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Modern Construction Technologies and Project Performance in Saudi Arabia: The Role of BIM and Industrialized Construction under Vision 2030

Neama Hassan Elsayed Omar[1,2]

[1]*Interior Design Department, College of Architecture and design- Alasala Colleges, Dammam 31483, Saudi Arabia1*

[2]*Architecture Department, Bilbeis Higher Institute for engineering, Egypt.* *neama.omar@alasala.edu.sa*

ABSTRACT

Saudi Arabia is delivering one of the world's largest construction programmes under Vision 2030, yet project delivery is still affected by delays, change orders and skills shortages. Building Information Modeling (BIM) and industrialized (offsite) construction are widely proposed as remedies, but the Saudi evidence on their effect has not been consolidated. This article presents a structured review of 15 scholarly sources published between 1995 and 2025: ten on BIM, offsite construction and Industry 4.0 adoption in the Kingdom, and five on delivery performance, workforce and digital transformation. The sources were compared by technology, method, sample and reported findings, then analysed thematically. Three results stand out. First, reported benefits are consistent but perception-based: earlier conflict detection, shorter design cycles, higher productivity and quality, and shorter schedules. Second, three barrier clusters recur across studies: a shortage of skilled personnel, low awareness, and weak demand or policy enforcement. Third, in the records reviewed, no technology study reports before-and-after project outcome data, so the real effect on time, cost and quality remains unquantified. The article links these findings to documented delivery problems in the Kingdom, proposes a conceptual framework, and sets out recommendations for policymakers, contractors and researchers, together with a research agenda centred on measured project-level evidence.

Keywords: Building Information Modeling (BIM); industrialized construction; offsite construction; Construction 4.0; project performance; Vision 2030; Saudi Arabia

1. Introduction

Saudi Arabia accounts for more than half of the value of the Gulf region's construction sector, and the Kingdom will host several global-scale events over the coming decade, including the 2029 Asian Winter Games, Expo 2030 in Riyadh and the 2034 FIFA World Cup (Bower, 2025). Delivering this pipeline alongside giga-projects and housing programmes places heavy pressure on cost, schedule and labour. A market report summarised by TradeArabia (2025) describes a sector that is growing quickly despite labour shortages, rising material costs and long procurement lead times, with most clients now investing in digital tools to streamline delivery and ease workforce limits.

Two families of technology are central to this response. The first is Building Information Modeling (BIM), a shared digital model used for planning, design, construction and operation. The second is industrialized or offsite construction, in which building components are manufactured and pre-assembled away from the site, in forms ranging from panelised and hybrid systems to fully modular units (Almutairi et al., 2017). Both sit within the wider Construction 4.0 agenda, which adds automation, artificial intelligence and the Internet of Things (Alsehaimi & Sanni-Anibire, 2024).

Research on these technologies in the Kingdom has grown, but it is fragmented. BIM studies mostly examine adoption barriers (Al-Hammadi & Tian, 2020; Alshibani et al., 2024; Iqbal et al., 2025). Offsite studies examine drivers and implementation strategies (Almutairi et al., 2017). Housing-policy work evaluates national incentives for building technology (Alzamil & Alangari, 2020). No single source brings these strands together or asks what they jointly show about delivery performance, which is what owners and regulators ultimately care about.

This article addresses that gap. It reviews the Saudi evidence on BIM, offsite construction and Industry 4.0 adoption, relates it to the delivery problems documented in earlier Saudi studies, and identifies what is still unknown. Its contribution is threefold: a consolidated map of the evidence, an analytical

link between technology mechanisms and recurring causes of poor project performance, and a research agenda for measured, project-level studies.

2. Research Problem

Saudi construction has struggled with schedule and cost control for decades. Assaf and Al-Hejji (2006) surveyed contractors, consultants and owners and reported that about 70% of projects experienced time overruns, with change orders named as the most common cause by all three parties. Earlier work on large building projects found financing problems ranked highest by all parties (Assaf et al., 1995). More recent evidence is similar: a master's study of infrastructure projects lists lack of finance, poor communication, inadequately skilled labour and slow decision-making as major causes, and cost overrun, time overrun and disputes as the main effects (Alharbi, 2020). Industry reporting adds that more than half of contractors set aside as much as 10% of construction budgets for contingencies such as replacing damaged materials and redoing work (Bower, 2025).

BIM and offsite construction target exactly these failure modes: coordination errors, late design changes and slow, labour-dependent site work. Yet the Saudi literature does not show whether they deliver. Adoption studies repeatedly find limited uptake despite policy attention: BIM has been mandated in the public construction sector, but its adoption remains limited (Alshibani et al., 2024). The problem this article addresses is therefore twofold:

1. **Evidence problem.** Findings on BIM, offsite construction and Industry 4.0 in Saudi Arabia are scattered across studies with different methods and samples, and no synthesis relates them to delivery performance.

2. **Measurement problem.** It is unclear whether the reported benefits come from measured project outcomes or from practitioners' perceptions, which limits their usefulness for policy and investment decisions.

3. Research Objectives and Questions

The study aims to consolidate what is known about how modern construction technologies relate to project delivery performance in Saudi Arabia. Its specific objectives are:

1. To map the published Saudi evidence on BIM, offsite construction and Industry 4.0 adoption by technology, method and sample.

2. To synthesise the benefits and barriers these studies report.

3. To relate the reported benefits to the recurring causes of poor delivery performance documented in earlier Saudi studies.

4. To identify evidence gaps and propose recommendations and a research agenda.

The objectives are operationalised through three research questions:

- **RQ1.** What benefits of BIM and offsite construction do Saudi studies report, and how were they established?

- **RQ2.** Which barriers to adoption recur across studies, and how do they relate to policy and workforce conditions?

- **RQ3.** How do the technologies' mechanisms map onto the documented causes of delay and cost overrun, and what evidence is missing?

4. Methodology

The study is a structured narrative review. It does not collect primary data, and every finding reported below comes from the cited sources.

Search. Targeted searches were run in November 2026 through publicly indexed scholarly sources, including publisher sites, university and national repositories (such as the Saudi Digital Library) and open-access journals. Search terms combined "Saudi Arabia" with BIM, building information modeling, offsite construction, modular construction, prefabrication, Construction 4.0, Industry 4.0, construction delay, Saudization and digital transformation.

Inclusion criteria. A source was included if it (a) concerned the Saudi construction sector, (b) addressed BIM, offsite or industrialized construction, Industry 4.0 technologies, delivery performance, or workforce and digital capability, and (c) was a journal article, conference paper or university thesis. Preprints without peer review were excluded. Trade press (Bower, 2025; TradeArabia, 2025) was used only for sector context, never as evidence of technology effects.

Corpus. Fifteen scholarly sources met the criteria: ten technology-focused studies and five studies of delivery performance, workforce and digital transformation. Five of the fifteen are university theses, which are not journal-peer-reviewed; they are flagged in Table 1.

Analysis. For each source the technology, method, sample and main findings were extracted. Findings were then coded into three themes (reported benefits, recurring barriers, and policy implications) and compared against the delay and cost-overrun causes documented in the context studies. Where the article links a technology mechanism to a documented problem, the link is an analytical proposition and is labelled as such; it is not an empirical result.

Limits of the review process. Records were screened mainly through abstracts and bibliographic entries, because several full texts are behind paywalls. The search was not run as a formal PRISMA protocol across Scopus or Web of Science, so coverage may be incomplete. A publication-ready version should repeat the search in those databases and report the PRISMA flow.

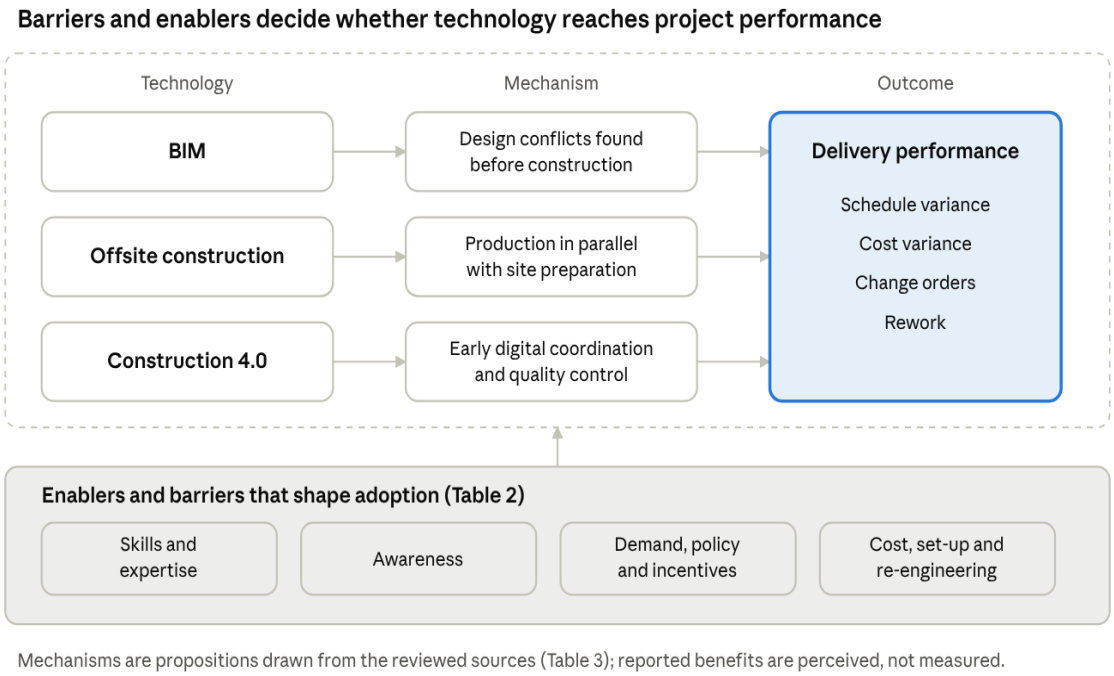
5. Conceptual Background

BIM. BIM is a shared-data workflow built on 3D models and used for planning, design, construction and management. Saudi researchers connect it to Vision 2030 as a digital-transformation lever and note that practices developed in mature markets may not fit the Kingdom's industry structure without adaptation (Iqbal et al., 2025; Al-Yami & Sanni-Anibire, 2021). Policy has moved over time. An early review found no policy initiatives to enforce BIM in the Kingdom (Al-Yami & Sanni-Anibire, 2021), while a 2024 study reports that BIM is now mandated in public construction yet still lightly adopted (Alshibani et al., 2024). One proposal is a national Saudi BIM authority with a dedicated taskforce to guide gradual adoption (Mostafa, 2023).

Offsite and industrialized construction. Offsite construction moves part of the work from the site to a controlled production setting. A Saudi doctoral study identifies four main techniques in the Kingdom: offsite pre-assembly, hybrid systems, panelised systems and modular construction (Al-Mutairi, forthcoming). The Ministry of Housing's Building Technology Stimulus Initiative was created to meet high housing demand and has been assessed for its social, economic and environmental effects against Vision 2030 (Alzamil & Alangari, 2020).

Construction 4.0. The wider Industry 4.0 agenda includes automation, analytics, artificial intelligence and connected devices. Alsehaimi and Sanni-Anibire (2024) note that implementation in emerging economies such as Saudi Arabia is still at an early stage and develop a model of benefits, challenges and critical success factors for it.

Analytical lens. The review treats technology adoption as a chain: a technology works through specific mechanisms (for example, early clash detection or parallel factory production), which may improve time, cost and quality outcomes, while enablers and barriers such as skills, awareness and policy shape whether the chain operates at all.



conceptual framework · synthesis of the reviewed sources

Figure 1. Conceptual framework. Each technology works through a specific mechanism toward delivery performance, and the four barrier clusters from Table 2 shape whether that chain operates.

6. Findings

The Saudi evidence reports consistent benefits for BIM and offsite construction, identifies the same three barriers across studies, and rests almost entirely on practitioner perceptions rather than measured project outcomes.

6.1 The evidence base

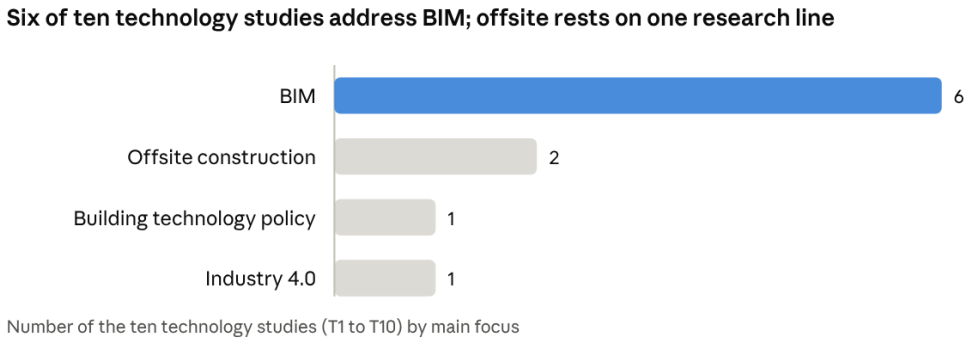
Table 1 lists the fifteen sources. Technology studies are numbered T1 to T10 and context studies C1 to C5. Theses are marked (thesis).

Table 1. Reviewed sources

ID	Source	Focus	Method and sample	Main reported finding
T1	Al-Yami & Sanni-Anibire (2021)	BIM	Literature overview and pilot-project case study; BIM team questionnaire analysed by relative importance index (RII)	No policy initiatives enforcing BIM; top benefit is detecting inter-disciplinary conflicts in drawings; top barrier is the need to re-engineer projects
T2	Al-Hammadi & Tian (2020)	BIM	Questionnaire, 228 responses, RII	Top barriers: lack of demand (RII 89.9), lack of experts (88.5), poor awareness of benefits (87.1)
T3	Alshibani et al. (2024)	BIM	Literature review, expert meetings, 69 responses (RII), interpretive structural modelling (ISM)	Top driving barrier is lack of skilled and experienced personnel, then lack of awareness, communication issues and longer set-up time
T4	Iqbal et al. (2025)	BIM	Fuzzy Delphi, ISM and MICMAC (expert-based)	Main driving forces: reduced design-cycle time and efficient construction planning and management
T5	Mostafa (2023)	BIM	Framework study	Proposes a national Saudi BIM authority with a dedicated taskforce for gradual adoption
T6	Alsofiani (2023) (thesis)	BIM, infrastructure	Method not stated in the record	Examines impediments to BIM adoption in infrastructure projects
T7	Almutairi et al. (2017)	Offsite	Questionnaire survey	Benefits: labour productivity, product quality, shorter schedule; challenges: inflexible on-site changes, limited design options, cost and risk, low awareness, resistance
T8	Al-Mutairi (forthcoming) (thesis)	Offsite	Mixed methods: 6 expert interviews, 136 questionnaires, ISM validation	Four main techniques; implementation factors go beyond time and cost to quality, environmental impact and perceptions
T9	Alzamil & Alangari (2020)	Building technology policy	Descriptive analysis of policy reports and a survey of 72 specialists	Proposes gradual transition to building technology in Ministry of Housing projects and incentives for private investment with international firms
T10	Alsehaimi & Sanni-Anibire (2024)	Industry 4.0	Confirmatory factor analysis	Theoretical model of benefits, challenges and critical success factors
C1	Assaf & Al-Hejji (2006)	Delay causes	Survey of 23 contractors, 19 consultants, 15 owners	About 70% of projects overran; change orders the most common cause

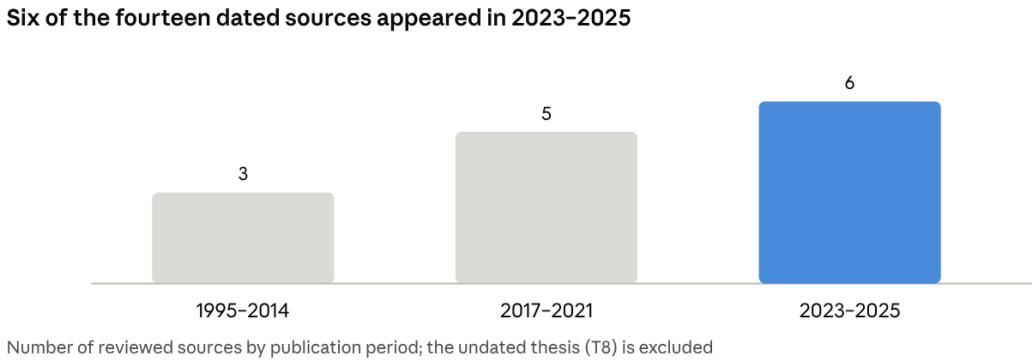
ID	Source	Focus	Method and sample	Main reported finding
C2	Assaf et al. (1995)	Delay causes, large buildings	Survey of 24 contractors, 15 A/E firms, 9 owners	Financing factors ranked highest by all three parties
C3	Alharbi (2020) (thesis)	Delay, infrastructure	Surveys and interviews with project managers	Causes include lack of finance, poor communication, unskilled workforce, slow decisions
C4	Almami (2014) (thesis)	Saudization	Mixed methods; 479 construction companies surveyed	Adopting Saudization was associated with higher productivity and other benefits
C5	Alruwaili (2025) (thesis)	Digital transformation	Structured questionnaire	Lack of professional training is the strongest obstacle

Two features of the corpus matter for interpretation. BIM dominates: six of the ten technology studies address it. Offsite construction is represented by one author, through a survey paper (T7) and the linked doctoral thesis (T8).



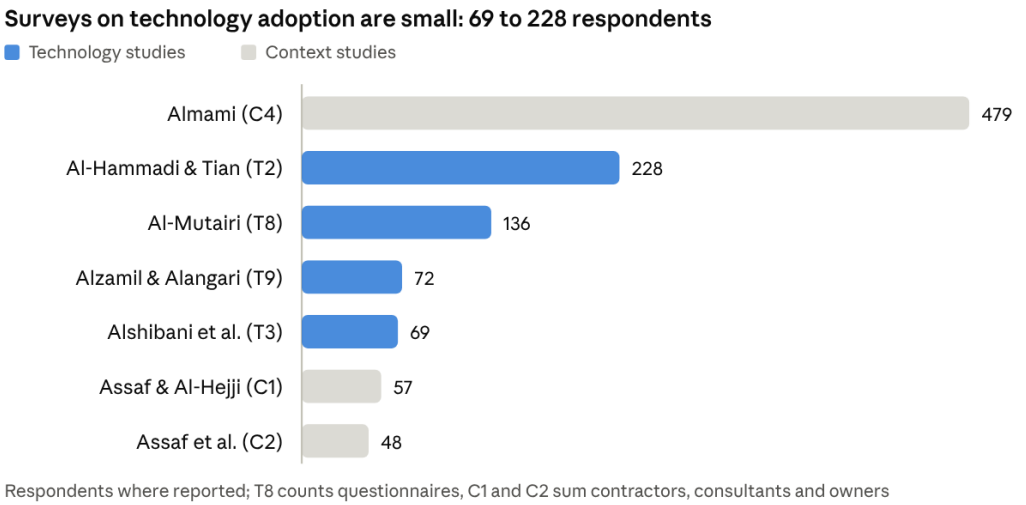
count of T1 to T10 by main focus · this review

Figure 2. Technology focus of the ten technology studies.



publication years of the sources in Table 1 · this review

Figure 3. The evidence is recent: six of the fourteen dated sources were published from 2023 onward.



sample sizes reported in the sources in Table 1

Figure 4. Sample sizes of the surveys in the corpus. Small samples limit how far the technology findings can be generalised.

6.2 Reported benefits (RQ1)

For BIM, the benefits reported are early detection of conflicts between disciplines, which reduces errors and protects design intent (T1), and shorter design cycles with more efficient planning and management, which experts rank as the main reasons to adopt it (T4). For offsite construction, practitioners report higher labour productivity, better product quality and shorter overall schedules (T7).

The basis of these claims is the key finding. The technology studies rely on questionnaires, expert panels and structured modelling techniques (T1 to T4, T7 to T10). In the records reviewed, none reports a before-and-after or matched comparison of project time, cost or quality. The benefits are therefore best read as informed expectations, not measured effects.

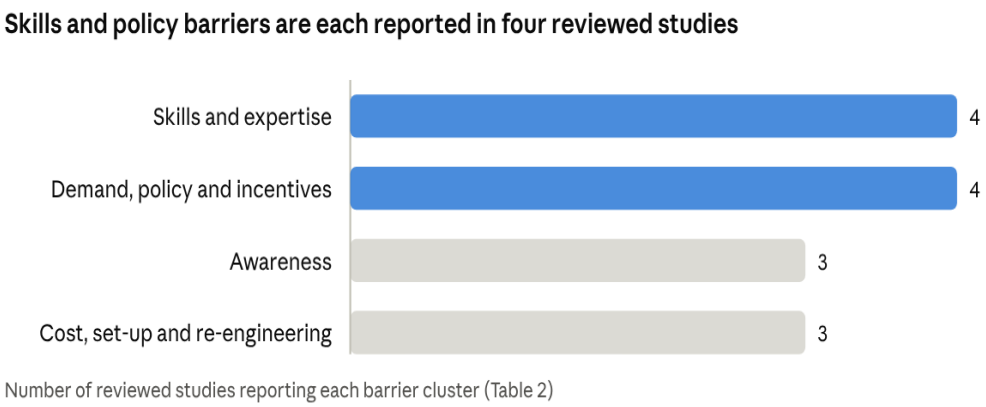
6.3 Recurring barriers (RQ2)

Three barrier clusters recur across independent studies, and a fourth appears for offsite and BIM set-up (Table 2).

Table 2. Barrier clusters and the studies that report them

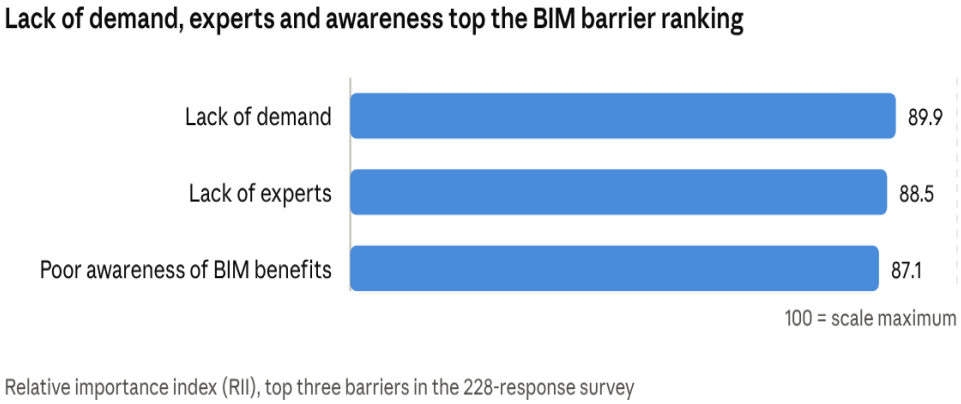
Barrier cluster	Reported in	Evidence
Skills and expertise	T2, T3, C3, C5	Lack of experts (T2); lack of skilled personnel is the top driving barrier (T3); inadequately skilled workforce (C3); lack of training (C5)
Awareness	T2, T3, T7	Poor awareness of benefits (T2); lack of awareness (T3); low awareness of offsite techniques (T7)
Demand, policy and incentives	T1, T2, T3, T9	No enforcement policy at the time (T1); lack of demand (T2); incentives proposed for private investment (T9) and for contractors and consultants (T3)
Cost, set-up and project re-engineering	T1, T3, T7	Need to re-engineer projects (T1); longer set-up time (T3); cost, risk and limited flexibility for on-site change (T7)

The policy cluster is changing. T1 found no enforcement policy, whereas T3 reports a public-sector BIM mandate with limited adoption. A mandate alone appears insufficient while the skills and awareness barriers remain.



cluster counts from Table 2 · this review

Figure 5. How many reviewed studies report each barrier cluster.



Al-Hammadi & Tian (2020), BIM barriers survey, 228 responses

Figure 6. The three highest-ranked BIM adoption barriers in the Saudi survey by Al-Hammadi and Tian (2020), which show how close their importance scores are.

6.4 Workforce and capability

The context studies show that skills are a delivery issue as well as an adoption issue. Inadequately skilled workforce appears among the causes of infrastructure delay (C3), and lack of professional training is the strongest obstacle to digital transformation in engineering project management (C5). A study of 479 construction companies associates Saudization with higher productivity (C4). Taken together, these suggest that localisation and technology-skills policies would work better if planned jointly, although no reviewed study tests that combination.

6.5 What is missing (RQ3, part 1)

The corpus lacks four things: measured project-level outcomes for BIM or offsite construction; studies that treat BIM and offsite construction together; offsite evidence beyond a single research line; and any study that tests whether the barrier clusters in Table 2 predict actual project performance.

7. Discussion

The technologies promoted in Saudi Arabia are aimed at the problems the delay literature has documented for thirty years, but the link between the two is still an expectation, not a demonstrated result. Table 3 sets the documented problems beside the mechanism through which each technology could help and the Saudi evidence available. The mechanisms are analytical propositions drawn from the reviewed sources, not tested findings.

Table 3. Documented delivery problems, technology mechanisms and available Saudi evidence

Documented problem	Possible technology mechanism (proposition)	Saudi evidence available
Change orders as the most common cause of delay (C1)	BIM coordination removes design conflicts before construction	Perceived conflict-detection benefit (T1); effect on change-order counts not measured
Poor communication and coordination (C3)	Shared digital model and structured information exchange	Not tested; communication issues are listed as a barrier to BIM adoption itself (T3)
Schedule overrun (C1)	Offsite production proceeds in parallel with site work	Perceived schedule reduction (T7); no schedule data
Inadequately skilled workforce (C3)	Factory-based, standardised work reduces dependence on site skills	Higher productivity reported (T7), but skills shortage is also the top barrier to BIM (T3)
Rework and contingency allowances of up to 10% of budgets (Bower, 2025)	Early digital coordination and quality control	Not tested in the reviewed studies

Three interpretations follow.

Technology and its barriers share a root. Poor communication, weak skills and slow decisions are both causes of delay (C3) and obstacles to adopting the tools meant to fix delay (T2, T3, C5). Technology alone cannot break this loop. Capability building has to run alongside, or ahead of, adoption.

Mandates are necessary but not sufficient. The shift from no enforcement (T1) to a public-sector BIM mandate with limited uptake (T3) suggests that regulation changes behaviour only when contractors and consultants have the skills and the awareness to comply. The incentive proposals in T3 and T9 and the national authority proposed in T5 point the same way: gradual, supported transition rather than abrupt obligation.

BIM and offsite construction are likely complements. Offsite construction is limited by inflexibility to on-site change and by design options (T7). Early BIM coordination could reduce late changes, which would make factory production more workable. No reviewed study tests this complementarity, and it is the most promising unexamined question in the corpus.

These interpretations should be read within the limits of the evidence. Most findings come from perception surveys, expert panels and modelling of expert judgement, and five of the fifteen sources are theses. The conclusions concern the state of the evidence and the plausibility of mechanisms, not proven effects on performance.

8. Recommendations

The recommendations follow from the recurring barriers (Table 2) and the evidence gaps (Section 6.5). Each is tied to the sources that motivate it.

For policymakers and regulators

1. **Pair mandates with capability.** Link BIM requirements to funded training and incentives for contractors and consultants, because lack of skills and awareness are the leading barriers (T2, T3, C5) and incentive programmes are explicitly proposed (T3, T9).

2. **Create a national coordinating body and standards.** A Saudi BIM authority with a dedicated taskforce, as proposed in T5, would give gradual adoption an owner and a single reference point.

3. **Require outcome reporting on pilot projects.** Publicly funded BIM and offsite pilots should report standard indicators (schedule variance, cost variance, change orders, rework) so that policy rests on measured results. This responds to the measurement gap identified in Section 6.2.

4. **Plan localisation and technology skills together.** Saudization programmes (C4) and digital-skills training (C5) should be designed jointly, so that new technologies expand skilled national employment instead of competing with it.

For contractors, consultants and owners

5. **Start with a pilot and train around it.** Begin with a bounded pilot project, as lack of experienced personnel and the need to re-engineer projects are the main practical barriers (T1, T3).

6. **Plan offsite work around its constraints.** Because offsite construction suffers from inflexibility to on-site change and limited design options (T7), design decisions should be frozen earlier and procurement aligned with factory lead times. This is an inference from T7 and should be tested.

7. **Measure from day one.** Record baseline and actual time, cost and rework on technology-enabled projects, so that internal evidence builds up alongside the public record.

For researchers and research centres

8. **Move from perceptions to project data.** Use matched or before-and-after comparisons of BIM and non-BIM, and offsite and conventional, projects.

9. **Test complementarity.** Study BIM and offsite construction together, starting with whether BIM coordination reduces the late changes that offsite systems tolerate poorly.

10. **Broaden the evidence.** Replicate barrier studies with larger, more representative samples, including giga-project contractors, and extend offsite research beyond a single research line.

Table 4. Proposed indicators for pilot-project reporting (Recommendation 3)

Indicator	Suggested definition	Documented problem it addresses
Schedule variance	(Actual duration − planned duration) ÷ planned duration	Time overruns (C1)
Cost variance	(Final cost − budgeted cost) ÷ budgeted cost	Cost overrun and disputes (C3)
Change orders	Number and value of change orders per project	Most common cause of delay (C1)
Rework	Cost of rework as a share of contract value	Contingency allowances of up to 10% of budgets (Bower, 2025)
Training hours	Technology-training hours per project team member	Skills shortage (C3, C5)

The definitions are this review's proposal and do not come from the cited sources.

9. Limitations and Future Research

This review has five limitations. First, the search was targeted rather than a full PRISMA protocol across Scopus and Web of Science, so relevant studies may be missing. Second, several sources were assessed through abstracts and bibliographic records because full texts were not accessible, which limits the detail extracted. Third, five of the fifteen sources are theses and have not passed journal peer review. Fourth, the corpus is uneven: BIM is well represented, while offsite construction rests on one research line and 3D printing, robotics and AI are not covered in depth. Fifth, the technology-to-performance links in Table 3 are propositions and not empirical results.

Future work should (a) repeat the search in Scopus and Web of Science with a documented PRISMA flow, (b) collect project-level outcome data to estimate the real effect of BIM and offsite construction on time, cost and quality, (c) test the BIM and offsite complementarity proposed in Section 7, and (d) examine how skills, awareness and policy variables moderate those effects. A survey-based follow-up study that measures these variables across a representative sample of Saudi contractors would be a natural next step.

Table 5. Proposed research agenda

Evidence gap (Section 6.5)	Proposed study design	Data needed
No measured project outcomes	Matched comparison of BIM and non-BIM projects, and of offsite and conventional projects	Planned and actual schedule, budget, change orders, rework
BIM and offsite studied separately	Case studies of projects that use both	Design-change logs, factory lead times, site schedules

Evidence gap (Section 6.5)	Proposed study design	Data needed
Thin offsite evidence	Mixed-methods survey and interviews across regions and building types	Practitioner survey, contractor and factory records
Barriers not linked to performance	Survey with structural equation modelling linking skills, awareness and policy to project indicators	Barrier ratings plus project indicators from Table 4

References

Al-Hammadi, M. A., & Tian, W. (2020). Challenges and barriers of building information modeling adoption in the Saudi Arabian construction industry. *The Open Construction and Building Technology Journal*, *14*, 98–110. https://doi.org/10.2174/1874836802014010098

Alharbi, W. H. (2020). *Causes and effects of delays on infrastructure construction projects in the Kingdom of Saudi Arabia (KSA)* [Master's thesis]. Saudi Digital Library. https://drepo.sdl.edu.sa/handle/20.500.14154/46407

Al-Mutairi, Y. (forthcoming). *Development of implementation strategies for offsite construction techniques in the Kingdom of Saudi Arabia* [Thesis]. University of Salford. https://salford-repository.worktribe.com/output/1411073

Almami, A. (2014). *Investigating the antecedents and consequences of Saudization in the construction sector* [Thesis]. University of Plymouth. https://doi.org/10.24382/3497

Almutairi, Y., Arif, M., & Khalfan, M. M. A. (2017). Development of implementation strategies for offsite construction techniques in the Kingdom of Saudi Arabia. *International Journal of Business Competition and Growth*, *6*(1), 12–27. https://doi.org/10.1504/IJBCG.2017.10008492

Alruwaili, A. A. (2025). *The impact of digital transformation in the management of engineering projects in the Kingdom of Saudi Arabia* [Thesis]. Jadara University. https://hdl.handle.net/20.500.14154/76806

Alsehaimi, A. O., & Sanni-Anibire, M. O. (2024). Industry 4.0 technologies: An examination of benefits, challenges and critical success factors for implementation in the Saudi construction industry. *Construction Innovation*. https://doi.org/10.1108/CI-01-2024-0001

Alshibani, A., Aldossary, M. S., Hassanain, M. A., Hamida, H., Aldabbagh, H., & Ouis, D. (2024). Investigation of the driving power of the barriers affecting BIM adoption in construction management through ISM. *Results in Engineering*. https://doi.org/10.1016/j.rineng.2024.102987

Alsofiani, M. (2023). *Impediments to adopting building information modeling in Saudi Arabian infrastructure projects* [Thesis]. Texas A&M University. https://drepo.sdl.edu.sa/items/10ad440c-7ee2-4b6d-a656-e49772cd9fa5

Alzamil, W., & Alangari, N. (2020). Evaluating the Building Technology Stimulus Initiative offered by Ministry of Housing within the Kingdom's Vision 2030. *Journal of Sustainable Development, 13*(4), 115–128. https://faculty.ksu.edu.sa/en/waalzamil/publication/321994

Al-Yami, A., & Sanni-Anibire, M. O. (2021). BIM in the Saudi Arabian construction industry: State of the art, benefit and barriers. *International Journal of Building Pathology and Adaptation*, *39*(1), 33–47. https://doi.org/10.1108/IJBPA-08-2018-0065

Assaf, S. A., & Al-Hejji, S. (2006). Causes of delay in large construction projects. *International Journal of Project Management*, *24*(4), 349–357. https://pure.kfupm.edu.sa/en/publications/causes-of-delay-in-large-construction-projects/

Assaf, S. A., Al-Khalil, M., & Al-Hazmi, M. (1995). Causes of delay in large building construction projects. *Journal of Management in Engineering*, *11*(2), 45–50. https://pure.kfupm.edu.sa/en/publications/causes-of-delay-in-large-building-construction-projects/

Bower, E. (2025, May 26). AI adoption could help meet ambitious Vision 2030 targets. *AGBI*. https://agbi.com/analysis/ai/2025/05/ai-adoption-could-help-meet-ambitious-vision-2030-targets

Iqbal, M., Ullah, I., Abdou, H., Alzara, M., & Yosri, A. M. (2025). Blueprint for progress: Understanding the driving forces of BIM adoption in Kingdom of Saudi Arabia (KSA) construction industry. *PLOS ONE*, *20*(2), 1–24. https://doi.org/10.1371/journal.pone.0313135

Mostafa, A. (2023). Towards a framework for BIM adoption in Saudi Arabia: An initiation to establish "Saudi BIM Authority". *Journal of Al-Azhar University Engineering Sector*, *18*(66), 323–337. https://doi.org/10.21608/auej.2023.283079

TradeArabia. (2025, September 15). Saudi construction sector enters next phase of transformation. https://tradearabia.com/News/298415/Saudi-construction-sector-enters-next-phase-of-transformation