

Risk, Change and Complexity: The Triple Threat to Mega-Project Control In Saudi Arabia & Beyond¹

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Abstract

Mega-projects play a vital role in driving economic growth and transformation, yet they often face challenges like budget overruns and missed deadlines. This paper takes a closer look at three key factors: risk, change, and complexity. These factors tend to disrupt how well large projects are managed with a special focus on Saudi Arabia's Vision 2030 mega-projects. By examining lessons learned from large-scale projects around the world, the study highlights how these three elements can overwhelm traditional project controls. To address this, the paper suggests that successful delivery requires a stronger focus on integrated risk management, structured change control processes, and better governance of complex systems. Ultimately, it proposes a more unified approach to project control that can improve predictability, keep stakeholders aligned, and allow for more agile execution even in the most dynamic and demanding project environments.

1. Introduction

Across the globe, countries are increasingly turning to mega-projects to drive national transformation, and Saudi Arabia is no exception. As part of its bold Vision 2030 agenda, the Kingdom is investing heavily in large-scale initiatives designed to reshape its economy, society, and global standing. From massive infrastructure undertakings like the Riyadh Metro and the Red Sea Project to futuristic urban developments like Neom, these projects reflect an ambitious vision for the future.

Yet, despite their scale and strategic importance, such initiatives often run into challenges. Cost overruns, missed deadlines, and unexpected complications are common not just in Saudi Arabia, but worldwide. Even with advancements in project management tools and techniques, delivering mega-projects on time and within budget remains a persistent challenge.

This paper explores the core reasons behind these difficulties, focusing on three key interrelated factors: risk, change, and complexity. These factors often disrupt traditional project control methods and can lead to significant setbacks. By examining real-world

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examples from both Saudi Arabia and other countries, the paper highlights how a more integrated and adaptive approach to managing these dynamics can improve outcomes. The goal is to strengthen control systems and increase the chances of success even in the most complex and fast-moving environments.

2. Risk in Mega-Projects: A High-Stakes Landscape

Risk is a natural part of any project, but in mega-projects, the stakes are much higher. These large-scale, multi-year, and often multi-billion-dollar initiatives stretch the limits of engineering, design, and management. They rely heavily on cutting-edge technologies and involve a wide range of stakeholders from global contractors and financial institutions to government agencies and local communities. With so many moving parts, even small or unexpected risks can snowball into major disruptions, affecting timelines, budgets, and overall project outcomes. The difficulties of managing a complex network of environmental laws, regulatory requirements, and aspirational Vision 2030 sustainability goals are exemplified by Saudi Arabia's Red Sea Project (Moser and Avni, 2023; Figure 1). Continuous, strict environmental monitoring and compliance inspections are necessary for construction in such ecologically sensitive places, which invariably raises costs, prolongs project schedules, and adds levels of administrative control.

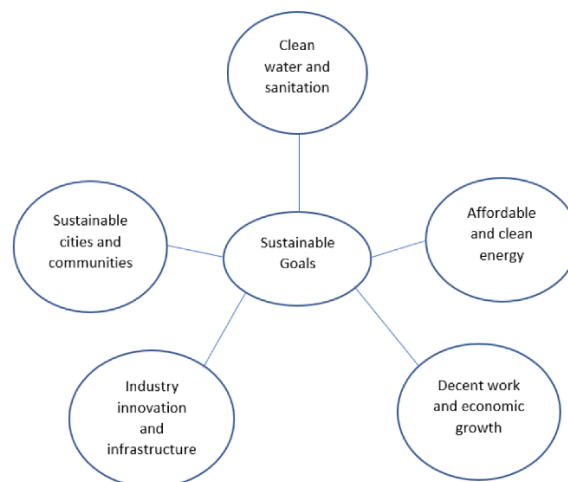


Figure 1: Vision 2030 sustainability goals (Alajmi and Memon, 2022)

This assertion is well supported by well-known examples from all throughout the world. The Boston "Big Dig," a project that acts as a warning in the realm of mega-project management, is among the most notable examples. A combination of poor early risk assessments, ongoing contractor disputes, and ever-changing political and regulatory impediments caused the project's initial anticipated cost of \$2.8 billion to soar to about

\$15 billion (Madhavan et al., 2023). These kinds of real-world examples clearly show just how crucial it is to take risk identification seriously from the very start, apply more advanced quantitative methods, and build proactive risk management into every stage of a project. By using tools like Monte Carlo simulations and probabilistic cost modeling, project managers can gain a much clearer picture of what-ifs and potential outcomes — far beyond what simple point estimates can offer. This kind of forward-looking approach helps teams anticipate problems, adjust plans early, and keep small issues from snowballing into major setbacks.

3. Change: The Scope Challenge

Changes in scope are almost inevitable in mega-projects due to shifting stakeholder perspectives, technology breakthroughs, and geopolitical events. However, they quickly turn into the main cause of significant delays and budget overruns in the absence of robust, established controls (Figure 2). The constantly shifting demands and strategic goals of stakeholders sometimes lead to scope revisions in Saudi Arabia's giga-projects. An excellent illustration of this fluidity is Neom, which was initially intended to be a linear futuristic metropolis but has now grown to include a number of expansive and unique expansions, such as the floating industrial port of Oxagon and the mountain resort of Trojena (Alogayell et al., 2024). Despite being in accordance with long-term transformation objectives, these expansions bring about a great deal of unpredictability, which makes it very difficult for control teams to set and uphold consistent performance baselines.

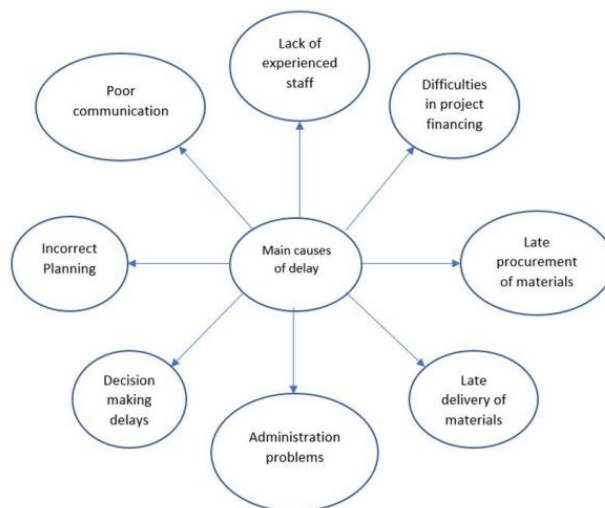


Figure 2: Main causes of delay in the Saudi Arabia construction industry
(Alajmi and Memon, 2022)

An excellent illustration of the real-world effects of unrestrained scope creep is the Sydney Light Rail project, whose total expenditures more than doubled as a result of significant unforeseen underground utility work and continuous design modifications. Every change had direct effects on procurement procedures, engineering plans, and contractual duties in addition to having an impact on compliance certifications; this created a domino effect that was challenging to control (Love and Ika, 2021). These kinds of disruptions really highlight how even small changes in a project's scope can snowball into bigger technical, financial, or regulatory problems if they aren't carefully managed. Think of it like steering a large ship, where even a slight turn in the wrong direction without proper course correction can send you way off track.

That's why major projects need strong, centralized systems to manage changes. These systems include having a dedicated team, such as a Change Control Board, that reviews every proposed change, understands its impact, and makes smart decisions before moving forward. Pairing this with clear documentation and formal assessments helps teams stay on top of risks before they grow out of control.

When you combine these governance practices with advanced tools for risk analysis and schedule tracking, project teams don't just react to problems but also start anticipating them. This proactive approach builds a stronger foundation for the project, helping it stay stable and on course, even when things inevitably change along the way.

4. Complexity: A Hidden Cost Driver

Beyond size, one of the most powerful yet unappreciated cost factors in large-scale projects is complexity. It results from the complex interaction of cutting-edge technology, complex legal and regulatory structures, a wide range of stakeholders, sheer size, and cross-regional implementation. The Riyadh Metro project, which requires smooth cooperation between three foreign consortia to construct six lines covering more than 170 kilometers, is a prime example of this systemic complexity (Alajmi and Memon, 2022). These project setbacks rarely come from just one mistake. More often, it's a mix of connected issues that snowball. For example, teams from different cultures may struggle to communicate clearly, technical systems might not fit together as planned, or shifting regulations could catch everyone off guard. All of these factors pile up, leading to costly delays and budget overruns.

A clear example of this is the Berlin Brandenburg Airport, which became infamous for its massive delays and cost escalations. Behind the scenes, the project was tangled in conflicting design standards, safety systems that didn't align with ventilation setups, and

a lack of coordination between contractors. These weren't just small hiccups; they created confusion and inefficiencies at every level, pushing the opening back by over nine years (Lin et al., 2024). It is imperative that we abandon fragmented, old management techniques and adopt digital collaboration platforms that offer a single, authoritative source of truth, as these high-profile failures highlight. These systems offer integrated project delivery (IPD) frameworks that maintain stakeholder alignment, impose strong and uniform governance structures, and facilitate more transparent communication. Additionally, using modular execution techniques whenever feasible can aid in separating interdependencies, streamlining the building schedule, and greatly minimizing the complexity's knock-on effects throughout the larger project ecosystem.

5. Toward Control: An Integrated Framework

Effective project control requires a comprehensive and integrated framework that permits real-time oversight and data-driven decision-making since risk, change, and complexity have the potential to be disruptive. For this objective, traditional, compartmentalized techniques are essentially insufficient. Methodologies like as structured change and impact analysis, risk-integrated scheduling, which incorporates uncertainty into the plan, and Earned Value Management (EVM) augmented by dynamic performance dashboards are all components of effective frameworks (Proaño-Narváez *et al.*, 2022). Digital transformation powers this integration; cloud-based platforms for Building Information Modeling (BIM) and Project Management Information Systems (PMIS) guarantee openness, responsibility, and flexibility for all parties involved (Taresh *et al.*, 2025). In the end, these tactics turn project control from a reactive, firefighting discipline into a proactive one that helps executives maintain these massive undertakings in line with their strategic goals for time, money, and quality.

6. Conclusion

Mega-projects may be complex, risky, and constantly evolving, but they remain essential to driving forward bold national visions like Saudi Arabia's Vision 2030. The reality is, managing these huge undertakings is no small feat. The combined pressures of unexpected changes, evolving risks, and growing complexity often push traditional project controls to their breaking point, leading to delays, budget overruns, and frustrated teams and stakeholders.

The key to turning this around lies in being proactive from the start. That means embedding solid risk assessments into the earliest planning stages, putting clear and

transparent processes in place to manage changes as they come, and building stronger governance systems that can keep up with the scale and complexity of today's projects.

At the same time, embracing modern digital tools and collaborative platforms can make a world of difference. These tools help teams communicate better, stay aligned, and see what's really happening across the project in real time.

By bringing all these elements together into a unified approach, mega-project teams can work smarter, stay ahead of surprises, and keep even the most ambitious initiatives on track from start to finish. It's about setting up not just for success, but for sustainable impact.

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Rashid Alrashid is a certified Project Management Professional (PMP), Risk Management Professional (RMP), and Six Sigma Black Belt with over 14 years of experience in planning and executing mega-projects within the oil and gas industry. Currently serving in a leadership role at Saudi Aramco in Saudi Arabia, he has previously led project teams in the Engineering, Procurement, and Construction (EPC) of complex mega-projects.

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- **“Aramco Enhances Hydrotesting & Reinstatement Process”** – OGN News (June 2023)
- **“The Role of Robotics in Oil & Gas Construction Safety”** – PMI-KSA Chapter (September 2024)

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