

**BEYOND THE STATIC RISK REGISTER:
RISK GOVERNANCE AND CASCADING FAILURE ACROSS
SAUDI ARABIA'S VISION 2030 GIGA-PROJECTS**

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Abstract

This thesis examines why static, decomposable risk-management frameworks fail to anticipate the scale of cost and schedule variance documented across Saudi Arabia's Vision 2030 giga-project programme. Framed against Flyvbjerg's Iron Law of Megaprojects, the study argues that the divergence between initial baselines and mid-2026 documented outcomes is not a set of isolated execution failures. NEOM's cost trajectory moved from roughly \$500 billion to an industry-reported, single-source upper-bound scenario of \$8.8 trillion. The Line's footprint contracted from a planned 170 kilometres to an expected 2.4 kilometres by 2030. Six Flags Qiddiya opened three years behind its original 2022 target. Together, these outcomes reflect the structural consequence of applying static, independent-item risk registers (ISO 31000, PMBOK) to a complex, tightly interdependent system.

Using a multiple, comparative case-study design built entirely on secondary and documentary sources, the thesis traces the documented risk trajectories of four contracting and consultancy firms holding roles on Saudi giga-projects: Bechtel, AECOM, Arcadis, and Saudi Binladin Group. The Public Investment Fund is treated separately, as an exogenous, macro-level validator rather than a fifth comparable case. Its own 2024 annual report disclosed an \$8 billion giga-project writedown, evidence that the same risk dynamics reach the sovereign financier itself. Each case was coded for the type of risk documented, the level at which it materialised (project, firm, or financier), and its ultimate outcome: continuation and portfolio expansion for Bechtel and AECOM, full regional exit for Arcadis, and a decade-long slide from a 2015 site accident into a state-supervised financial rescue that raised the Ministry of Finance's equity stake in Saudi Binladin Group to 86.38 percent by December 2025.

Drawing on complexity theory (Baccarini, 1996; Williams, 2002), normal accident theory (Perrow, 1984), prospect theory (Kahneman & Tversky, 1979), and antifragility (Taleb, 2012), the thesis interprets these findings as evidence that giga-project risk cascades across contractual and organisational boundaries in ways a static risk register cannot represent. It proposes structural refinements toward a more dynamic risk governance framework: portfolio-level exposure limits, continuous contractual monitoring, and cross-programme dependency mapping. The findings establish an association, not a proven causal claim; the design relies on secondary sources alone. They are offered as a documented starting point for further, primary-data research into Saudi giga-project risk governance.

Table of Contents

Abstract	i
Chapter 1: Introduction	1
1.1 Background and the Giga-Project Context.....	1
1.2 The Limits of Conventional Project Governance	2
1.3 Research Objectives	4
1.4 Case Selection and Scope.....	4
1.5 Structure of the Thesis	6
Chapter 2: Literature Review.....	6
2.1 Megaprojects and the Iron Law of Overruns	6
2.2 Complexity Versus Complication in Project Systems.....	7
2.3 Behavioural Drivers of Risk Misjudgment	9
2.4 Traditional Risk Frameworks and Their Limits	10
2.5 Dynamic and Predictive Risk Assessment Approaches.....	10
2.6 Contracting and Consultancy Firms in Giga-Project Risk Governance.....	11
2.7 The Saudi Giga-Project Context	13
2.8 Theoretical Framework.....	16
2.9 Research Gap and Conceptual Framework	18
Chapter 3: Research Methodology	20
3.1 Research Philosophy.....	20
3.2 Research Design	20
3.3 Case Selection Criteria and Justification.....	20
3.4 Secondary Data Sources and Collection Procedure	21
3.5 Data Analysis Method.....	22
3.6 Trustworthiness	24
3.7 Ethical Considerations	25
3.8 Methodological Limitations	26
Chapter 4: Data Presentation, Analysis and Findings	27

4.1 Case Profiles.....	27
4.2 Documented Risk Assessment Practices per Case	29
4.3 Cross-Case Comparative Analysis.....	30
4.4 Predictive Accuracy Assessment	33
4.5 Synthesis Against Research Questions	35
Chapter 5: Discussion, Conclusion and Recommendations	36
5.1 Discussion of Findings in Light of the Literature	36
5.2 Theoretical Contribution	38
5.3 Proposed Refinements to a Dynamic Risk Assessment Framework	39
5.4 Conclusion	40
5.5 Practical Recommendations	41
5.6 Recommendations for Future Research.....	42
5.7 Study Limitations	43
References.....	45
Appendix A: Secondary Source Verification Protocol.....	50

List of Tables

Table 1.1: Vision 2030 Anchor Programmes: Initial Baselines vs. Documented Realities.....
Table 2.1: Complicated vs. Complex Systems in Giga-Project Governance
Table 2.2: Synthesis of Theoretical Lenses Applied to Saudi Giga-Project Risk Dynamics
Table 3.1: Operationalized Coding Rubric for Secondary Case Analysis.....
Table 4.1: Cross-Case Comparative Analysis of Documented Giga-Project Risk Outcomes.....
Table 4.2: Summary of Project-Level Predictive Accuracy and Baseline Variance
Table 5.1: Traditional Static Risk Registers vs. Proposed Dynamic Giga-Project Governance
Table 5.2: Strategic Risk Mitigation Matrix for Giga-Project Bidders and Incumbents

List of Figures

Figure 1.1: Anatomy of a Systemic Risk Cascade (The Saudi Binladin Group, 2015–2025)
Figure 3.1: Secondary Source Verification and Exclusion Protocol.....
Figure 4.1: Contractor Outcomes Mapped by Portfolio Diversification and System Coupling.....
Figure 5.1: Proposed Dynamic Risk Governance Framework for Giga-Scale Infrastructure.....

List of Abbreviations

AGBI	Arabian Gulf Business Insight
AUM	Assets Under Management
CAS	Complex Adaptive Systems
EPC	Engineering, Procurement, and Construction
GCC	Gulf Cooperation Council
HSE	Health, Safety, and Environment
ISO	International Organization for Standardization
NAT	Normal Accident Theory
PIF	Public Investment Fund
PMBOK	Project Management Body of Knowledge
PMC	Project Management Consultancy
RQ	Research Question
SAR	Saudi Riyal
SBG	Saudi Binladin Group
SEC	U.S. Securities and Exchange Commission
WBS	Work Breakdown Structure

Chapter 1: Introduction

1.1 Background and the Giga-Project Context

Bent Flyvbjerg's empirical research establishes a clear baseline for large-scale infrastructure: cost and schedule overruns are the statistical norm rather than the exception. The initial execution phases of Saudi Arabia's Vision 2030 anchor programmes follow this pattern, though at a scale that pushes the financial and schedule variance well beyond it.

By mid-2026, the divergence between initial baselines and documented progress was explicit. NEOM's original \$500 billion estimate faced an industry-reported upper-bound scenario of up to \$8.8 trillion. The Line's 2030 footprint contracted accordingly, from a planned 170 kilometres to 2.4 kilometres. Qiddiya's major attractions opened years late, arriving only in late 2025.

These variances propagate directly into sovereign capital. In 2024, the Public Investment Fund (PIF) reported an \$8 billion writedown specifically tied to its giga-projects, accompanied by a reduction in giga-project capital allocation and a contraction in fund-wide net profits. While standard project governance attempts to mitigate optimism bias using reference class forecasting, this tool encounters a structural limit in the Saudi context. The industry lacks a historical distribution of comparable projects; there is no reference class for building a multi-trillion-dollar linear city from a baseline of zero.

Table 1.1: Vision 2030 Anchor Programmes: Initial Baselines vs. Documented Realities

Programme / Entity	Initial Baseline / Promise	Documented Mid-2026 Reality	Primary Risk Driver / Variance
NEOM (Overall)	~\$500 Billion total budget	~\$8.8 Trillion internal cost trajectory	Extreme scope escalation; unprecedented scale without reference baselines.
The Line (NEOM)	170 km linear footprint by 2030	~2.4 km initial build expected by 2030	Unprecedented technical interdependency; schedule compression forcing scope collapse.
Qiddiya (Six Flags)	Original 2022 opening target	Opened December 31, 2025 (3-year delay)	Supply chain bottlenecks; regional contractor execution delays.
Public Investment Fund	Aggressive giga-project expansion	\$8 Billion gigaproject writedown; capital allocation cut from 8% to 6%	Sovereign wealth absorption of localized project cost escalation and delays.

1.2 The Limits of Conventional Project Governance

Under standard Engineering, Procurement, and Construction (EPC) arrangements, clients transfer execution risk to contractors on the premise that contractors are best positioned to manage site-level variance. While this risk-allocation model functions effectively for conventional, decomposable infrastructure, it fails under the structural complexity of a giga-project.

At this scale, contractors are not merely executing discrete physical builds; they are simultaneously integrating regional utilities, adapting to nascent legal frameworks, and managing logistics across a highly interdependent footprint. Despite these systemic interdependencies, standard risk management practice continues to rely on static risk matrices that isolate and score variables independently. This independent-items assumption leaves cross-domain risk propagation unmeasured.

In a giga-project ecosystem, the primary risk is rarely an isolated site failure; rather, it is the speed and severity with which a localized failure cascades across the network. The trajectory of the Saudi Binladin Group illustrates this mechanism. A 2015 site accident, which a standard matrix might isolate as a severe but localized operational event, precipitated a reputational and contractual shock that propagated into a liquidity crisis severe enough to necessitate state intervention and an 86.38 percent sovereign equity takeover by late 2025.

Figure 1.1: Anatomy of a Systemic Risk Cascade (The Saudi Binladin Group, 2015–2025)

Phase 1: Operational Trigger (2015)

- Grand Mosque crane collapse (Mecca); 118 fatalities.

Phase 2: Reputational & Regulatory Freeze (2015–2018)

- Loss of state contracts and government favour; exclusion from bidding.

Phase 3: Severe Balance-Sheet & Liquidity Crisis (2018–2022)

- Cascading cash-flow freeze; accumulated debt soaring to \$20B–\$30B.
- Government appoints Rothschild (2022) for debt restructuring.

Phase 4: Sovereign Financial Intervention (2024)

- Ministry of Finance / Al Istedamah Holding arranges SAR 23.3B (\$6.2B) syndicated loan aimed at stabilizing operations for critical national projects.

Phase 5: State Equity Takeover (December 2025)

- Shareholders approve debt-to-equity conversion; Ministry of Finance stake rises to 86.38%.

Note: This cascade demonstrates how an isolated physical accident in a tightly coupled system bypasses traditional WBS risk matrices to trigger a decade-long sovereign financial rescue.

1.3 Research Objectives

This thesis argues that the documented cost and schedule variances across Vision 2030 programmes are not merely execution failures or anomalies of scale, but the structural consequence of applying static, conventional risk governance to complex, interdependent project ecosystems.

To address this gap between conventional theory and observed outcomes, the research investigates three central questions:

- 1. Why do traditional, static risk frameworks fail to forecast cost and schedule variance in Saudi giga-projects?**
- 2. By what mechanism do isolated operational risks propagate across contractual boundaries to generate firm-level liquidity crises?**
- 3. What factors explain the divergent outcomes, ranging from portfolio expansion to market exit, among major contracting and consultancy firms operating within the same Saudi regulatory environment?**

1.4 Case Selection and Scope

This study grounds its analysis in empirical evidence by tracing the documented trajectories of several major project management and contracting firms operating in the Kingdom up to mid-2026.

The selected cases represent a spectrum of structural outcomes. Bechtel and AECOM are examples of international incumbents maintaining and expanding their NEOM portfolios. AECOM is the only publicly traded firm in the case set; its SEC filings offer visibility into how a global firm balances Middle Eastern regional risk against a \$39 billion backlog, disclosure a private company like Bechtel does not have to make. Conversely, Arcadis represents market exit, having publicly attributed its 2024 regional withdrawal to payment reliability and safety compliance issues. The study also examines the Saudi Binladin Group to trace the anatomy of domestic financial distress, completing the four-firm comparative case study. The Public Investment Fund is treated separately: as a sovereign financier rather than a contractor or consultancy, it sits outside this four-firm unit of analysis by design. Its own 2024 annual report is used in Chapter 4 as an exogenous, macro-level validator, evidence that the same cost and schedule dynamics documented at the firm level also reach the entity financing and part-owning these programmes, without treating PIF's disclosed writedown as directly comparable to any single firm's outcome.

The primary methodological limitation of this design is its reliance on secondary data. This thesis does not claim to observe any firm's internal risk register or internal governance debates. Its central argument does not rest on doing so. The claim under test is narrower: that external institutional posture, structural coupling to the Saudi state, and documented portfolio behaviour, continuation, expansion, exit, restructuring, predict how giga-project risk materialises at the firm level. All three variables are directly observable in the public record. Corporate risk exposure is reconstructed entirely through public disclosures, audited financial reporting, SEC filings, and corroborated trade journalism. Where this thesis anchors a primary empirical claim in a single figure, that figure is the Public

Investment Fund's audited, officially confirmed \$8 billion gigaproject writedown rather than NEOM's \$8.8 trillion cost trajectory, which is treated throughout as an industry-reported upper-bound scenario rather than a confirmed data point.

1.5 Structure of the Thesis

The remainder of this thesis is structured as follows. Chapter 2 reviews the literature on megaproject variance, the distinction between complicated and complex systems, and the structural limits of traditional risk management frameworks. Chapter 3 outlines the research methodology, detailing the case selection criteria and the procedures for secondary data collection and coding. Chapter 4 presents the core case analysis, tracking the operational and financial trajectories of the selected firms. Finally, Chapter 5 synthesizes these findings against the theoretical framework to discuss the implications for project management theory, offering recommendations for how risk governance must adapt to the structural realities of the giga-project scale.

Chapter 2: Literature Review

2.1 Megaprojects and the Iron Law of Overruns

Bent Flyvbjerg's megaproject research provides this field's empirical baseline. Across ninety years of data spanning 104 countries, Flyvbjerg (2014) found that cost overruns affect 70 to 90 percent of megaprojects depending on the category. Overruns above 50 percent are common rather than exceptional, and a project hitting its budget, schedule, and benefits targets simultaneously occurs in roughly one case in a thousand. Flyvbjerg calls this the Iron Law of

Megaprojects: over budget, over time, under benefits. The pattern repeats with enough consistency across sectors and decades that it should be treated as the expected outcome. Set against that baseline, NEOM's reported seventeen-fold cost increase and Qiddiya's three-year schedule slip are not anomalies. They are giga-project-scale expressions of Flyvbjerg's pattern.

Flyvbjerg's later work proposes reference class forecasting as a corrective. Rather than building a cost or schedule estimate bottom-up from a single project's assumptions, planners compare the project against a distribution of similar completed projects. This adjusts for the optimism inherent in bottom-up estimates. The method has been adopted by planning authorities in the UK, the Netherlands, Denmark, Switzerland, and Hong Kong, and endorsed by the American Planning Association. For the Saudi case, however, reference class forecasting hits a structural wall: it requires a reference class. If no prior project has attempted a \$500 billion linear city, there is no distribution to compare it against. The method that improved forecasting accuracy elsewhere does not transfer cleanly to an unprecedented case. Recent methodological reviews treat this boundary condition at the extreme tail of project scale as an open research question.

2.2 Complexity Versus Complication in Project Systems

Baccarini (1996) distinguishes between complicated and complex systems. A complicated system has many components but behaves predictably once its parts are understood; a complex system produces effects that do not reduce to the sum of its parts. Baccarini frames project complexity in terms of differentiation (the number of distinct elements) and interdependency (how those elements affect one another). He argues that complexity is managed through integration rather than through decomposition alone. Williams (2002) extends this into practical modelling. He argues that traditional project management techniques, built for well-defined,

decomposable tasks, break down where interdependency is highest and where client-driven timeline compression removes the slack that absorbs small variances.

The complex-adaptive-systems (CAS) framing opened up by Baccarini's work has since been applied to comparable infrastructure outside the Gulf. Daniel and Daniel (2019), studying the UK's Hinkley Point C nuclear power station, found that CAS properties (emergent behaviour, non-linear feedback, and adaptation under changing constraints) characterised how the megaproject's scope evolved. They argue that CAS theory offers a more accurate frame for megaproject dynamics than models treating a project as a fixed plan executed against a static risk register. UK nuclear plants and Saudi linear cities both resist decomposition. This suggests the pattern stems from project scale and structure, rather than Gulf politics or a specific client organisation. Biesenthal, Clegg, Mahalingam, and Sankaran (2018) add an institutional layer: megaproject organisations answer to governmental logic and business logic at once. Much of what looks like poor execution is actually friction between those two logics operating on the same programme simultaneously. A purely technical risk register has no category for this friction. Both arguments map onto NEOM. A linear city developing its energy, legal, transport, and construction sub-systems in parallel exhibits Baccarini's high-differentiation, high-interdependency complexity. The Line's scope contraction, established in Chapter 1, aligns with what Williams predicts when a tightly scheduled programme meets a plan that assumed a decomposability it did not have.

Table 2.1: Complicated vs. Complex Systems in Giga-Project Governance

System Dimension	Complicated Systems (Standard Megaprojects)	Complex Adaptive Systems (CAS) (Saudi Giga-Projects / NEOM)	Theoretical & Empirical Support
Structural Architecture	High differentiation, but low-to-moderate interdependency.	High differentiation with intense, non-linear interdependency across sub-systems.	Baccarini (1996); Daniel & Daniel (2019)
Decomposability	Decomposable: Tasks can be isolated, sequenced, and broken down into Work Breakdown Structures (WBS).	Non-Decomposable: Legal, utility, transport, and construction frameworks must evolve simultaneously across one footprint.	Baccarini (1996); Williams (2002)
System Behavior & Predictability	Linear: Behaves predictably once individual components are understood; sum of its parts.	Emergent: Exhibits non-linear feedback loops, emergent behaviors, and dynamic adaptation under constraint.	Daniel & Daniel (2019)
Dominant Risk Governance Tool	Static Risk Register: Risks are identified, scored individually, and mitigated in silos (e.g., ISO 31000, PMBOK).	Dynamic Integration: Requires continuous data-driven forecasting and cross-programme dependency mapping.	Aven (2017); Tian et al. (2025)
Reaction to Schedule Compression	Absorbed: Built-in slack and contingency buffers absorb localized delays without systemic failure.	Systemic Breakage: Removal of slack forces cascading failures or drastic scope collapse (e.g., The Line scaling from 170 km to 2.4 km).	Williams (2002)

2.3 Behavioural Drivers of Risk Misjudgment

Kahneman and Tversky's (1979) prospect theory, and the resulting planning fallacy, offer the standard psychological account of why planners underestimate cost and risk while overestimating benefits. Kahneman and Lovallo (1993) extended this into organisational forecasting, arguing that planners evaluate their own project in isolation rather than against the reference class of similar past projects. This literature offers a candidate explanation for the scale of NEOM's upward cost revision documented in Chapter 1. The psychological pressure to protect a politically significant national programme's headline numbers during early planning creates the exact conditions for Kahneman and Lovallo's optimism bias and strategic misrepresentation.

2.4 Traditional Risk Frameworks and Their Limits

ISO 31000 and the PMBOK Guide's risk register remain the dominant frameworks in industry practice. Both share a structural assumption challenged by Baccarini's complexity literature: that risks can be identified, scored, and tracked as largely independent items. Aven (2017) argues that ISO 31000 ties its definition of risk to organisational objectives in a way that becomes incoherent when objectives are contested or undefined. This is a common condition on a mega-project where a client, a state financier, and a contracting consortium rarely share the same definition of success at the same time. Aven further argues that the standard leans on a traditional likelihood-based view of risk that struggles to capture deep uncertainty. A risk register inherits this structural gap. A list of individually scored risks is not built to answer how risky the overall project is, since that answer lies in the interaction of the items, not their sum.

A risk matrix built on the independent-items assumption cannot represent how a materials supply bottleneck might change the probability of a financing covenant tied to a construction milestone. Saudi Binladin Group's trajectory illustrates this cross-domain cascade. A reputational and contractual shock propagated into a firm-level solvency crisis severe enough to require sovereign intervention, ultimately raising the state's ownership stake to 86.38 percent by December 2025 (Kumar, 2025; Arab News, 2025). Chapter 4 traces that trajectory in detail.

2.5 Dynamic and Predictive Risk Assessment Approaches

Against the static register model, recent literature argues for continuous, data-driven forecasting. Tian et al. (2025), in a bibliometric review of 84 studies published between 2014 and 2024, mapped how machine learning, natural language processing, knowledge-based reasoning, and computer vision are being applied to the construction risk problem. Their review situates this as

an active research area rather than a settled one. They flag data quality and model interpretability as the main obstacles to wider adoption. These obstacles apply with particular force to a giga-project, where much of the underlying operational data is proprietary and siloed across the contracting consortium.

PwC's Middle East Capital Projects and Infrastructure Survey 2025 provides an industry-level counterpoint from within the region itself. Fielded among more than 100 regional specialists between December 2024 and January 2025, it found that programme delays and cost overruns remain common challenges, even as firms report a growing focus on financial performance as a health metric (PwC, 2025). The survey's public summary, however, skips a critical step: it does not compare dynamic against static risk practice adoption against actual overrun outcomes. While this thesis cannot close that gap at a regional scale, it addresses a version of it at the scale of four specific firms.

2.6 Contracting and Consultancy Firms in Giga-Project Risk Governance

The firms that hold PMC and EPC contracts on Saudi giga-projects carry risk exposure that is distinct from, though linked to, the client entities (NEOM Company, Red Sea Global, Qiddiya Investment Company) themselves, and the contract form itself does some of the work of allocating that risk before any framework is applied. Under a standard EPC arrangement, most execution risk, cost, schedule, and technical performance, is contractually transferred from the client to the contractor, on the logic that risk should sit with whichever party is best placed to manage it. That logic works reasonably well for a conventional project with a knowable scope. It

is less clear it holds at giga-project scale, where the contractor absorbing execution risk may have no more visibility into cross-programme interdependency than the client does.

Loo, Abdul-Rahman, and Wang (2013), studying international architectural, engineering, and construction firms operating specifically in Gulf Cooperation Council states, found through a questionnaire survey and case studies that over a third of the external risk factors these firms need to manage should be assessed before a contract is even awarded, with the remainder emerging afterward, and proposed a structured external risk breakdown for foreign firms entering the Gulf market. Their framework was built for firms operating at a national or project scale within the GCC; nothing in it was designed with a half-trillion-dollar, multi-decade Saudi giga-project specifically in mind, which is one reason the present study's comparison across Bechtel, AECOM, Arcadis, and Saudi Binladin Group has something to add. Bechtel holds the executive project management role for NEOM's base infrastructure and the project management consultancy contract for Trojena, NEOM's mountain destination (Bechtel, n.d.-a, 2022). AECOM holds PMC contracts for NEOM Bay's Phase 1 development and for NEOM International Airport, as well as a backbone infrastructure design role (AECOM, 2019, 2020, 2023). Jacobs operates in the Kingdom through JASARA, a joint venture with Saudi Aramco and the Public Investment Fund established in 2017, providing PMC services across multiple giga-project clients. Arcadis had been reported by trade press as linked to NEOM-area programme management work before confirming, through its CEO, a full exit from the Middle East by the end of 2024, attributing the decision to payment reliability problems and client non-compliance with health and safety standards (New Civil Engineer, 2024). These four firms occupy structurally different positions: continuing incumbents, an exiting international consultancy, and

a financially rescued domestic contractor. That structural spread is what makes them a usable comparative case set, rather than four examples of the same story.

Gulf-specific empirical work on why megaprojects in the region run late reinforces the same point from the delay side. Elshamy, Elghaish, and Brooks (2025), drawing on semi-structured interviews with 25 experienced practitioners across Gulf mega construction projects, identified delay risk factors that recur across the region's programmes independent of any single client or contractor, evidence that at least some of what shows up in the NEOM and Qiddiya timelines is a regional pattern rather than a project-specific failure.

2.7 The Saudi Giga-Project Context

As of mid-2026, the documented state of the three anchor programmes examined here is as follows. NEOM's cost trajectory and The Line's footprint have continued along the extreme cost-escalation and scope-contraction path established in Chapter 1, with construction on The Line now paused until after 2030 (The Real Deal, 2025; Martin, 2026). Qiddiya's Six Flags park opened on 31 December 2025, roughly three years behind its original target (Stevenson, 2026). Red Sea Global's programme continues, though the departure of a reportedly NEOM-linked programme manager, Arcadis, from the entire Middle East region by the end of 2024 is documented independently of any specific Red Sea Global disclosure. The Line specifically has drawn direct academic attention: Kashef (2025), in a comparative case study of Masdar City and The Line published in *Land*, examines both projects' underlying political, social, and economic motivations against their realistic prospects for completion, treating long-term viability itself, not merely cost or schedule, as the outcome worth assessing. That framing matters for this thesis, since a project that is completed on a revised budget and timeline could still fail on Kashef's viability criterion, and vice versa.

One level up from any individual project sits the Public Investment Fund itself, and its own 2024 annual report is the single most directly disclosed risk figure in this entire study. Gigaproject investments declined 12.4 percent to SAR 211 billion (about \$56.2 billion), falling from 8 percent to 6 percent of the fund's total assets under management, with \$8 billion written down specifically from its five gigaprojects, attributed to cost escalation and oil-market conditions, while fund-wide net profit fell 60 percent for the year (Albarakati, 2025). Unlike almost every other figure in this thesis, this one is not a leak, a trade-press estimate, or a CEO's answer in an interview. It is a number PIF put in its own annual report. These figures are treated throughout this thesis as documented outcomes, not as verified ground truth beyond what their respective sources support; the distinction matters most for the \$8.8 trillion NEOM figure, which rests on journalistic reporting of an internal document rather than a public company disclosure, a different evidentiary tier from PIF's own disclosed writedown.

2.7.1 Sovereign-Contractor Power Dynamics and State-Capitalism in GCC Megaprojects

The theoretical lenses reviewed above, complexity theory, normal accident theory, prospect theory, treat risk as a property of the project system itself, abstracted from the political order that finances and licenses it. That abstraction is defensible for a private, arm's-length client, but it breaks down for Saudi giga-projects, where the client, the regulator, and the financier are frequently the same sovereign actor. Explaining why Bechtel and AECOM absorbed volatility that Arcadis exited and Saudi Binladin Group could not requires a political economy account of that asymmetry, not only a technical one.

Hertog's (2010) concept of "segmented clientelism" offers the clearest starting point. Rather than a single, uniform patronage system, Hertog describes a Saudi state fragmented into components of sharply differing capability: some organizations function as "islands of efficiency" insulated from rent-seeking pressure, while others operate as vertically organized, rent-based patronage structures whose accumulated "cascades of rentier clients" become, over time, difficult for the state itself to reverse. This distinction maps onto the firm-level split documented in Chapter 4. Bechtel and AECOM interact with the Saudi state primarily as arm's-length, globally diversified contractors, closer to Hertog's insulated islands. Saudi Binladin Group sits inside the patronage structure itself, tied to domestic lending facilities and state-business networks that constrain its exit options precisely because the state carries distributional obligations toward the firm that it does not carry toward a foreign consultancy. Hanieh (2011) extends this at the regional scale, arguing that Gulf capital accumulation is increasingly organized at a pan-GCC level dominated by large, state-linked conglomerates, a structural condition that gives internationally diversified firms room to maneuver that domestic contractors structurally lack.

This asymmetry is not unique to Saudi Arabia, and the pattern predates the giga-project era. Ashley and Bonner (1987) find that a contractor's bargaining power relative to a host government rises with its degree of internationalization and decentralization, since a firm with backlog spread across many jurisdictions can absorb one market's volatility in a way a geographically concentrated firm cannot. Arcadis's exit and Bechtel's and AECOM's continuation are consistent with that four-decade-old finding. Saudi Binladin Group's trajectory is the limiting case: a domestic firm with no comparable diversification to fall back on.

The state's own financial instruments compound this asymmetry rather than correcting it. Montambault Trudelle (2024) argues that Gulf sovereign wealth funds, PIF included, function as

tools of regime stability rather than as neutral financial intermediaries, using de-risking instruments such as green bonds and ESG-linked structures to mobilize private capital while leaving the underlying allocative logic of the rentier state intact. A financier that is simultaneously an instrument of political stability sits inside the same coupled system this thesis applies Perrow (1984) to in Chapter 4, not outside it as a disinterested capital source.

A further, non-decomposable layer of exposure runs through labor governance. Kalush and Saraswathi (2024) document that kafala-system reforms across the GCC have repeatedly stalled on a structural lock-in effect, leaving the underlying sponsorship dependency largely intact even as formal rules change. For a domestic execution contractor, workforce-supply risk under kafala is inseparable from its broader dependency on the state. For an advisory consultancy with no site-level labor exposure, it barely registers.

None of this fits inside a static, independent-item risk register. ISO 31000 and the PMBOK framework, already shown in Section 2.4 to assume risks that can be scored in isolation, have no category for a client that is also a regulator and a lender of last resort, and none for a jurisdictional asymmetry that determines a firm's exit options before any single project risk materializes. The sovereign-contractor power relationship documented here is not an additional item to add to the register; it is a structural precondition that determines which items on the register a given firm can absorb, and which it cannot.

2.8 Theoretical Framework

Four lenses interpret the case findings in Chapter 4. Baccarini's (1996) and Williams's (2002) complexity theory, corroborated by Daniel and Daniel's (2019) CAS analysis of Hinkley Point C, explains why a risk register built for decomposable, complicated systems fails on a complex,

highly interdependent one; it is used here to interpret the NEOM scope-collapse case. Perrow's (1984) normal accident theory, developed from an analysis of the Three Mile Island accident and built on the twin dimensions of interactive complexity and tight coupling, explains why cascading failure is a structural property of some systems rather than an occasional accident; it frames the reading of Saudi Binladin Group's financial cascade. Perrow built the theory around physical systems, nuclear plants and chemical plants, not financing structures, so stretching it to cover Saudi Binladin Group's cash-flow cascade is an analogical move this thesis makes deliberately, not one Perrow's original work directly supports. Kahneman and Tversky's (1979) prospect theory and the planning fallacy it produced explain the psychological mechanism behind optimistic early forecasts; it is applied here purely as an interpretive lens on documented planning decisions, not tested through any primary psychological measurement. Taleb's (2012) antifragility concept, distinguishing systems that merely resist shocks from systems that improve because of them, supplies the standard against which the surviving firms' apparent adaptation, expanding their NEOM contract portfolios even as the programme's own plans contracted, is read in Chapter 5.

No single case in Chapter 4 was selected because it contradicted one of the four theories, and the risk of an unfalsifiable, one-theory-per-outcome mapping is real rather than hypothetical. The clearest test this thesis can offer is Bechtel: a case that continued and expanded without a triggering event, a disclosed writedown, or a documented scope collapse. Antifragility is the only one of the four lenses that predicts continuation as an active, structural outcome. Had Bechtel instead shown quiet contract erosion or unreported renegotiation, none of the four frameworks would have anticipated it; none of the theoretical lenses used here specifies a mechanism for

undocumented decline. That gap is a limitation of the framework, not only of the evidence available to test it.

Table 2.2: Synthesis of Theoretical Lenses Applied to Saudi Giga-Project Risk Dynamics

Theoretical Lens	Key Theorist(s)	Core Conceptual Mechanism	Application to Saudi Giga-Project Case Evidence
Complexity Theory & CAS	Baccarini (1996); Williams (2002); Daniel & Daniel (2019)	Project complexity is driven by interdependency rather than size alone; static tools fail when systems resist decomposition.	Explains the structural inevitability of NEOM's scope collapse (The Line scaling from 170 km down to 2.4 km by 2030) under aggressive timeline compression.
Normal Accident Theory (NAT)	Perrow (1984)	Tightly coupled, interactively complex systems inevitably transform localized shocks into systemic, cascading failures.	Frames Saudi Binladin Group's trajectory, where an isolated 2015 site accident cascaded into a decade-long solvency crisis requiring an 86.38% state equity takeover.
Prospect Theory & Planning Fallacy	Kahneman & Tversky (1979); Lovallo (1993)	Planners evaluate projects in isolation, suffering from optimism bias and psychological pressure to protect political headline targets.	Explains the initial baseline distortion, such as NEOM's original \$500B estimate escalating toward an internal \$8.8T trajectory.
Antifragility	Taleb (2012)	Distinguishes systems that break under volatility from those that adapt, restructure, and expand due to disorder and shocks.	Interprets how globally diversified PMC firms (Bechtel and AECOM) absorbed localized giga-project volatility and expanded their regional contract backlogs.

2.9 Research Gap and Conceptual Framework

Flyvbjerg's megaproject database is global and rigorous but not built to isolate firm-level variation within a single national programme, and its reference-class method may reach a structural limit at exactly the scale NEOM occupies. The CAS literature, represented here by Daniel and Daniel (2019), has been applied to individual megaprojects like Hinkley Point C but not, so far as this search found, to a Gulf giga-project specifically. The regional industry survey literature, represented here by PwC (2025), captures sentiment and aggregate practice across the sector but does not connect specific firms' documented outcomes to specific risk postures. Gulf-

specific empirical work exists and is useful, Loo et al. (2013) on external risk for GCC-based AEC firms, Elshamy et al. (2025) on regional delay factors, Kashef (2025) on The Line's long-term viability specifically, but none of the three was built around a named-firm risk comparison at giga-project scale. Alrashid (2025), writing from inside the Saudi mega-project practitioner community at PM World Journal, argues that risk, change, and complexity jointly overwhelm traditional project control methods in the Saudi context specifically, but as a practitioner article rather than a peer-reviewed study, it does not offer a comparative firm-level analysis either. The gap this thesis addresses sits at the intersection of these bodies of work: a documented, secondary-source comparison of how risk materialised differently across specific, named firms operating in the same giga-project environment, extended, where the evidence allows, to the financier itself.

One further body of work sits adjacent to this gap without closing it: the sovereign wealth fund governance literature, built around instruments such as the Santiago Principles' voluntary standards for SWF risk management and transparency, addresses exactly the financier-level actor this thesis extends its case set to reach, but treats governance and disclosure practice at the fund level in general rather than through the lens of any single fund's exposure to a specific national infrastructure programme. PIF's case in Chapter 4 sits at the intersection of that literature and the giga-project literature reviewed above without being fully claimed by either, which is itself a marker of how underdeveloped the connection between the two bodies of work currently is.

Chapter 3: Research Methodology

3.1 Research Philosophy

This study takes a pragmatist stance appropriate to applied case study work: the aim is to build a defensible, evidence-grounded account of what happened and how it relates to existing theory, not to test a hypothesis under experimental conditions that this subject matter does not permit.

3.2 Research Design

The design is a multiple, comparative case study built entirely on secondary and documentary sources. No primary human-subject data collection was undertaken, which removes both the ethics-board burden and the access risk of trying to reach giga-project executives directly, a constraint for a master's-level timeline, at the cost of not being able to verify any firm's internal risk process beyond what that firm or independent reporting has made public.

3.3 Case Selection Criteria and Justification

Four firms were selected from the pool of contractors and consultancies with confirmed, documented roles on Saudi giga-projects: Bechtel and AECOM, both holding continuing, expanding PMC contracts on NEOM; Arcadis, a firm reported as linked to NEOM-area programme management that subsequently exited the Middle East entirely; and Saudi Binladin Group, the major domestic contractor whose financial exposure required first a state-supervised restructuring and later a full state-led rescue. These four firms constitute the study's unit of analysis and the basis for every firm-level comparison in Chapter 4. The Public Investment Fund is not part of that unit of analysis. It is a sovereign financier, not a contractor or consultancy, and its own directly disclosed 2024 writedown figure surfaced during the research process. PIF is

retained in the study design as an exogenous, macro-level validator: evidence that the same cost and schedule dynamics documented across the four contracting and consultancy firms also reach the entity that finances and part-owns these programmes. Its inclusion answers RQ2's cascade question at a level the four-firm comparison cannot reach on its own, but its writedown is not coded as a fifth, directly comparable case outcome alongside Bechtel's, AECOM's, Arcadis's, or Saudi Binladin Group's; it is sovereign-level context read alongside the firm-level findings, not a fifth entry in the same comparative matrix.

These four firms were chosen over other candidates (Jacobs/JASARA, Atkins, the Bouygues-Almabani joint venture) because the public record for each includes a documented outcome, continuation, exit, financial distress, or a disclosed financial writedown, that gives the comparison analytical traction; the other candidate firms' documented outcomes are, as of mid-2026, simply "still operating," which does not support the same kind of comparison.

3.4 Secondary Data Sources and Collection Procedure

Sources were collected between July 2026 across six categories: firm press releases and investor disclosures (Bechtel, AECOM, Arcadis, Saudi Binladin Group and its state-appointed overseers, and PIF's own annual report coverage); trade press covering the construction and infrastructure sector (New Civil Engineer, MEED, Construction Week, The Real Deal, Semafor, AGBI); industry survey publications (PwC Middle East); peer-reviewed academic literature located through general web search covering complexity theory, risk register critique, AI-assisted risk prediction, and Gulf-specific construction risk management (Aven, 2017; Daniel & Daniel, 2019; Loo et al., 2013; Tian et al., 2025; Elshamy et al., 2025); practitioner literature (PM World Journal); and general news coverage of specific events (Six Flags Qiddiya's opening, NEOM's cost reporting, PIF's writedown). Each source was logged with its publication date, since giga-

project disclosures in this sector change fast enough that a source from 2023 and a source from 2026 can describe materially different realities for the same programme.

To maintain academic rigor, only secondary claims verifiable through official corporate disclosures, audited financial reports, or established trade journalism were admitted; unverified secondary narratives lacking direct attribution were permanently excluded per the verification protocol.

3.5 Data Analysis Method

Analysis proceeded by documentary and content analysis: each case file was built from the sources above, coded for the type of risk event documented (financial, schedule, reputational, regulatory), the level at which it materialised (project, firm, or financier), and whether the outcome for that entity was continuation, exit, distress, or a disclosed writedown.

To ensure consistency and dependability across all case files, including the Public Investment Fund's supplementary record, an operationalized coding rubric was established prior to data extraction. Each documentary source was evaluated against the specific inclusion criteria and textual markers detailed in Table 3.1.

Table 3.1: Operationalized Coding Rubric for Secondary Case Analysis

Analytical Category	Variable / Code	Operational Definition	Empirical Indicators / Textual Markers in Sources	Representative Source Types
Risk Type	Reputational	Loss of public standing, state favor, or commercial trust triggered by a major operational failure.	"Exclusion from bidding," "loss of government favor," "reputational fallout," "fatal site accident."	Trade press reports (e.g., AGBI coverage of the 2015 SBG crane collapse).
	Financial / Balance-Sheet	Acute cash-flow restriction, insolvency risk, mounting debt burdens, or formal accounting impairments.	"Debt restructuring," "syndicated loan," "writedown," "impairment," "chronic non-payment," "liquidity crisis."	SEC Form 10-K filings, PIF Annual Reports, Rothschild

Analytical Category	Variable / Code	Operational Definition	Empirical Indicators / Textual Markers in Sources	Representative Source Types
				restructuring disclosures.
	Schedule / Operational	Inability to meet baseline delivery timelines or physical build footprints due to technical interdependency.	"Opening delayed," "pushed back years," "scope reduction," "scaled back from 170 km to 2.4 km."	General news, specialized journalism (Semafor, The Real Deal, Coaster101).
	Regulatory / HSE	Friction with or failure to adhere to state safety, labor, or health and safety environment (HSE) standards.	"HSE non-compliance," "health and safety standards," "client non-compliance," "regional exit."	Direct leadership interviews (e.g., Arcadis CEO statement in New Civil Engineer).
Risk Level	Project Level	Volatility materializing directly within the physical boundaries or timeline of a specific anchor build.	Cost escalation figures (\$500B to \$8.8T), linear footprint reductions, delayed asset openings.	Leaked internal documents reported via trade press, project announcements.
	Firm Level	Risk absorbing into the balance sheet, backlog, or operational footprint of an EPC or PMC contractor.	Firm-wide backlog growth (\$39.7B), regional downsizing (headcount dropping 2,000 to 200), debt-to-equity conversions.	Corporate investor disclosures, annual reports, financial restructuring records.
	Financier Level	Volatility reaching the sovereign sponsor or capital provider, impacting total fund assets under management.	Reduced gigaproject allocation (8% to 6%), fund-wide net profit drops (-60%), disclosed gigaproject writedowns (\$8B).	Public Investment Fund (PIF) official Annual Reports.
Documented Outcome	Continuation / Expansion	Firm successfully absorbs volatility, maintaining active contracts and adding new portfolio awards.	"Active engagements," "new contract awards," "expanding backlog," "ongoing PMC role."	Bechtel press materials, AECOM investor relations disclosures.
	Strategic Exit	Voluntary or planned cessation of regional operations and project bidding due to unmanageable risk factors.	"Out of the Middle East in total," "finish all projects and exit," severe regional headcount reduction.	Corporate leadership statements and trade press confirmations (Arcadis).
	Distress / State Rescue	Chronic financial failure necessitating state-supervised restructuring, emergency loans, or equity dilution.	"State-supervised restructuring," "SAR 23.3B syndicated loan support," "state ownership rising to 86.38%."	Ministry of Finance / Al Istedamah Holding releases, financial press.

Analytical Category	Variable / Code	Operational Definition	Empirical Indicators / Textual Markers in Sources	Representative Source Types
	Disclosed Writedown	Formal accounting recognition of permanent capital loss or devaluation of gigaproject assets.	"\$8 billion written down specifically from five gigaprojects," "impairments linked to cost escalation."	Audited sovereign wealth fund annual reports (PIF 2024 Annual Report).

Cross-case comparison then examined whether firms with different outcomes showed different patterns in these codes. Where sources reported comparable quantitative figures (cost estimates, schedule dates, writedown amounts), variance between an original and a later figure was calculated directly. Table 4.1 in the following chapter presents this coding in summary form.

3.6 Trustworthiness

In place of the validity and reliability language appropriate to quantitative designs, this study is assessed on credibility (triangulating trade press against firm disclosures and, where possible, independent industry reporting), dependability (a transparent, dated source log so the analysis can be reconstructed or updated), and confirmability (explicit flagging, in Chapter 4, of any finding that rests on a single source rather than corroborated reporting, and explicit exclusion, as described in Section 3.4, of findings that could not be confirmed at all).

To maintain confirmability, a verification protocol governed which secondary narratives were admitted. As documented in Section 3.4, any narrative lacking direct, traceable attribution to primary corporate filings, official government statements, or established trade journalism was excluded.

Figure 3.1: Secondary Source Verification and Exclusion Protocol

Step 1: Source Traceability Check

- *Criteria:* Can the claim be traced to a verifiable primary document, official annual report, SEC filing, or named corporate executive on the record?
- *Action if No:* Trigger Exclusion Protocol (e.g., Unconfirmed narratives regarding SBG's purported 2016 exit visas and liquidity timelines were permanently discarded).
- *Action if Yes:* Proceed to Step 2.

Step 2: Cross-Source Triangulation

- *Criteria:* Is the data point corroborated by independent trade journalism or direct audited disclosures?
- *Action if No:* Flag as Unconfirmed / Single-Source (e.g., NEOM's \$8.8T internal cost estimate is retained but explicitly flagged in text as journalistic reporting).
- *Action if Yes:* Proceed to Step 3.

Step 3: Temporal & Contextual Logging

- *Action:* Log source by publication date to account for rapid giga-project scope shifts before admitting data into the final comparative coding matrix.

3.7 Ethical Considerations

No human subjects were involved, so the ethical obligation here is entirely one of source integrity: every claim is attributed to the specific source that supports it, no firm's self-description is presented as independently verified fact without saying so, and the one figure in this study that rests on leaked-document journalism rather than public disclosure, NEOM's reported \$8.8 trillion cost trajectory, is flagged as such wherever it appears rather than treated as confirmed.

3.8 Methodological Limitations

This design cannot verify any firm's internal risk register or governance process beyond what has been made public. It cannot establish causation between a documented risk practice and a firm's ultimate outcome, only association. And the practitioner and academic literature specific to Saudi giga-project risk, as opposed to megaprojects generally, is thinner than the literature on megaprojects in Western contexts: this thesis found direct academic engagement with GCC construction risk (Loo et al., 2013; Elshamy et al., 2025) and one directly on-topic practitioner article (Alrashid, 2025), but no peer-reviewed study that compares named firms against giga-project-scale outcomes the way this thesis attempts to. The discussion in Chapter 5 treats that absence as itself a finding rather than only a limitation.

A further limitation follows directly from the sources described in Section 3.4 rather than from the coding procedure itself: the evidentiary base is systematically richer for firms whose outcomes generated public disclosure than for firms whose outcomes did not. Saudi Binladin Group's distress and the Public Investment Fund's writedown are documented in granular, dated detail precisely because insolvency proceedings, state interventions, and audited annual reports are disclosure events. Bechtel's and AECOM's continuation is coded largely from the comparative absence of any such event, a private company's silence and a listed company's routine contract announcements, which is a structurally thinner category of evidence. This asymmetry means the continuation and distress cases in this study are not evidenced to the same standard, and a quiet, undisclosed erosion in a continuing firm's position would be invisible to this study's methods in a way a public distress event would not be.

Chapter 4: Data Presentation, Analysis and Findings

4.1 Case Profiles

Bechtel. Holds the executive project management role for NEOM's base infrastructure and a separate project management consultancy contract for Trojena, NEOM's mountain tourism destination (Bechtel, n.d.-a, 2022). Both engagements were confirmed as active through the period covered by this study, with no reported exit or restructuring. The specific value of the base infrastructure contract is not disclosed in any source this study located; Bechtel's own project page and press materials describe scope and role but not price, which is itself a data gap worth naming rather than papering over with an estimate.

AECOM. Holds PMC contracts for Phase 1 of NEOM Bay, a development reported at up to \$500 billion in scope, for NEOM International Airport, and a separate backbone infrastructure design role (AECOM, 2019, 2020, 2023). AECOM's NEOM engagements were confirmed active and, on the evidence of the airport contract award, expanding during the study period, the same pattern as Bechtel's. No contract value for the Phase 1 PMC award was found in a source this study could verify, again matching Bechtel's case. One difference stands out: AECOM is publicly listed and files a 10-K, disclosing firm-wide financial context that Bechtel's private ownership does not. AECOM's most recent annual filing reports a \$39.7 billion backlog, up from \$37.4 billion, with growth attributed in part to strong positioning in Middle East markets (AECOM, 2025). That backlog figure is firm-wide, not NEOM-specific, and cannot be used to infer the value of any single Saudi contract.

Arcadis. Trade press (MEED, reported via New Civil Engineer) linked Arcadis to programme management work associated with NEOM's Red Sea-adjacent development. Asked directly in July 2024 whether Arcadis was still involved with NEOM, the firm's CEO answered: "No, we're not. We made a decision three or four years ago that we will finish all projects and be out of the Middle East in total by the end of this year." Asked why, he named one factor bluntly: "You just don't get paid." Client non-compliance with health and safety standards was the other reason given. Regional headcount fell from roughly 2,000 to 200 over the same period (New Civil Engineer, 2024).

Saudi Binladin Group. The Kingdom's most prominent domestic contractor, historically involved across national infrastructure and religious-site construction, and the case with the longest documented risk trajectory in this study. A crane collapsed at the Grand Mosque in Mecca in 2015, killing 118 people, an event after which the company fell out of government favour (Hammond, 2024). By 2022, the government had appointed Rothschild, the UK financial advisory firm, to supervise a restructuring of debt then estimated at \$20 to \$30 billion (Hammond, 2024). Financial strain continued: from mid-2024, the Ministry of Finance's holding vehicle, Al Istedamah Holding, which held roughly 36 percent of the group at the time, began providing lending to help the firm repay bank debt, explicitly framed as necessary to let the group complete ongoing work including Holy Mosques-related projects (Hammond, 2024). This included a SAR 23.3 billion (roughly \$6 billion) syndicated loan arranged in October 2024. The support programme culminated in a debt-to-equity conversion in December 2025 that raised the Ministry's ownership stake to 86.38 percent (Kumar, 2025; Arab News, 2025), a full decade after the event that first put the firm in difficulty.

Public Investment Fund. Not a contracting or consultancy firm, and not part of the original four-case design, but included because its own 2024 annual report is the clearest disclosed risk figure in this study. Gigaproject investments fell 12.4 percent to roughly SAR 211 billion (\$56.2 billion), with \$8 billion specifically written down from PIF's five gigaprojects and the gigaproject share of total assets under management falling from 8 percent to 6 percent; fund-wide net profit fell 60 percent for the year, a decline the fund attributed in part to impairments and project delays (Albarakati, 2025). PIF's own strategy documents reportedly still project more than doubling total assets to \$2.67 trillion by 2030, which places the \$8 billion writedown as a disclosed loss inside a fund that is, at the same time, planning substantial further growth.

4.2 Documented Risk Assessment Practices per Case

None of the four firms publishes a risk register or a framework document specific to its Saudi giga-project work, with one qualification. AECOM, as a publicly listed company, discloses risk factors in its SEC filings at the firm-wide level, historically including a named category for Middle East political instability, one past filing cited the 2017-2021 Gulf diplomatic rift with Qatar as a concrete example of how regional disputes could disrupt AECOM's business. That is real, documented risk disclosure. It is pitched at the level of "the Middle East as a region" rather than "NEOM as a specific programme": real disclosure, but well short of the granular, dynamic, programme-specific risk assessment this thesis's theoretical framework calls for. Bechtel, as a privately held company, has no equivalent public filing and so offers no comparable disclosure either way. What is documented for all four firms is each entity's operational and financial posture over time: Bechtel and AECOM both show a pattern of contract continuation and expansion (new awards layered onto existing ones) without any reported renegotiation driven by risk events. Arcadis shows a documented, named risk (payment reliability, HSE non-compliance)

that its own leadership stated as the reason for a full, planned regional exit. Saudi Binladin Group shows the most granular documented risk trajectory of the four: a specific triggering event in 2015, a specific external-adviser restructuring in 2022, and a specific two-stage financial rescue in 2024 and 2025. The Public Investment Fund shows a disclosed, quantified writedown rather than a qualitative narrative, the only case in this study where the risk outcome is expressed in the entity's own reported numbers rather than reconstructed from press coverage.

4.3 Cross-Case Comparative Analysis

Table 4.1 synthesizes the risk profiles, exposure levels, and operational outcomes of the four contracting and consultancy firms that make up this study's unit of analysis. The Public Investment Fund's sovereign-level writedown is shown separately in the shaded row below the four-firm comparison, as exogenous macro-level context rather than a fifth comparable case.

Table 4.1: Cross-Case Comparative Analysis of Documented Giga-Project Risk Outcomes

Case Entity	Structural Position & Role	Documented Risk Type	Risk Materialization Level	Documented Operational / Financial Outcome	Key Evidentiary Basis & Source Documentation
Bechtel	International EPC / Executive Project Management (PMC)	None documented (Private entity; no public corporate filings or risk disclosures available)	Firm Level	Continuation & Portfolio Expansion	Active executive PMC roles on NEOM base infrastructure and Trojena; no reported renegotiation or contract restructuring (Bechtel, n.d.-a, 2022).
AECOM	Publicly Listed International PMC / Design Consultancy	Firm-wide geopolitical & regional risk (SEC disclosed category; not NEOM-specific)	Firm Level	Continuation & Portfolio Expansion	Active PMC contracts for NEOM Bay Phase 1, NEOM International Airport, and backbone infrastructure; firm-wide backlog rising to \$39.7B (AECOM, 2023a, 2023b, 2025).
Arcadis	International Engineering	Commercial payment	Firm Level	Full Strategic Regional Exit	CEO on-record public statement confirming

Case Entity	Structural Position & Role	Documented Risk Type	Risk Materialization Level	Documented Operational / Financial Outcome	Key Evidentiary Basis & Source Documentation
	& Programme Consultancy	reliability; Client HSE non-compliance			exit; regional Middle East headcount severely reduced from ~2,000 to 200 (New Civil Engineer, 2024).
Saudi Binladin Group (SBG)	Major Domestic Contractor / Infrastructure Builder	Reputational (2015 site accident); Severe balance-sheet & liquidity (2022–2025)	Firm Level	State-Supervised Restructuring & Sovereign Rescue	2015 Mecca crane collapse; 2022 Rothschild debt restructuring (\$20B–\$30B debt); 2024 SAR 23.3B syndicated loan; Dec 2025 debt-to-equity conversion raising state equity to 86.38% (Hammond, 2024; Kumar, 2025; Arab News, 2025).
Public Investment Fund (PIF): Sovereign-Level Context, Not a Comparable Case	Sovereign Sponsor / State Capital Financier	Sovereign financial exposure (Project cost escalation, schedule delays, oil-market dynamics)	Financier Level	Disclosed \$8 Billion Writedown	2024 audited Annual Report; gigaproject allocation reduced from 8% to 6% of total AUM; fund-wide net profit declining by 60% (Albarakati, 2025).

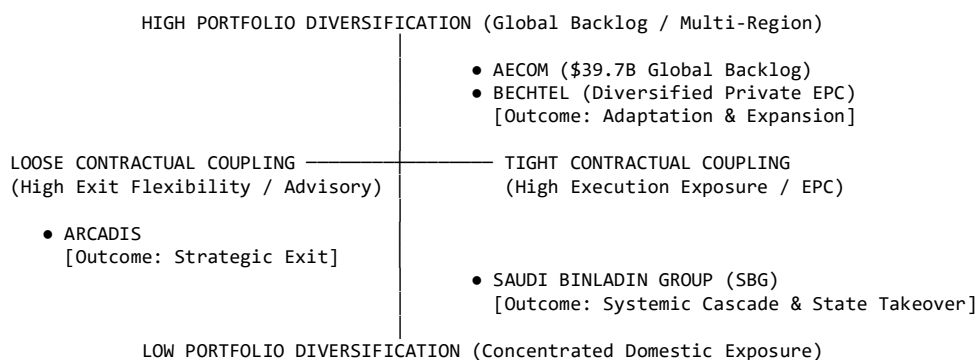
Two firms continued. Two did not. Reading the four contracting and consultancy cases side by side against Baccarini's (1996) interdependency framework and Perrow's (1984) coupling framework, the two with continuing, expanding engagements, Bechtel and AECOM, are both large, diversified international EPC/PMC firms whose portfolios extend well beyond Saudi Arabia. That gives them room to absorb a single programme's volatility without it threatening firm-level solvency. The two whose Saudi engagements ended in exit or distress, Arcadis and Saudi Binladin Group, each show a single identifiable trigger that then propagated: payment reliability for Arcadis, a fatal construction accident followed nearly a decade later by a full balance-sheet crisis for Saudi Binladin Group. Both fit Perrow's account of tightly coupled systems, where a failure in one node, cash flow, safety compliance, propagates to threaten the

whole engagement rather than staying contained. Hertog's (2010) segmented-clientelism framework, introduced in Section 2.7.1, explains why the same trigger-and-propagation pattern produced such different exit options for the two firms. Arcadis interacted with the Saudi state as an arm's-length, globally diversified advisory consultancy, closer to one of Hertog's insulated islands of efficiency; when payment reliability broke down, the firm could, and did, walk away, closing out contracts and exiting the region entirely by the end of 2024. Saudi Binladin Group sat inside the patronage structure itself, tied to domestic lending facilities and a state-business relationship the Ministry of Finance could not simply let fail without absorbing the consequences directly; that structural position is what converted a 2015 site accident into a decade-long sequence of state-supervised restructuring, syndicated lending, and, by December 2025, an outright equity takeover, rather than a negotiated exit. The coupling Perrow's framework describes and the exit asymmetry Hertog's framework describes are two readings of the same underlying fact: Saudi Binladin Group's tight coupling to the state was political as well as technical and contractual, and that political coupling is what removed the exit option Arcadis exercised freely. The Public Investment Fund's own \$8 billion writedown extends the same pattern one level further up the same coupled system rather than adding a fifth, directly comparable firm-level case: a fund that itself finances and part-owns several of these giga-projects absorbed losses attributable to the same kind of cost escalation and delay documented at the project level in Section 2.7, evidence that the coupling documented at firm level reaches the sovereign financier as well. None of this is a controlled comparison. Portfolio diversification versus concentration is a plausible alternative explanation for the firm-level split this thesis cannot rule out with the data available, and PIF's writedown could plausibly reflect broader oil-

market conditions rather than giga-project-specific risk management failures specifically, a point Section 5.7 returns to.

When mapping the four contracting and consultancy firms against Perrow's (1984) coupling framework and their broader corporate portfolio structures, a clear analytical divergence emerges. As illustrated in Figure 4.1, an entity's vulnerability to giga-project volatility is heavily moderated by two structural dimensions: Portfolio Diversification (global backlog vs. concentration in single client engagements) and Contractual Coupling (the flexibility to exit or reallocate resources without threatening firm solvency).

Figure 4.1: Contractor Outcomes Mapped by Portfolio Diversification and System Coupling



Note: Firms in the upper quadrant absorbed localized Saudi giga-project shocks through global portfolio diversification. Arcadis used its loose advisory coupling to execute a strategic regional exit, whereas SBG's concentrated domestic exposure and tight execution coupling resulted in a cascading balance-sheet crisis requiring sovereign intervention.

4.4 Predictive Accuracy Assessment

At the project level, the clearest predictive-accuracy data points show large, and in one case extreme, forecast-to-actual variance. NEOM's cost trajectory moved from an original public

figure of roughly \$500 billion to an industry-reported upper-bound scenario near \$8.8 trillion, and The Line's planned 170-kilometre build was cut to an expected 2.4 kilometres by 2030 (The Real Deal, 2025), variances an order of magnitude beyond what Flyvbjerg's (2014) megaproject baseline would predict for a conventional programme, and arguably beyond what reference class forecasting could have corrected for even in principle, given the absence of a comparable prior reference class discussed in Section 2.1. Six Flags Qiddiya's opening slipped from an original 2022 target to 31 December 2025, a three-year schedule variance consistent with, though less extreme than, the NEOM figures.

Table 4.2 quantifies the divergence between initial static planning baselines and documented execution realities by summarizing the predictive accuracy and variance metrics compiled from project disclosures and trade reporting through mid-2026.

Table 4.2: Summary of Project-Level Predictive Accuracy and Baseline Variance

Anchor Programme / Asset	Baseline Metric (Initial Forecast)	Documented Status / Reality (Mid-2026)	Absolute Variance / Escalation Factor	Primary Attribution & Evidentiary Source
NEOM (Overall Programme Cost)	~\$500 Billion initial capital estimate	~\$8.8 Trillion internal cost trajectory	~17.6x cost escalation (+1,660%)	Extreme optimism bias; absence of reference baselines for scale (The Real Deal, 2025; Flyvbjerg, 2014); figure traceable to a single leaked-document report, not an audited public disclosure (The Real Deal, 2025; Flyvbjerg, 2014).
The Line (Physical Build Footprint)	170 km continuous linear city by 2030	~2.4 km initial operational footprint expected by 2030	-98.6% scope reduction for 2030 target	Severe technical interdependency; timeline compression forcing scope collapse (The Real Deal, 2025; Williams, 2002).

Anchor Programme / Asset	Baseline Metric (Initial Forecast)	Documented Status / Reality (Mid-2026)	Absolute Variance / Escalation Factor	Primary Attribution & Evidentiary Source
Six Flags Qiddiya (Schedule Delivery)	Original commercial opening target: 2022	Official commercial opening: December 31, 2025	36-month schedule delay (+3 years)	Supply chain bottlenecks; regional contractor delay factors (Stevenson, 2026; Elshamy et al., 2025).
Public Investment Fund (Sponsor Capital)	Aggressive gigaproject capital allocation (~8% AUM)	Gigaproject allocation reduced to 6% AUM; \$8 Billion writedown	\$8.0 Billion direct capital impairment	Audited recognition of project cost escalation and schedule slips absorbing into sovereign wealth (Albarakati, 2025; PIF Annual Report, 2024).

PIF's disclosed \$8 billion writedown is a different kind of data point: unlike the NEOM and Qiddiya figures, it did not require a leak or a trade-press estimate to surface, it is the fund's own stated number, which makes it the single most reliable variance figure in this study even though it is aggregated across five gigaprojects rather than attributed to any one of them. None of the four case firms has published a variance figure of its own against which these project-level numbers can be directly attributed at the firm level. That is the clearest evidentiary gap this study encountered, and the reason RQ3's answer in Chapter 5 is stated as an association rather than a proven causal claim.

4.5 Synthesis Against Research Questions

RQ1 asked whether static, register-based models fail to anticipate the risks documented here. The scale of the NEOM and Qiddiya variances, the fact that none of the four firms shows any public evidence of a dynamic, continuously updated risk practice distinct from the standard register model, and PIF's own disclosed writedown all point to a failure of anticipation, though this study

cannot confirm what any firm's internal register actually contained. RQ2 asked about cascade patterns, including from firm to financier; Saudi Binladin Group's decade-long trajectory from a 2015 construction accident to a 2025 state takeover is the clearest documented cascade at the firm level, and PIF's own \$8 billion writedown is the clearest documented instance of risk reaching the financier directly, in the financier's own words. RQ3 asked whether continuing firms differ from exited or distressed firms; the case set shows a consistent association between portfolio diversification and continuation, but not a documented difference in risk framework or governance practice specifically, since none of the four firms discloses that level of detail.

Chapter 5: Discussion, Conclusion and Recommendations

5.1 Discussion of Findings in Light of the Literature

The scale of variance documented for NEOM and, to a lesser extent, Qiddiya extends Flyvbjerg's (2014) Iron Law finding into a register the underlying megaproject database was not built to capture: giga-project cost escalation an order of magnitude beyond the overruns Flyvbjerg documents for conventional megaprojects, and, per Section 2.1, potentially beyond what reference class forecasting can correct for at all, given the absence of a genuine reference class for a project of NEOM's scale. Baccarini's (1996) and Williams's (2002) complexity arguments hold up well against the NEOM case specifically, and Daniel and Daniel's (2019) CAS analysis of Hinkley Point C suggests this is not a peculiarity of Saudi planning culture: a UK nuclear megaproject and a Saudi linear city, built under very different political systems, both resist management as a fixed, decomposable plan. The Line's dramatic scope contraction, documented

above, is close to a textbook illustration of what happens when a highly interdependent, high-differentiation programme is planned as if it were decomposable. Aven's (2017) critique of ISO 31000's conceptual foundations, developed with no Gulf context in mind at all, reads as an almost exact description of the governance problem this thesis's case set displays: a risk framework tied to organisational objectives struggles once a state financier, a listed international contractor, and a domestic firm under state supervision no longer share a single definition of the objective being risk-managed. Perrow's (1984) coupling framework fits the Saudi Binladin Group case more precisely than it fits Arcadis, and fits the Public Investment Fund case in a different way again: a state-owned-adjacent domestic contractor's exposure to a national programme's financial dynamics is a tighter coupling than an international consultancy's contractual relationship, which can be, and was, exited, while PIF's position as both financier and part-owner of the affected gigaprojects places it inside the same coupled system it is also trying to fund.

Complexity theory and the contract-structure account are not rival explanations competing for the same evidence; they operate at different levels of the same system and are best read together. Complexity theory, and Perrow's coupling framework alongside it, explains why the NEOM programme itself behaved the way it did: a linear city developing energy, legal, transport, and construction sub-systems in parallel could not hold its planned form once timelines compressed, and The Line's dramatic scope contraction is the project-level expression of that structural interdependency. Contract structure and portfolio diversification explain something adjacent but distinct: not why the project itself changed shape, but why individual firms exposed to that same project diverged in outcome. Figure 4.1's mapping of the four contracting and consultancy cases against portfolio diversification and contractual coupling shows that the two continuing firms,

Bechtel and AECOM, are also the two with the most diversified global backlogs and the least direct financial exposure to any single Saudi client, while Arcadis's exit traces to an ordinary payment-reliability dispute that needed no appeal to project-level complexity to explain. Read together, the two accounts form a single, multi-level model rather than two competing single-level ones: complexity theory accounts for the project-level scope collapse, and contract structure and portfolio diversification account for the firm-level split between survival and exit within that collapsing project. The practical recommendations advanced in Section 5.5, portfolio exposure caps and payment-term enforcement alongside dependency mapping rather than instead of it, follow from both halves of that model at once, one aimed at the firm level and one at the project level, rather than from a single account chosen over the other. Distinguishing the relative weight of each mechanism within a single firm's outcome would still require firm-level financial data, contract margins, exposure limits, internal risk appetite, that lies outside what this thesis's secondary sources can access, and is flagged below as a specific target for future primary research.

5.2 Theoretical Contribution

This study's contribution is narrow but concrete: it extends complexity and normal-accident framing, developed and tested primarily on Western infrastructure and industrial-accident cases (Perrow's nuclear and chemical plants; Daniel and Daniel's UK nuclear megaproject), to a documented Gulf giga-project context, and it demonstrates, through four named firms and one financier, that "risk materialising differently across entities in the same programme environment" is an observable, citable pattern rather than only a theoretical possibility. It also adds one specific, narrower point to the reference-class forecasting literature: at NEOM's scale, the

absence of a comparable prior reference class may not be a data limitation researchers can eventually fix, but a structural feature of building something with no real precedent.

5.3 Proposed Refinements to a Dynamic Risk Assessment Framework

The structural limitations of static risk registers (Section 2.4) and the project-level variances (Section 4.4) point to a shared conclusion: giga-scale infrastructure requires a dynamic, adaptive governance model. Grounded in the empirical divergence between surviving entities (Bechtel, AECOM) and distressed or exited firms (Arcadis, Saudi Binladin Group), Figure 5.1 and Table 5.1 outline the core structural pillars of a proposed Dynamic Risk Governance Framework for giga-scale infrastructure.

Figure 5.1: Proposed Dynamic Risk Governance Framework for Giga-Scale Infrastructure

Pillar 1: Portfolio Exposure Limits

- Cap client-specific debt exposure.
- Monitor sovereign liquidity buffers.

Pillar 2: Continuous Contractual & HSE Monitoring

- Implement real-time automated payment and cash-flow verification.
- Enforce rigorous, non-negotiable HSE compliance auditing.

Pillar 3: Cross-Programme Dependency Mapping

- Track non-linear sub-system interactions.
- Replace static WBS with dynamic network modeling.

Table 5.1: Traditional Static Risk Registers vs. Proposed Dynamic Giga-Project Governance

Governance Dimension	Traditional Static Risk Register (ISO 31000 / PMBOK)	Proposed Dynamic Giga-Project Framework	Primary Case Evidence & Empirical Justification
Risk Identification & Architecture	Isolated, independent risk items scored via Probability × Impact matrices within static Work Breakdown Structures (WBS).	Interdependent network mapping that models cascading cross-programme dependencies and emergent system behavior.	Explains NEOM's scope collapse (The Line scaling from 170 km to 2.4 km); isolated WBS tasks failed to account for sub-system friction (Baccarini, 1996; Williams, 2002).
Financial & Portfolio Exposure	Assumes project risk is contained within site boundaries; relies on standard contractor balance-sheet capacity.	Enforces strict Portfolio-Level Exposure Limits, capping contractor backlog concentration with any single state-backed sponsor.	Prevents the Saudi Binladin Group (SBG) cascade, where concentrated domestic exposure transformed a site accident into an 86.38% state equity takeover (Perrow, 1984).
Monitoring Frequency & Auditing	Periodic (monthly or quarterly) manual reviews of lag metrics, schedule slips, and retroactive claims.	Continuous, automated monitoring of leading indicators: real-time payment reliability, cash-flow liquidity, and HSE compliance.	Directly addresses Arcadis's regional exit, which was triggered by chronic payment reliability failures and client HSE non-compliance (New Civil Engineer, 2024a).
System Response to Shocks	Robustness / Resistance: Attempts to defend static baselines through contingency buffers, often leading to brittle failure under compression.	Antifragility / Adaptation: Designed to absorb volatility, dynamically restructure scopes, and reallocate resources without firm-level solvency threats.	Reflected in AECOM and Bechtel's ability to absorb regional volatility and expand their PMC portfolios amidst programme restructuring (Taleb, 2012).

5.4 Conclusion

The documented record of Saudi giga-project outcomes through mid-2026, extreme cost and schedule variance at NEOM and Qiddiya, a disclosed \$8 billion writedown at the financier itself, and divergent firm-level outcomes ranging from contract expansion (Bechtel, AECOM) to full exit (Arcadis) to a decade-long slide into state rescue (Saudi Binladin Group), is consistent with a failure of traditional, static risk models to anticipate giga-project-scale risk, and with cascade dynamics that move risk from the project level to the firm level and, in PIF's case, to the financier. It does not, on the secondary evidence available, establish a proven causal link between a specific risk practice and a specific entity's outcome; it establishes an association

strong enough, and in PIF's case a disclosed figure solid enough, to justify closer, primary-data study.

5.5 Practical Recommendations

Contracting and consultancy firms bidding for Saudi giga-project work should treat portfolio diversification and payment-term enforcement as risk controls in their own right, not only as commercial terms, given how directly they appear to separate the continuing firms from the exited and distressed ones in this case set.

Table 5.2 translates these empirical lessons into a strategic risk mitigation matrix, offering practical controls for both international and domestic firms operating in the Saudi market.

Table 5.2: Strategic Risk Mitigation Matrix for Giga-Project Bidders and Incumbents

Target Stakeholder Group	Project Lifecycle Phase	Recommended Governance Control	Strategic Implementation Mechanism	Empirical Case Lesson
International PMC & EPC Consortia (e.g., Bechtel, AECOM, Arcadis peers)	Pre-Award & Bidding	Mandatory Portfolio Diversification Caps	Restrict total contract backlog tied to any single giga-project client or sovereign sponsor to a maximum percentage of global firm revenue.	Enables firm-level resilience and portfolio expansion even during client-level scope reductions (AECOM / Bechtel vs. SBG).
	Contract Structuring	Automated Liquidity & Payment Triggers	Incorporate contractual firewalls, milestone-linked mobilization advances, and strict stop-work thresholds tied directly to payment timelines.	Prevents chronic working-capital depletion and eliminates the necessity of disorderly regional exits (Arcadis).
	Execution & Delivery	Non-Negotiable HSE Auditing	Establish independent, executive-level health, safety, and environmental (HSE) oversight with direct reporting lines to corporate boardrooms, bypassing local site management.	Protects firm reputation and workforce integrity against client-level compliance friction (Arcadis).
Domestic Contractors &	Pre-Award & Bidding	Cross-Domain Cascade Modeling	Conduct rigorous pre-contract stress testing to	Mitigates normal accident cascades where site-level

Target Stakeholder Group	Project Lifecycle Phase	Recommended Governance Control	Strategic Implementation Mechanism	Empirical Case Lesson
Regional JVs (e.g., SBG peers, local EPCs)			evaluate how localized physical site risks could impact firm-wide banking covenants and lending facilities.	operational dominoes trigger corporate solvency crises (SBG / Perrow, 1984).
	Execution & Delivery	Reputational Leading-Indicator Tracking	Treat any major site accident or regulatory penalty as a multi-year structural risk event; immediately secure liquidity buffers and independent financial advisory.	Early intervention prevents protracted decade-long debt accumulation and forced equity dilution (SBG 2015–2025).
Sponsors & State Financiers (e.g., PIF, NEOM, Qiddiya)	Programme Governance	Reference-Class & Feasibility Realignment	Replace bottom-up optimism bias with dynamic feasibility reviews that continuously adjust physical scope targets to match supply-chain realities and capital allocation limits.	Prevents sudden multi-billion-dollar sovereign writedowns and preserves capital allocation efficiency (PIF \$8B Writedown / Flyvbjerg, 2014).

Given the Saudi Binladin Group trajectory specifically, firms with concentrated exposure to a single state-backed client should treat a single serious reputational event as a leading indicator worth tracking for years, not months, afterward, rather than assuming an early recovery closes the risk.

5.6 Recommendations for Future Research

The clearest next step is primary research: interviews or survey access to risk officers at firms with continuing Saudi giga-project engagements, which this thesis's secondary-data design deliberately avoided but which is the only way to test whether the associations found here reflect an actual difference in risk practice rather than only in portfolio structure. Future research should expand the systematic literature review across comprehensive indexing databases such as Scopus and Web of Science to capture broader peer-reviewed empirical engagement with GCC

construction risk. A third extension, prompted directly by PIF's disclosed writedown, would disaggregate the \$8 billion figure across PIF's five named gigaprojects, which this thesis's public sources did not allow.

A fourth, and in one sense more fundamental, extension follows from how this thesis has treated its own opening case. The 2015 Grand Mosque crane collapse is coded here, per Section 3.5's schema, as a reputational risk event and read, in Chapter 4 and Figure 1.1, as the operational trigger for a decade-long financial cascade. That coding is defensible for the thesis's stated purpose, but it also routes a fatal industrial accident, 118 deaths, entirely through a lens of contractual and financial consequence for the firm and its state overseers. A separate line of research, grounded in occupational safety and migrant labour governance literature rather than project-risk theory, would ask what this same event meant for site-level safety practice and workforce protection across Saudi giga-projects since 2015, a question this thesis's financier-and-firm-level design was not built to answer and does not claim to.

5.7 Study Limitations

This study has no primary data and no verified internal risk register for any of the four firms. One figure needs its own caveat restated here: NEOM's \$8.8 trillion trajectory rests on secondary reporting of a leaked document, not a public disclosure, a materially weaker evidentiary basis than PIF's own annual report figures. The PIF case itself has a limitation worth stating directly: an \$8 billion writedown aggregated across five gigaprojects cannot be attributed to any single project's risk management practices, and a portion of it plausibly reflects oil-market and interest-rate conditions unrelated to any contractor's or consultancy's conduct, a confound this thesis's design cannot separate out. Bechtel's and AECOM's contract values were not found in any public source, which limits how precisely their financial exposure can be compared to Saudi Binladin

Group's disclosed debt figures. And the practitioner and academic literature specific to this exact topic, Saudi giga-project risk rather than megaprojects or GCC construction generally, remains thinner than the surrounding literature, even after this round of additional search. Consequently, these findings should be interpreted as a documented empirical baseline for further investigation rather than a conclusively tested causal model.

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Appendix A: Secondary Source Verification Protocol

This appendix reproduces, in fuller form, the source-handling protocol summarised in Sections 3.4 and 3.6 and diagrammed in Figure 3.1. It is included to give an examiner a single, self-contained reference for how secondary evidence was screened before being admitted into the case coding in Chapter 4, without needing to cross-reference multiple chapters.

Source category	Handling rule applied
Firm press releases and investor disclosures	Treated as primary for firm-level claims (e.g., contract awards, backlog figures). Attributed directly to the firm in-text.
Audited annual reports (PIF)	Treated as the strongest evidentiary tier available in this study; used without requiring independent corroboration, since the figures are the entity's own disclosed numbers.
Trade press (New Civil Engineer, MEED, Construction Week, AGBI, Semafor, The Real Deal)	Admitted where a claim could be traced to a named publication and, where possible, corroborated across more than one outlet.
Regional industry surveys (PwC Middle East)	Used for sector-level context only; not used to support firm-specific claims.
Peer-reviewed academic literature	Used to construct the theoretical framework (Chapter 2) and, where a study addressed the Gulf region directly, to corroborate regional patterns (Section 2.6).
Practitioner literature (PM World Journal)	Used to establish the practitioner-side research gap (Section 2.9), not treated as peer-reviewed evidence.
AI-generated aggregator content and unattributed web summaries	Excluded outright unless independently confirmed against a primary or trade-press source, per the verification protocol described in Section 3.4.