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Original Research Article

Digital Transformation of Construction Supply Chains through SAP S/4HANA and SAP Ariba: An Integrated Procurement Management Framework for Saudi Vision 2030 Megaprojects

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Abstract: Saudi Arabia's megaproject programme is placing ever greater pressure on the coordination required in construction procurement, with the various demands of design changes, a multitude of dispersed suppliers, complex contractual interfaces and long delivery times all coming into play. While research into digitalisation has identified the potential for improved visibility and collaboration, it is rarely clear from that research how enterprise transaction controls and engagement with external suppliers should be arranged as one integrated process. This integrative review critically reviews 30 publications identified via DOI search between 2020 and 2025 in the areas of construction supply chain management, e-procurement, enterprise integration, supplier governance and sustainable delivery. The evidence was gathered via targeted literature discovery, a backward search of relevant reference lists and source level bibliographic checks. The review distinguishes between the actual challenges that are documented in the literature and the capabilities which could plausibly be realised through the use of SAP S/4HANA and SAP Ariba. Its key contribution is a six-layer procurement management framework which links project requirements through to performance assurance via a set of common data definitions and controlled decision rights. The framework treats financial commitment validation, material traceability, exception management and supplier accountability as interdependent functions rather than as separate software features. A staged adoption pathway and a set of auditable performance indicators are proposed for use in the Saudi megaproject context. As a conceptual review it makes no claim as to the framework having been experimentally validated or as having delivered any quantifiable savings. The review concludes that the value of integration is as much to do with data stewardship, contractual alignment and cross organisational engagement as it is with the functionality of the platform itself.

Keywords: Construction Supply Chains, SAP S/4HANA, SAP Ariba, Digital Procurement, Megaprojects, Saudi Vision 2030, Enterprise Integration.

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1. INTRODUCTION

The procurement system of a construction megaproject is not simply an administrative mechanism for buying stuff. It's the mechanism through which engineering intent becomes a contractual obligation, manufacturing capability becomes a credible promise of delivery and delivery documentation becomes an auditable financial transaction. The fragmentation of the procurement process at these interfaces leads to a range of different forms of loss: duplication of order, specification ambiguity, unrecognised commitments, late supplier mobilisation and poor evidence of conformity. Information dispersion and coordination failure are cited as persistent problems in the construction supply chain literature [1–3], and more recent work has looked at resilience and digital connectivity as potential solutions. The implication is that a credible digital transformation agenda cannot be limited to simply replacing the paper tender with an electronic tender.

Saudi Arabia is a tough environment in which to operate. The Vision 2030 related activity is characterised by huge capital programmes, extensive subcontracting, evolving design packages and material flows sourced from both within the country and from overseas. Research into the Saudi capital projects environment has shown that material delays are often attributable to design documentation errors, poor estimation and price volatility [13]. Tendering research has also demonstrated that incomplete specifications and tender evaluation procedures can have a detrimental effect on the level of competition [12]. The upshot of this is that project risk is present right from the point of the initial design and it continues right through to after the commercial award. Digital systems won't remove those risks, but they can make the approvals, the revisions and the lines of responsibility much more visible if the underlying workflow is correctly designed.

The literature is full of useful stuff but it's all rather disjointed. You've got studies on digital construction procurement looking at the technologies and the sustainable applications [1-23], studies on electronic procurement in Saudi Arabia looking at governance and public procurement [8], and work on circular construction which shows why you need to consider lifecycle material information and purchasing decisions in tandem [9–11]. None of it however provides any actual evidence of a validated end-to-end implementation of SAP S/4HANA and SAP Ariba in a Saudi megaproject contractor. The difference is that general evidence of electronic procurement won't in itself prove that a particular software suite will deliver a specific financial or schedule benefit in a particular programme that has not been studied.

SAP S/4HANA is the proposed system of record for requirements, budgets, purchase commitments, inventory, receipts and accounting. SAP Ariba is the proposed collaborative layer for supplier engagement, sourcing events and the associated procurement workflows. The exact extent of integration between the two will be determined by software editions, licensed functions, configuration and interfaces. The argument being made here is therefore about a defensible process architecture rather than an assumption that all of the named capabilities will operate in a fully automatic fashion. The boundary between the contracting organisations is of particular importance in the review as a technically integrated application can still give rise to organisational silos if the identifiers, permissions and acceptance criteria are not consistent.

The paper makes three contributions. It brings together the disparate evidence on construction and procurement into a coherent diagnosis of the points at which integration has failed. It proposes a process based framework which allocates the control of the process between the two platforms without mixing sourcing decisions with the accounting records. It also provides a set of implementable tests which will allow you to tell the difference between real project level improvement and just increased platform usage. It is of course a model that has been constructed through a process of reasoned synthesis rather than one that has been observed in the field as a deployed system. The intended audience is procurement directors, commercial managers, enterprise architects, project controls people and researchers in the field of large scale construction delivery.

1.1. Aim, Objectives and Review Questions

The objective is to build a robust procurement management framework that explains how SAP S/4HANA and SAP Ariba could work together to improve coordination, accountability and material flow visibility within the supply chains of the Saudi Vision 2030 megaprojects. The inquiry is guided by four objectives: to identify the procurement failures specific to the construction sector; to assess how enterprise and supplier facing processes can mitigate those failures; to define the integration controls and the ownership of decisions; and to produce a fully testable implementation and measurement plan. The core questions are: which procurement interfaces need to be shared; which controls should be kept separate at the organisational level; and what would constitute evidence of improved performance without compromising on

transparency, supplier inclusion or contractual flexibility.

2. REVIEW METHODOLOGY

2.1. Design and Source Identification

An integrative critical review was chosen as the research problem is one that cuts across construction management, digital supply chain architecture and procurement governance and there are very few directly comparable SAP implementations. The approach allows for the conceptual synthesis of qualitative studies, sector reviews and applied research without the need to treat findings from different studies as if they were combinable experimental effect sizes. The documentary corpus consists of 30 papers published between 2020 and 2025. The papers were identified via targeted searches of the publisher's own websites and DOI indexed records using a range of search terms including construction supply chain, digital procurement, supplier management, Saudi Arabia, megaproject, enterprise resource planning, SAP Ariba, sustainability and traceability. The studies referenced in the background papers provided were also reviewed.

2.2. Selection Boundaries and Appraisal

Sources were included if they dealt with a substantive element of the proposed framework: construction logistics or procurement, supplier selection, information integration, governance, lifecycle resource accountability or implementation barriers. Preference was given to peer reviewed journals, sources which employed identifiable empirical methods and reviews with a clearly defined scope. The publication window was applied to the article year rather than the sometimes earlier year contained in the DOI. Each item was checked against a publisher, university repository or scholarly metadata page to confirm title, authorship, year and DOI. Sources from outside the construction sector were only included where they provided otherwise inaccessible technical detail on the subject of SAP procurement integration [28, 29].

This was a deliberately limited evidence sample and not a claim to have covered the entire database. There are no made up screening figures, no inter-rater agreement rates and no pooled statistical estimates. The studies were assessed on research design, context, unit of analysis, mechanism and whether the outcomes as reported could in fact be applied to megaproject procurement. The empirical observations are distinct from the authors' recommendations and from the inferences made in this paper. This is especially important in the case of studies relating to circularity, blockchain or e-procurement in general rather than a production SAP deployment. Those findings inform the design requirements; they are not presented as platform validation.

2.3. Analysis and Synthesis Procedure

A concept matrix was built around six recurring analytical themes: requirements integrity, supplier market engagement, contract and financial control, physical flow visibility, regulatory and sustainability assurance and organisational adoption. Papers were placed in one or more of these themes depending on the decision problem they addressed. Contradictory findings were not simply averaged out but acknowledged. For instance digital networks may enhance traceability but their value diminishes in the absence of supplier involvement and authoritative records [6-21]. The synthesis then went on to turn the supported mechanisms into functional requirements, assign provisional process ownership and develop falsifiable indicators. The architecture that results is therefore an analytical proposition derived from the literature rather than a design science artefact that has been tested.

2.4. Interpretive Safeguards

The evidence matrix separated out national procurement policy from contractor practice and software configuration. It treated the survey results as stakeholder perceptions rather than as controlled estimates of platform effects. Claims on sustainability were assessed on the basis of how they were measured and in what context they were made. Material traceability was only regarded as credible where the documentation could be linked to the actual deliveries. The framework therefore specifies testable controls rather than promising benefits prior to deployment. This distinction prevents the inappropriate transfer of evidence between sectors, contract types and project phases. The source hierarchy serves to protect interpretive validity and explains why findings from procurement policy, observations from a construction project and vendor specific implementation descriptions are not to be treated as equivalent forms of evidence when it comes to the design, evaluation or recommendation of an integrated software solution.

3. Evidence Synthesis

3.1. Structural Characteristics of Construction Procurement

Construction supply chains are very different from the kind of supply chain you'd see in a repetitive manufacturing environment. Demand is a function of design maturity, site conditions and the sequence of work packages. An order might be for a piece of engineered equipment with a very long fabrication cycle, it might be for a commodity material which is going to be replenished on a regular basis, or it might be for a specialist subcontractor's services which are certified as complete in stages. The

uncertainty is all over the place with designers having an influence on the specification, the client having an influence on the approvals, the contractor having an influence on the supplier selection and the logistics provider having an influence on the delivery. The literature is full of references to the continuing weaknesses in the sharing of information and the coordination between the various parties [2-30]. The solution therefore is to have an integrated process which links the transactions to the project and the work breakdown structure rather than simply having a database of supplier invoices.

The issue is particularly problematic when the tender, budget and site systems all use different material numbers. An approved technical revision can get to the engineering team before it gets to the purchasing team and the purchasing team may therefore be committing to an obsolete specification. The same issue arises with supplier delivery dates which are often just recorded as dates without any reference to the actual manufacturing dates or the site being ready to receive the goods. Saudi evidence linking the delays to documentation issues, estimation and lifecycle cost controls underlines the need for clear data definitions at the point of procurement [12, 13]. The value of integration is precisely where a revision has a controlled impact assessment across the schedule, the contract, the budget and the open orders rather than just being a series of ad hoc email requests.

3.2. Digitalisation and the Interoperability Problem

Reviews link digital procurement with the potential for better shared information, better procurement visibility and better coordination, with a caveat that the technologies are often looked at in isolation [1]. Construction supply chain modelling is capable of providing a range of sophisticated optimisation techniques but Chen and Hammad point out that the modelling literature still has a long way to go in terms of dealing with the closure of the supply chain and the actual interaction of the various systems [3]. Digital twins can provide visibility across the supply chain but of course that is predicated on having up to date and reliable operational data [4]. All of this suggests that the architecture should be based on a single, coherent transaction and event model with the dashboards and predictive capabilities being the downstream services that consume that model.

The real practical issue isn't simply whether two systems are exchanging messages. It's whether they're giving the same commercial meaning to the various messages that are exchanged (requests, awards, contract lines, service entries and receipts). For an integration to be audit able every business object has to have an authoritative creator, a defined lifecycle and a reconciliation rule for rejected or amended messages. The procurement problems identified by Gurgun and co-workers are a case in point in terms of the procedural as well as the technological hurdles that organisations face when trying to integrate e-procurement into construction supply chains [7]. The measure of architectural success should therefore be in terms of transaction completeness, exception closure and traceability of approval rather than the number of interfaces installed or the number of users registered.

3.3. Competitive Sourcing and Supplier Governance

Sourcing is an information heavy decision which has to balance technical compliance, delivery credibility, capacity, commercial exposure and supplier capability. Saudi tendering research is very clear on the dangers of incomplete requirements and the perils of a simplistic lowest price approach [12-14]. The same is true of supplier performance assessment studies which highlight the need to have a formalised set of evaluation criteria and to be very careful about the reliability of the evaluators themselves [25]. A supplier facing platform can help with structured submissions, clarification history and consistent bid comparison. The ultimate decision is still going to be driven by the contract rules, the delegated authority and engineering approval. An automated ranking system should not be doing the thinking for you in any way.

Prequalification should also be designed to take account of market development and localisation objectives without blurring the line between eligibility and preferential treatment. The Saudi public procurement scholarship makes a number of points about the interplay between digital tendering, regulatory transparency and industry participation, as well as the difficulties of applying a one size fits all approach to very large, exceptional projects [8]. The framework therefore distinguishes between the qualification gates and the subsequent weighted bid assessment and award process. Supplier records must contain details of the legal entity, any relevant certifications, evidence of ownership and the expiry dates of that evidence. There are also procedures in place for appeals, for disclosure of any conflict of interest and for the documentation of any deviations. Equal access to the portal is of course not sufficient if the requirements placed on smaller subcontractors in terms of documentation and digital onboarding are disproportionately onerous.

The purchasing organisation must separate out supplier identity from project performance. A contractor may be a very good provider of standard materials but may not have the capacity to deliver a specialist package. Master data which is reusable

therefore needs to be augmented with a contextual assessment of fabrication capability, logistics routes, financial exposure and subcontracting dependencies. The review of construction supply chain risk management confirms that risk exposure should be assessed across the supplier network rather than at the individual firm level [5]. In practice an integrated platform would need to be able to show how supplier risk changes after award, for example as a result of a missed inspection, a design change or a delayed progress certificate.

3.4. Commercial Commitment and Physical Delivery

One of the most significant procurement disconnects is between sourcing acceptance and the financial commitment. A winning bid is not necessarily a purchase order that has been authorised and a contract that has been signed may contain variation clauses which are completely invisible to the budget holder. In the proposed arrangement SAP S/4HANA should be the source of the controlled reference for the committed value, the project code, the inventory or service receipt and the financial recognition. SAP Ariba should retain the external market and supplier interaction record. There should be an agreed transfer event which links the accepted bid to the approved purchase instrument with any failed validation being returned for resolution rather than simply being bypassed.

For engineered packages the execution visibility needs to go well beyond dispatch. A useful event chain might be drawing approval, material release, factory acceptance test, shipping documentation, customs milestones, gate receipt, inspection and installation availability. Each event would need a timestamp, an accountable originator and a documentary basis. Bakhshi *et al*., demonstrate the analytical power of digital twin thinking across the construction supply chain [4], and there is a wider body of modelling work which highlights the need to consider the interlinkages [3]. Again, these papers don't in any way suggest that an SAP implementation already has this chain in place. They simply provide the underpinning for the specification of event capture as a verifiable integration requirement.

Goods receipt and service acceptance require a degree of care. You can have a physical delivery in before you have the quality documentation to go with it and you can have a subcontractor's invoice in before you have the work certified. The framework therefore has separate states for logistics arrival, technical acceptance and financial eligibility. Matching logic can be used to flag any discrepancies in quantity, approved price, tax treatment or contract milestone but any disputed work would be escalated to the relevant commercial authority. This maintains the contractual distinction between receipt and acceptance of liability and also removes the incentive to record a receipt simply to clear an invoice exception.

3.5. Resilience and Anticipatory Control

A broken procurement process will typically only spot a shortfall once a schedule activity has failed. The construction supply chain literature is more focussed on resilience attributes (visibility, adaptability and cross party response coordination) [2-5]. The use of integrated data would allow schedule critical materials to be moved into an exception queue when the promised dates, quality approvals and remaining float are no longer in line. The alerts would need to be accompanied by reason codes which would differentiate between supplier fabrication delays, design holds, transport disruption and client approval backlog. The reason for the alert is important as the recovery actions and contractual responsibilities are very different in each case.

Predictive escalation should come after, not in place of, reliable descriptive control. If a delivery forecast is derived from partial commitments or inconsistent work package codes then a pretty model will simply magnify the misleading signals. The literature on digital construction adoption is replete with references to skills, interoperability and the problems of legacy processes as barriers to implementation [21]. The review therefore recommends a threshold based monitoring phase as a pre-requisite to any form of predictive forecasting. Evidence for a later stage of prediction would be in the form of forecast calibration, the level of false alerting and the proportion of management interventions that actually do protect the critical path. The risk scores should be meaningful to the contract admin and planner rather than just the data folk.

3.6. Sustainability and Lifecycle Accountability

Procurement is also the mechanism which determines whether sustainability objectives become binding decisions. The circular construction research shows that the extent to which materials can be reused, the quality of the documentation and the level of supplier coordination all depend on how resources are managed across the asset lifecycle [9–27]. Reviews of the barriers to the circular economy identify weak regulation, lack of awareness and poor data continuity as the key impediments to implementation [16–20]. Sustainability aspects should therefore only be attached to the procurement of an object where the definition of the aspect, the source of assurance and the contractual implications are all clear. Marketing claims that are unverifiable in any way must not be converted into performance

indicators simply because they have been entered onto a platform.

A good example of this would be evidence-led material procurement. A request for structural elements might contain a specification number, approved source, required environmental documentation, inspection plan and potential recovery pathway. The supplier submissions would then be assessed against the specification and the award made on that basis with the evidence of compliance linked to the actual deliveries. Rajabi *et al*., go on to state that sustainability indicators need to be operational in the course of the project [24]. Procurement data can be used to achieve that if the data records both the intended criteria and the actual conformance. The system must clearly distinguish between estimated embodied impacts and actual product level declarations otherwise the project level reporting is going to be highly misleading.

Digitalised circular supply chain research shows how shared object information and traceability can support downstream reuse [6]. Blockchain or immutable registries should not be the default though. An immutable record of incorrect input is still incorrect. The real requirement is a trusted chain of custody between the design, the product you purchase, the batch you receive and the location where it's installed. At that point governance, documented corrections and data portability are far more important design principles than some technological novelty. The proposed framework therefore views sustainability and circularity as bounded assurance processes which procurement can facilitate rather than as benefits which simply accrue from the purchase of an enterprise software solution.

4. Proposed Integrated Procurement Management Framework

4.1. Layers, Ownership and Interfaces

Figure 1 shows six linked control layers. The first defines the engineering requirement and its current version. The second deals with supplier qualification and sourcing. The third takes the evaluated awards and turns them into controlled contract and budget commitments. The fourth layer reconciles the manufacturing, logistics, site receipt and service progress. The fifth layer holds the assurance evidence for quality, safety, local content and sustainability. The sixth layer is the one that brings together the exceptions, ownership and learning across the programme. The sequence is purely conceptual and does not imply that a particular SAP configuration will deliver all of the activities. There will be need for bidirectional change signals as execution information may well require upstream reapproval.

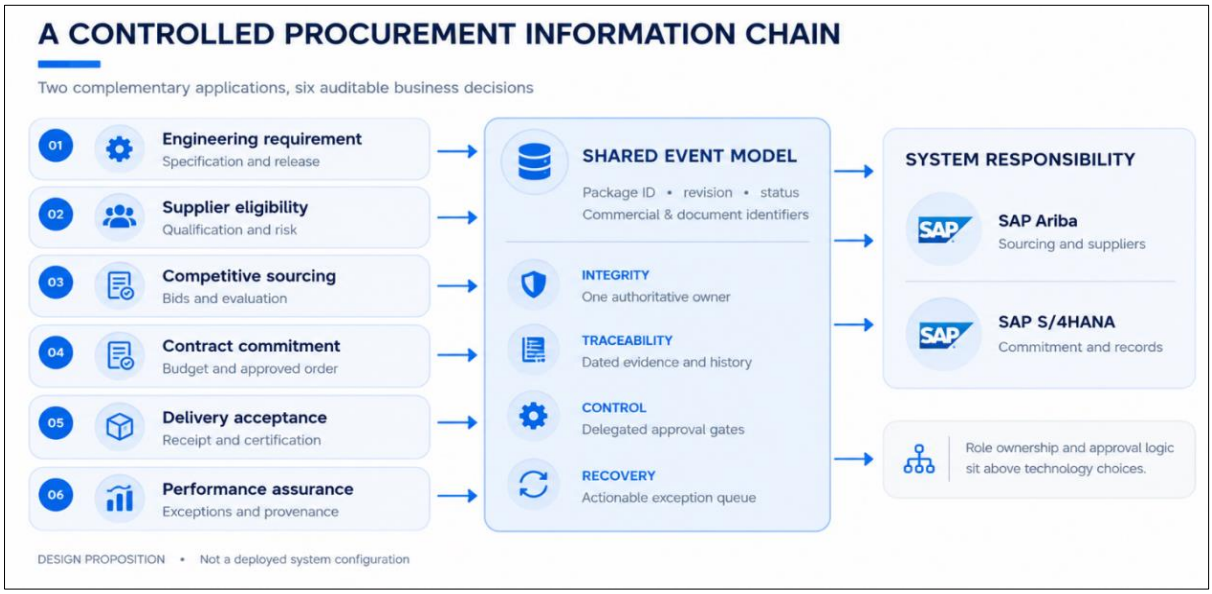


Figure 1: Proposed integration architecture connecting enterprise controls, supplier collaboration and auditable project events. Conceptual illustration developed for this review

Architecture assigns record authority at the process boundary. The Engineering Document Controller owns the released specs; the Procurement team own the tender strategy and award recommendations; the Financial Controller owns the commitment rules; the Site / Quality Authority own the receipt and acceptance; and the Programme Assurance function own the exceptions. Supplier facing activity is in the collaborative system, approved purchasing and accounting transactions are still in the enterprise backbone. There is a canonical package identifier which links the two. A

Master Data Stewards board should resolve any disputes around supplier identifiers, units, cost codes and document versions prior to any automation being considered reliable.

Table 1: Evidence-derived design requirements and associated ownership principles

Control layer	Required record or evidence	Accountable role
Technical baseline	Released specification, revision and project-package identifier	Engineering document control
Supplier eligibility	Valid qualification evidence and risk classification	Procurement governance
Sourcing award	Traceable clarifications, evaluation and authorisation	Sourcing committee
Commercial commitment	Approved contract, coding and purchasing reference	Commercial and finance
Execution acceptance	Milestones, receipts, inspection and exception records	Logistics and site quality
Programme assurance	Documented provenance and verified compliance attributes	Programme assurance

4.2. Transaction Model and Control Gates

A workable integration has to be event driven but not permissionless. The initial request is checked against the published technical baseline and project budget. Competitive sourcing will be conducted in accordance with the organisation's approved tendering procedure. Award selection results in a controlled contract or purchase order request which is then checked in the enterprise system for delegation, coding and commitment availability prior to the actual purchasing reference being issued. Supplier acknowledgements and evidence of execution are then linked to that reference with exceptions of course triggering a formal review. Revision events should identify which of the bids, contracts and deliveries are potentially impacted and decisions should be recorded prior to records being replaced.

Technical implementation will need a very careful approach to message retries, duplicate events and partial failure. If a purchase order update gets through to the supplier network twice the receiving process must be able to identify that it's the same transaction and not create a second obligation. If supplier master data fail validation then the procurement team need to have an actionable exception queue and an escalation time limit. The secure interface design will need to be such that it minimises the amount of personal data that is transmitted whilst still preserving the commercial audit trail. These are all fairly standard interoperability principles as identified in the digital construction research [1-21], and will require a detailed level of validation against the particular SAP deployment and the policies of the contracting organisation.

4.3. Performance Indicators and Staged Implementation

A credible assessment cannot be based just on the % of POs that are processed electronically. The indicators in Table 2 are those that measure process reliability, commercial discipline, supplier outcomes and site performance. Baselines should be established by material category, contracting route, project stage and supplier segment. Pre and post implementation periods should only be compared where the complexity of the periods is similar. A shorter average tender cycle for example is not necessarily a good thing if the level of qualified supplier participation drops or the number of technical clarifications increases post award. The indicators need to be viewed in conjunction with one another and supported by exception narratives.

Table 2: Proposed evaluation indicators, definitions and foreseeable measurement threats

Indicator	Operational definition	Interpretation risk
Award-to-order latency	Days between approved award and valid purchase order	Complexity and approval exceptions
Unmatched receipts	Receipts lacking linked acceptance evidence, as a percentage	Late site recording
Critical-item variance	Days between required date and confirmed availability	Design holds misclassified
Supplier participation	Qualified bids per relevant sourcing event	Category and onboarding differences
Commitment accuracy	Open obligations reconciled with authorised budgets	Unrecorded contract variations
Evidence completeness	Accepted items with required traceability records, percentage	Invalid or obsolete documents

Figure 2 shows a staged approach to adoption starting with data quality and controlled pilot transactions and progressing through to network coverage and anticipatory analytics. The first pilot should be a bounded, repeatable purchase category with a clear owner. The next stage would be to introduce a more complex engineered package to test the waters with revision, inspection and milestone management. At each gate you need to demonstrate successful reconciliation and user adoption before you move on to the next stage. The objective is to work out where decision ownership and data definition breaks down rather than simply to get as many technical features as possible turned on.

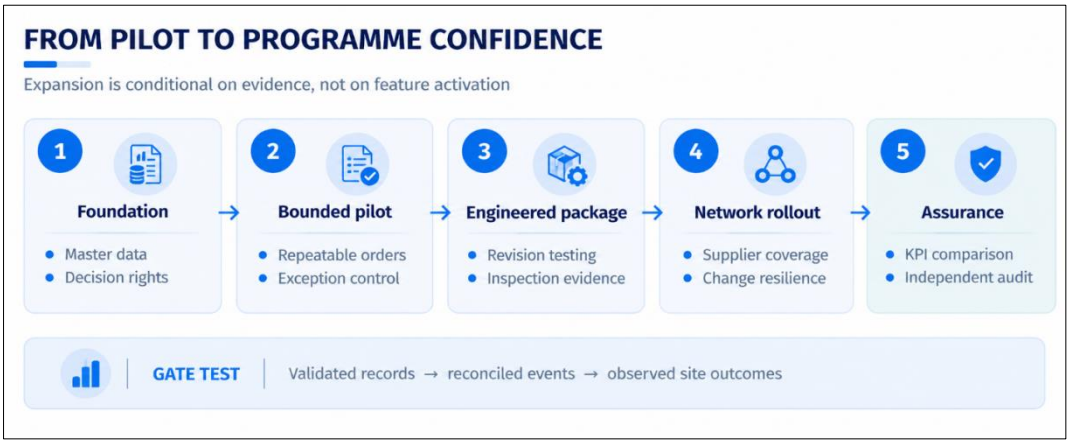


Figure 2: Phased validation pathway from foundational data discipline to programme-scale procurement intelligence. Conceptual illustration developed for this review

5. DISCUSSION

5.1. Theoretical Contribution and Transferability

The framework reorients procurement digitalisation from a focus on the availability of software to the governance of the interdependent decisions that are made. It's an extension of the construction supply chain literature which has long focused on resilience, information integration and lifecycle coordination [1–5]. At its heart is the proposition that operational visibility is derived from sound transaction semantics and acceptance authority rather than from the existence of a dashboard. It also sharpens the digitalisation debate by treating supplier collaboration and financial record keeping as two separate and distinct domains which are complementary. That separation is what gives substance to the concept of accountability: the party that proposes the commercial change is not automatically the party that is entitled to recognise the financial impact of that change.

The framework is most readily transferable in the context of projects which use formal work package structures, have documented commitments and have clearly defined acceptance authorities. The precise form it takes will of course vary from one public client to another, from one development company to another, from one main contractor to another and from one EPC organisation to another. The regulatory discussion in the Saudi electronic procurement literature suggests that institutional arrangements can differ from one procuring entity to another and from one particular project to another [8]. It would therefore be wrong to treat the model as a legal interpretation or as a one size fits all procurement rule. It would need to be adapted following a mapping exercise to determine the specific tender requirements, contract conditions, data hosting requirements and delegated approval limits that apply.

5.2. Tensions, Trade-Offs and Governance Safeguards

Integration brings with it its own set of costs as well as benefits. Standardised master data will of course improve the ability to compare items, but inflexible item structures can be a poor fit for bespoke engineering packages. Greater supplier connectivity may bring more competition, but the onboarding and security requirements may work against smaller suppliers. Automated matching will reduce the amount of clerical effort required, but an inflexible rule could well lead to a payment being delayed for work which is only partially certified. There are a number of studies on procurement constraints, supply chain adoption and supplier evaluation which would all provide reasons to expect such trade-offs [7-25]. The implementation decisions should therefore clearly state which of the exceptions are to remain under the professional judgement of the user and which can be safely processed without any further intervention.

Vendor dependency is also something that needs to be looked at. The article does identify two SAP products as providing a clear architectural

boundary, but the selection of a commercial solution should be the result of functional testing, configuration review and a full cost analysis. It would be completely wrong to suggest that any form of product comparison has taken place in this instance. There are also a number of standalone SAP publications that touch on the potential for automation of the procurement process, but again the methodologies and the contexts in which they operate do not allow any causal conclusions to be drawn for the Saudi construction industry [28, 29]. The framework makes no mention of any promised % savings. Any such figures would only be legitimate once they had been derived from actual operational data (i.e. data on the actual implementation cost, the cost of the disruption to the business and the cost to the supplier).

5.3. Validation Agenda and Limitations

A sensible research programme would start with a process mapping exercise across one developer, one principal contractor and a selection of suppliers. You'd establish baseline handover failure rates, follow a sample of purchase commitments through to site acceptance and test whether the proposed identifiers are robust to variation and partial deliveries. A subsequent comparative multiple case study could then look at different work package types and different organisational contexts. Difference in differences would be an option if you had suitable comparable projects and reliable baseline periods, otherwise you'd be better off with carefully documented longitudinal cases than with an unsubstantiated claim of causation. An independent audit of the source records would be absolutely essential.

This review is of course limited. The 30-source corpus was deliberately constructed and does not in any way represent all the relevant work that has been published in the period. It is heavily skewed towards construction digitalisation, procurement governance and sustainability as no peer reviewed studies were found that actually evaluated the named SAP integration in the Saudi megaprojects. The figures are a depiction of the proposed control logic only; they are not software screenshots, they are not actual deployed configurations. There was no primary data collected, no supplier interviews, no live system data or any form of experimental data. The framework is therefore best viewed as a research proposition and its generalisability, cost and practicality all require empirical testing.

6. CONCLUSION

Procurement transformation needs to link an engineering decision to a supplier obligation, a deliverable event and a financial consequence via an accountable information chain. The literature reviewed confirms the value of integration, supplier governance, resilience and lifecycle assurance but provides no justification for ascribing any of the measured outcomes from the Saudi megaprojects to a specific SAP pairing. The paper proposes a six layer framework which defines where SAP S/4HANA and SAP Ariba could be integrated, which controls should remain with which authorities and how improvement should be measured. The practical implication is that you need to get master data right, design your workflows around the contract and have your suppliers properly involved before you go any further with forecasting. The research implication is a falsifiable, multi actor implementation agenda which tests process reliability and project outcomes rather than platform adoption per se. In those circumstances digital procurement can be viewed as a governance capability that enables the delivery of Vision 2030 rather than as a technological panacea.

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