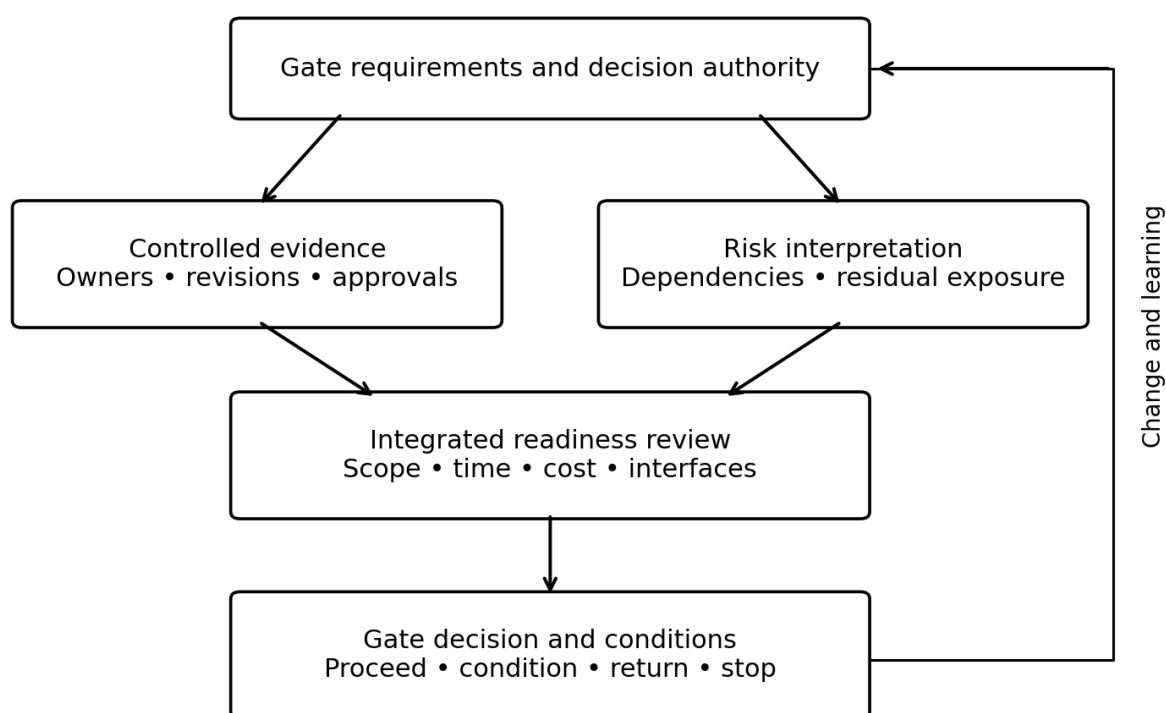
189 Manufacturing literature offers additional transfer considerations. Tao et al. (2018) connect data
190 lifecycles to smart manufacturing, while Soori et al. (2023) review digital-twin applications and
191 challenges. Project-to-operations handover can benefit conceptually from compatible asset
192 identities, but capital-project control and production optimization require different measurement
193 boundaries.

194 Forecast methods also require evaluation before gate reviewers rely on automated predictions.
195 Ottaviani et al. (2024) investigate progress-based forecast factors, and Yalçın et al. (2024) evaluate
196 earned-value-based machine learning. Bahnas et al. (2024) examine blockchain-enabled buffer
197 monitoring. These approaches inform possible extensions of the evidence architecture; none
198 substitutes for verified scope, credible schedules or explicit acceptance of residual risks.

199 6. Proposed integrated execution readiness framework

200 6.1 Evidence architecture

201 The proposed architecture connects five layers: project requirements, controlled evidence,
202 integrated controls, risk interpretation, and gate decisions. Requirements define what must be
203 demonstrated. Controlled evidence records approved documents and accountable sign-offs.
204 Integrated controls establish consistency across scope, cost, time, and procurement. Risk
205 interpretation tests the resilience of those commitments under uncertainty. Gate decisions record
206 authorization, limitations, and follow-up obligations. Figure 2 represents the relationships and
207 feedback paths. The diagram is a conceptual model developed here; it does not describe an
208 implemented system or report empirical causality.



Digital evidence register connects requirements, records, controls and risks

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210 Figure 2 Proposed integrated execution readiness framework. Original conceptual diagram; arrows represent proposed
211 information and decision relationships, not estimated causal effects.

212 The evidence register records each requirement's domain, owner, controlled source, revision,
213 approval, schedule activity, cost account, risk and open condition. It can reference existing
214 platforms rather than replace them. A drawing change should expose linked quantity, procurement,
215 cost and gate consequences instead of appearing as disconnected updates.

216 Engineering certifies technical evidence; controls reconcile scope, time and cost; procurement
217 verifies commitments; risk owners confirm responses; operations assesses handover. The PMO
218 coordinates assurance without replacing specialist authority. Independent reviewers challenge
219 material assumptions, and the investment authority records acceptance of remaining exposure.

220 **6.2 Readiness domains and decision rules**

221 Table 2 defines seven proposed readiness domains: investment case, engineering, schedule and
222 cost, commercial execution, infrastructure and permits, risk response, and operational handover.
223 Domain assessment considers evidence maturity, cross-functional consistency, and unresolved
224 dependencies. A three-state classification can support practical implementation: demonstrated,
225 demonstrated with bounded conditions, or not demonstrated. The middle state requires explicit
226 conditions whose effects are understood. These categories are proposed for piloting; their reliability
227 should be evaluated through independent reviewer agreement before being adopted as
228 organizational policy.

229 Review mandatory constraints, investment validity and domain maturity before assessing
230 interactions among residual conditions. Late equipment selection, incomplete foundations and
231 restricted access may collectively threaten construction despite appearing manageable separately.
232 The decision must explain combined exposure, not merely list individual approvals.

233 Gate outcomes are proceed, proceed with bounded conditions, return for definition, or stop.
234 Conditional approval specifies permitted commitments, blocking conditions and closure authority.
235 Returned projects need clear evidence requirements. Stopped projects should retain decision
236 records and lessons, allowing capital to be redirected responsibly.

237 **6.3 Change control and continuing assurance**

238 Execution changes can alter approved scope or accepted assumptions. Link each material change to
239 gate evidence, costs, schedules, risks and benefits. Routine changes follow delegated authority;
240 changes undermining the investment basis require escalation. Earlier approval remains defensible
241 only while its essential conditions remain sufficiently valid.

242 Continuing assurance should respond to material resource reinterpretation, design changes,
243 infrastructure loss or vendor failure. Targeted review can address affected domains without
244 repeating the entire gate. Lessons from execution should update readiness requirements, including
245 commissioning and operating preparations where repeated deficiencies emerge.

246 **Table 2 Proposed readiness domains and gate evidence**

Domain	Evidence to examine	Blocking concern
Investment case	Benefits, options, sensitivity and assumptions	Invalid value proposition
Engineering	Approved basis, tests and scope interfaces	Unresolved critical technical basis
Schedule and cost	Logic, quantities, estimate basis and risk model	Incompatible baseline assumptions
Commercial execution	Package scope, vendor capability and commitments	Unbounded supply dependency
Infrastructure and permits	Utility interfaces and approval requirements	Missing mandatory authorization
Risk response	Owners, actions, evidence and residual exposure	Unaccepted critical exposure
Operational handover	Commissioning sequence and operating requirements	Unsafe or infeasible handover

247

248 **Table 2 is a proposed assessment structure. It does not reproduce an official Ma'aden procedure.**

Material assumption failure should trigger reassessment before further irreversible commitments. Record the affected benefits, remaining options, committed expenditure and suspension consequences. Preserving this history distinguishes deliberate adaptation from uncontrolled drift. Pilot evaluation should examine whether reassessment occurred promptly and used current evidence. Reviewers should retain disagreement records so later evaluations can distinguish accepted uncertainty from overlooked evidence.

7. Implementation and practical measurement

Begin with a limited pilot spanning different project conditions. Confirm authorized record access and observe readiness before major outcomes occur. Map existing evidence, identifiers and certification responsibilities before procuring software. Test whether traceability improves without disproportionate administrative effort.

Measurement should separate process quality from delivery results. Process indicators include the proportion of gate requirements linked to current approved evidence, unresolved condition age, reconciliation exceptions, decision turnaround time, and reviewer agreement. Delivery indicators include forecast stability, rework arising from incomplete definition, contingency consumption, and milestone deviation. Table 3 presents operational definitions and cautions. Improvements in reporting completeness should not be claimed as reductions in project risk unless the additional evidence changes uncertainty, response effectiveness, or the quality of the authorization decision.

Forecast stability deserves particular attention because a repeatedly revised baseline can hide weak definition. Researchers should distinguish changes caused by approved scope growth from deviations caused by omitted work or inaccurate assumptions. The same distinction applies to cost. A final cost increase may reflect a value-creating expansion rather than poor readiness. Outcome assessment should therefore retain original and revised baselines, change classifications, and the date when the information became available. These records support a more defensible evaluation than comparing final expenditure with the latest approved budget.

Training should address cross-functional evidence, uncertainty interpretation and decision responsibility. Dashboard operation alone cannot resolve governance weaknesses. Establish access controls and confidentiality arrangements for owner and contractor records. Research use requires separate authorization; operational access does not establish permission to publish sensitive project information.

Indicator	Operational definition	Interpretation caution
Evidence coverage	Requirements with current approved evidence ÷ applicable requirements	Completion is not adequacy
Condition age	Elapsed days since condition creation; report median and maximum	Complexity affects closure time
Reconciliation exceptions	Open inconsistencies across linked scope, cost and schedule records	Detection may initially increase counts
Review agreement	Independent classifications agreeing ÷ classifications compared	Agreement is not correctness
Decision time	Days from complete submission to recorded gate decision	Track review effort separately
Forecast stability	Successive forecast changes classified by cause	Scope growth differs from error
Definition-related rework	Verified rework attributed to incomplete pre-execution definition	Requires consistent attribution

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292 **8. Discussion and research propositions**

293 The framework’s central proposition is complementarity. Governance determines whether
294 commitments may be made, digital controls determine whether relevant evidence is connected and
295 inspectable, and risk management determines how uncertain commitments should be interpreted.
296 Each function can be present without the others being effective. Their integration is expected to
297 matter when an approval decision depends on relationships spanning organizational boundaries.
298 This expectation is conceptually grounded in the reviewed themes, but its strength and boundary
299 conditions remain empirical questions rather than established Saudi mining findings.

300 Proposition one states that evidence traceability is associated with more consistent readiness
301 judgments when reviewers have access to comparable source records. Proposition two states that
302 integrated schedule, cost, and risk reconciliation is associated with earlier identification of
303 contradictory delivery assumptions. Proposition three states that mandatory constraints reduce the
304 incidence of authorization despite unresolved critical conditions. Proposition four states that
305 benefits depend on decision authority and specialist participation, rather than software availability
306 alone. These propositions identify observable mechanisms and can be rejected or refined through
307 project-level evidence.

308 Potential counterarguments deserve consideration. Additional review can delay procurement,
309 increase transaction costs, or duplicate existing assurance. Strict evidence requirements may also
310 disadvantage early projects whose uncertainty is legitimate and unavoidable. The proposed answer
311 is proportionality: evidence maturity should match the commitment being authorized. A study-
312 stage gate need not demand construction-level detail, but it should identify which uncertainties
313 require resolution before later commitments. Evaluation must measure the administrative burden as
314 well as decision quality. A framework that identifies more issues but delays every decision
315 unnecessarily may have limited practical value.

316 Another concern is measurement behavior. Teams can optimize indicators by redefining
317 requirements, closing conditions prematurely, or moving uncertain work outside the assessed
318 boundary. Independent sampling and preserved decision records help detect these responses.
319 Researchers should examine whether indicators change underlying behavior or merely reporting
320 presentation. Qualitative interviews can explain why formally compliant projects still experience
321 avoidable failures. Such evidence is especially important when organizational incentives encourage
322 optimistic forecasts or when authority to challenge a gate is weaker than the documented
323 governance structure suggests.

324

325 **9. Empirical validation and future research**

326 A longitudinal comparative design would provide a stronger evaluation than a retrospective
327 satisfaction survey. Projects assessed with the integrated framework could be compared with
328 similar projects using existing assurance arrangements. Matching should consider investment scale,
329 commodity, location, delivery model, technical novelty, and baseline engineering maturity. Where
330 adoption is phased, researchers may examine before-and-after differences while controlling for
331 market and portfolio changes. The analysis should retain unsuccessful, delayed, and cancelled
332 projects to avoid selecting only investments that survived the governance process.

333 The unit of analysis should include both the project and the gate decision. Project outcomes reveal
334 delivery consequences; gate records reveal what decision makers knew and accepted at the time.
335 Combining them allows researchers to distinguish unforeseeable events from information that was
336 available but ignored. Data should include dated evidence registers, independent review comments,
337 risk-model versions, approved baselines, condition closure records, and categorized changes.
338 Interviews can contextualize these records but should not replace contemporaneous evidence when
339 evaluating the quality of authorization.

340 A mixed-method approach could test reviewer agreement, model associations between readiness
341 domains and outcomes, and examine decision episodes qualitatively. Quantitative analysis must
342 report uncertainty and avoid claiming causality from small observational samples. Interview
343 analysis should disclose sampling and coding procedures. Access agreements should protect
344 commercially sensitive technical data and ensure that researchers can report unfavorable findings
345 without identifying confidential projects. These arrangements are prerequisites for credible
346 research, particularly where the participant also holds a professional role within the project
347 organization.

348 Future studies should investigate differences between greenfield development, brownfield
349 expansion, and infrastructure-dependent processing investments. They should also examine
350 whether digital integration increases decision speed after initial adoption costs are absorbed.
351 Another priority is calibration of readiness thresholds using outcomes rather than expert preference
352 alone. Cross-country comparison could establish which mechanisms transfer across mining
353 jurisdictions and which depend on regulatory or organizational context. The Saudi setting offers a
354 relevant application, but the framework should be tested for specificity rather than assuming
355 universal applicability from national strategic ambition.

357 **10. Managerial and policy implications**

358 For project owners, the practical implication is to make readiness evidence inspectable before
 359 commitments become difficult to reverse. PMOs can coordinate the register, standardize
 360 definitions, and monitor exceptions while specialist functions retain certification responsibility.
 361 Investment committees can require explicit treatment of material uncertainty and documented
 362 boundaries for conditional approval. Contractors can improve interface clarity by linking
 363 commitments to controlled technical records and realistic required dates. These practices should be
 364 introduced through proportionate pilots, with administrative effort and decision turnaround
 365 included in the assessment.

366 For policymakers and sector institutions, the framework suggests a capability agenda rather than a
 367 mandatory national software platform. Shared training in front-end assurance, risk interpretation,
 368 and evidence governance could improve professional consistency while allowing different owners
 369 to retain appropriate systems. Research partnerships could develop anonymized benchmarks
 370 without disclosing proprietary resource or process information. Policy relevance lies in
 371 strengthening the credibility of investment delivery and benefit realization. The paper does not
 372 recommend replacing legal approvals or claiming that an internal readiness assessment satisfies
 373 regulatory requirements.

374 **11. Limitations**

375 The review is targeted and integrative rather than exhaustive. Search results and publicly accessible
 376 material cannot substitute for a complete database search or detailed appraisal of every full text.
 377 Several foundational sources originate outside Saudi mining, so transfer depends on context.
 378 Official corporate reporting supplies descriptive evidence only. No project dataset, interviews,
 379 causal estimates, or validated readiness thresholds are presented. Accordingly, statements about
 380 potential improvements describe mechanisms and hypotheses, not demonstrated reductions in cost,
 381 time, or risk. Journal submission should retain these distinctions and expand the evidence base
 382 where required.

383 The proposed architecture also assumes that organizations can maintain reliable identifiers and
 384 specialist accountability across systems. Projects with fragmented contracts, weak data ownership,
 385 or limited review capacity may struggle to implement it. Organizational culture and incentives
 386 could undermine formal procedures even when technical integration succeeds. These factors should
 387 be treated as variables in validation rather than implementation details outside the research model.
 388 The framework's practical value will depend on whether it improves decisions under real resource
 389 constraints, not simply whether its register can be populated.

390 **12. Conclusion**

391 Execution readiness in Saudi mining projects requires a defensible relationship between investment
 392 purpose, delivery evidence, and accepted uncertainty. This paper proposes an integrated framework
 393 in which stage-gate governance establishes decision authority, digital controls connect evidence,
 394 and risk management tests the reliability of planned commitments. Mandatory constraints,
 395 traceable conditions, and continuing assurance preserve the meaning of authorization. The
 396 framework provides a structured basis for piloting and longitudinal research under Vision 2030. Its

effectiveness remains to be tested with authorized project records before improved delivery performance or investment outcomes can be asserted.

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