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Digital Insights:

Fast-Track Mega Projects Accelerating Delivery in Oil and Gas Infrastructure

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Saudi Aramco envisions a project delivery model where speed, quality, and safety are not trade-offs but integrated pillars of execution excellence. By leveraging advanced planning, innovative engineering practices, and a culture of accountability, Aramco is redefining how mega projects are delivered faster, more efficiently, and with uncompromising adherence to the highest standards of quality and operational safety. This vision supports the Kingdom's broader strategic goals while setting a global benchmark for capital project performance.

Haitham M Alawwad
Saudi Aramco
Project Management
Manager Project
Controls

Anwar R Alodail Saudi
Saudi Aramco
Process & Control
Systems
Sr. Engineer
PMI PMP

Saad F. Alkhaldi Saudi
Saudi Aramco
Project Management
Project Engineer
PMI PMP- PMI RMP-PMI

ABSTRACT

Fast-tracking mega oil and gas projects has emerged a strategic priority as the industry confronts increasing pressure to expand production capacity in order to meet global energy demand within short timeline along with more efficient and cost-effective delivery. This paper explores various strategies used to compress project lifecycles in large-scale gas processing with a specific focus on the Fadhili Gas Increment Program in the Kingdom of Saudi Arabia – one of Saudi Aramco's flagship initiatives aimed to boost domestic gas production. The paper outlines a suite of execution strategies specifically designed to compress project schedules while preserving cost-efficiency and technical integrity approaches such as early engagement of Engineering, Procurement, and Construction (EPC) contractors, extensive use of modularization, replication (cloning) of existing plant designs, and early procurement of long-lead item during Front-End Engineering Design (FEED). It also contextualizes these strategies within Saudi Aramco's Capital Management System (CMS), analyzing benefits, risks, and overall impacts on schedule and cost.

1. INTRODUCTION

Mega oil and gas infrastructure projects such as gas processing facilities and oil refineries are typically complex, capital-intensive, and span several years from conception to completion. Traditional project execution models often struggle with inefficiencies, prolonged timelines, and cost overruns. In contrast, fast-track execution strategies have emerged as a means to streamline delivery by overlapping project phases, leveraging lessons learned from previous projects, enabling agile and accelerating decision-making.

Fadhili Gas Increment Program is a prime example of such approach. The program seeks to expand Fadhili Gas Plant's processing capacity from 2.5 to 4.0 billion standard cubic feet per day (Bscfd) with 50% expansion. The project has adopted several acceleration measures to redefine the typical execution standards as well as influence future best practices across Saudi Aramco and the broader industry.

2. STRATEGIC APPROACHES TO PROJECT ACCELERATION

2.1 EARLY ENGAGEMENT OF EPC CONTRACTORS

One of the cornerstone acceleration strategies implemented in Fadhili Gas Increment Program was the engagement of EPC contractors. Instead of waiting for the completion of the FEED phase, Saudi Aramco strategically involved shortlisted EPC firms during project proposal and early engineering phases. This collaborative approach fostered alignment between project sponsor, designers, and execution contractors from the outset. Engaging EPC contractor in the early stage of project lifecycle enabled project team to accomplish the following:

- **Seamless Transitions from Design to Execution:** By aligning the EPC contractors with the project's engineering consultants during early design, the transition from FEED to detailed engineering and construction was significantly streamlined. Design decisions were made with execution constraints in mind, reducing gaps, misalignments, and redesigns that typically occur when the EPC is brought in late.

- **Proactive Constructability Reviews:** Early contractor involvement enabled field-experienced personnel to participate in constructability reviews from the outset. This facilitated early identification of design elements that would be difficult, inefficient, or costly to construct in the field, particularly within constrained or brownfield environments. As a result, design revisions were made preemptively, improving field productivity and reducing the likelihood of late-stage changes.
- **Streamline Procurement Strategy Development:** With contractors engaged early, procurement planning benefited from practical input on market availability, vendor capabilities, logistics considerations, and fabrication timelines. This enabled early placement of long-lead items, optimized bid packaging, and supplier engagement strategies that reduced supply chain bottlenecks.
- **Enhance Schedule and Cost Predictability:** By accelerating the alignment between engineering and execution, the project avoided the typical delays associated with pre-FEED bidding, contract award, and engineering team mobilization. This contributed to a 6–4-month reduction in the overall project lifecycle, a significant gain in a capital-intensive program of this scale.

However, project acceleration introduced certain risks throughout project development leading to reduction in project flexibility for scope evolution. Early contractor engagement necessitated a higher degree of definition and commitment to the project's scope, technology selections, and configuration at earlier stage. This reduced the flexibility to implement significant design optimizations later in the project, particularly as new information or operational priorities emerged. Moreover, engaging EPC contractors required innovative contracting models that could accommodate evolving designs while managing commercial exposure and accountability.

To mitigate these risks, the project team implemented a robust governance framework within Saudi Aramco's Capital Management System (CMS), including phased approvals, change control protocols, and rigorous value assurance reviews. This ensured that early EPC involvement translated into measurable schedule and cost benefits without compromising project integrity or flexibility.

2.2 LONG-LEAD ITEM PROCUREMENT DURING FEED

Another key acceleration strategy employed in Fadhili Gas Increment Program was the early initiation of procurement and manufacturing for long-lead equipment—particularly major rotating machinery such as Gas Compressors, Blowers, and other Critical Equipment—during FEED phase. Traditionally, such equipment is procured following the completion of detailed engineering to ensure technical specifications are fully defined. However, given the extended global lead times for custom-engineered machinery and ongoing supply chain volatility, the project adopted a parallel execution strategy to mitigate procurement delays and maintain alignment with aggressive construction targets. By strategically initiating the procurement process during the FEED phase, the project realized several key benefits:

- **Reduction in Equipment Lead Times:** Early placement of Purchase Orders (POs) allowed manufacturers to begin engineering, fabrication planning, and raw material sourcing well in advance. For certain high-specification rotating equipment, this approach reduced manufacturing and delivery timelines up to 8 months, significantly de-risking the construction sequence and startup milestones.
- **Vendor Alignment with Execution Strategy:** Engaging equipment suppliers earlier in the project lifecycle enabled better integration of vendor engineering teams and EPC's design processes. This improved the quality and responsiveness of technical documentation, interface definition, and fabrication sequencing, ensuring that equipment design and delivery schedules were aligned with construction and installation requirements.

The strategy carried inherent risks primarily with potential exposure to design changes post-order. Placing orders before detailed engineering completion introduced the risk that later design refinements or process modifications could render the original equipment specifications partially or wholly obsolete. In such cases, rework, redesign, or even re-procurement could lead to cost overruns and schedule impacts.
To address these risks, Fadhili project team employed several mitigation measures, including:

- Issuing **purchase orders with staged technical hold points**, allowing critical design aspects to be frozen progressively as engineering matured.
- Leveraging **frame agreements and proven vendor relationships** to ensure flexibility in technical configuration without triggering major commercial penalties.
- Implementing a **cross-functional technical assurance process,** integrating process, mechanical, and procurement disciplines to validate design readiness before order placement.

By proactively managing these risks through structured controls, the project was able to capitalize on the schedule advantages of early equipment procurement while maintaining technical and commercial discipline. This strategy was an essential step in maintaining momentum across critical path activities and ensuring timely delivery of major mechanical packages.

2.3 CLONING APPROACH TO FACILITY DESIGN

The most innovative strategic approach adopted in the Fadhili Gas Increment Program was the cloning of the existing Fadhili Gas Plant design instead of initiating a new design cycle from scratch, the project team strategically opted to replicate the technical specifications, engineering deliverables, process philosophies, and even vendor selections from the existing facility making only minimal, project-specific modifications where necessary.

This approach rooted in the principles of standardization and design replication where it enabled a significant reduction in front-end engineering effort, shortened the procurement cycle, and enhanced project execution certainty by leveraging lessons learned from the original plant.

Key Elements of the Cloning Strategy:

- **Combined Front-End Engineering Phases:**

The project combined the FEL-2 (conceptual engineering) and FEL-3 (detailed engineering) phases into a single Management Committee (MC) gate, enabled by the high degree of design maturity inherited from the original plant. This consolidation shortened the front-end approval cycle by several months and allowed early mobilization of design resources.

- **Rapid Issuance of Material Requisitions (MRs):**

By reusing validated MR templates and technical specifications from the original project, the team was able to issue a significant portion of procurement packages within the first three months of detailed design. This early action allowed concurrent procurement and engineering activities to progress with minimal delay.

- **Shortened Procurement Cycles:**

Utilizing vendor specific Non-Material Requirements (NMRs), datasheets, and technical bid evaluations from the original plant enabled the procurement team to cut cycle times by up to 40%. Additionally, previously qualified vendors were re-engaged, further reducing lead times by as much as two months, particularly for engineered-to-order equipment.

Despite cloning design offered considerable advantages, there were multiple challenges encountered during the project lifecycle:

- **Use of Outdated Standards:**

In some cases, reliance on legacy specifications—such as engineering standards dating back to 2014 (SAES, SAMSS, SAEP)—created compatibility issues with newer vendor technologies or missed opportunities for incorporating more cost-effective, modern solutions.

- **Limited Flexibility for Optimization:**

Strict adherence to the previous design constrained opportunities for technical innovation or performance improvements that could have been realized through updated engineering analysis.

To mitigate these risks, the project instituted a technical validation task force to systematically review cloned documents against current Saudi Aramco Engineering Standards (SAES) and market developments. Selective updates were implemented where clear benefits could be demonstrated without compromising schedule.

3. MODULARIZATION AS A SCHEDULE DRIVER

Modularization, an increasingly adopted strategy in large-scale oil and gas projects, was a key execution tactic in Fadhili Gas Increment Program. It involves the off-site fabrication and pre-assembly of major plant components, which are subsequently transported to and installed at the project site. By shifting a significant portion of construction activity to controlled fabrication yards, modularization effectively decouples site readiness constraints from the overall construction timeline and drives substantial gains in schedule, quality, safety, and labor efficiency.

Fadhili modularization was selectively applied to key facility elements such as pipe racks, utility skids, and instrument shelters, enabling early fabrication parallel to site preparation and civil works. This approach allowed the project to advance multiple workstreams concurrently, particularly in areas of the plant where early mechanical completion was critical to achieving phased startup objectives.

Key Advantages of Modularization:

- **Schedule Compression of 30–20%:**

By executing fabrication and site development activities in parallel, the project reduced overall construction duration by an estimated 30–20%, aligning with industry benchmarks for modular execution in large infrastructure projects.

- **Improved Labor Productivity and Quality:**

According to McKinsey & Company (2022), modular construction can improve labor efficiency by more than 25% due to better working conditions, streamlined workflows, and fewer weather-related disruptions in off-site fabrication yards. This held true for Fadhili, where welding, assembly, and pre-commissioning activities were completed with higher productivity and fewer rework cycles compared to traditional stick-built methods.

- **Enhanced Safety Performance:**

Modular construction reduces on-site workforce density and the volume of high-risk activities conducted in confined, congested areas. At Fadhili, this translated into a lower incidence of safety events, better housekeeping, and improved compliance with safety protocols, especially during peak construction periods.

Despite of above benefits, modularization introduced specific challenges that required strategic management:

- **Transportation and Logistics Complexity:**

Oversized and heavy modules demanded detailed transport planning, including route surveys, permitting, and coordination with port and customs authorities. Delays or damage during transport could jeopardize downstream schedules. The Fadhili team mitigated these risks by engaging logistics specialists early, conducting dry runs, and coordinating with regulatory agencies well in advance.

- **Interface Management Challenges:**

The success of modular integration relies on precise interface control between modules and stick-built elements. Any misalignment or dimensional inconsistency can lead to costly field adjustments. At Fadhili, a dedicated interface management team was deployed to ensure design integration, coordinate tolerances, and validate tie-in points during 3D model reviews and pre-shipment inspections.

- **Early Design Freeze Requirement:**

Modularization demands a higher degree of design maturity early in the project to allow for fabrication to begin. This reduces flexibility for later design changes, which was managed through phased design freeze protocols and robust change control mechanisms.

4. INTEGRATION WITH ARAMCO'S CAPITAL MANAGEMENT SYSTEM (CMS)

Saudi Aramco's Capital Management System (CMS) serves as the foundational project governance and assurance framework, providing a structured, stage-gated process that guides capital project development from concept through execution and final handover. Designed to ensure that all capital investments align with corporate objectives, technical standards, and financial discipline, the CMS typically consists of a series of defined gates—each requiring formal approvals, deliverables, and value assurance reviews before the project is allowed to advance. In Fadhili Gas Increment Program, the project team successfully leveraged CMS to enable a fast-tracked delivery approach, while still maintaining full compliance with Aramco's governance requirements. This was achieved by strategically utilizing CMS's built-in flexibilities to streamline approvals, reduce redundancy, and accelerate decision-making for cloned, low-risk work scopes.

Key CMS Enablers and Customizations:

- **Gate Skipping Based on Pre-Defined Scope:**

Owing to the reuse of a mature and fully developed design from the original Fadhili Gas Plant, the project scope was already well-defined and technically vetted. This allowed the project team, with approval from the Capital Programs governance body, to bypass Gate 1 (Business Case Development) and Gate 2 (Concept Selection) proceeding directly to Gate 3 (Pre-FEED Completion). This significantly reduced the front-end planning cycle and allowed earlier mobilization of engineering and procurement resources.

- **Tailored Schedule B Metrics for Cloned Projects:**

For cloned systems and modules, standard CMS progress tracking metrics were modified to better reflect the project's fast-track nature. A custom Schedule B was developed to emphasize early milestones such as the issuance of Issued for Construction (IFC) deliverables and long-lead procurement. This enabled the project to track progress based on tangible execution outputs rather than traditional document-heavy gate criteria.

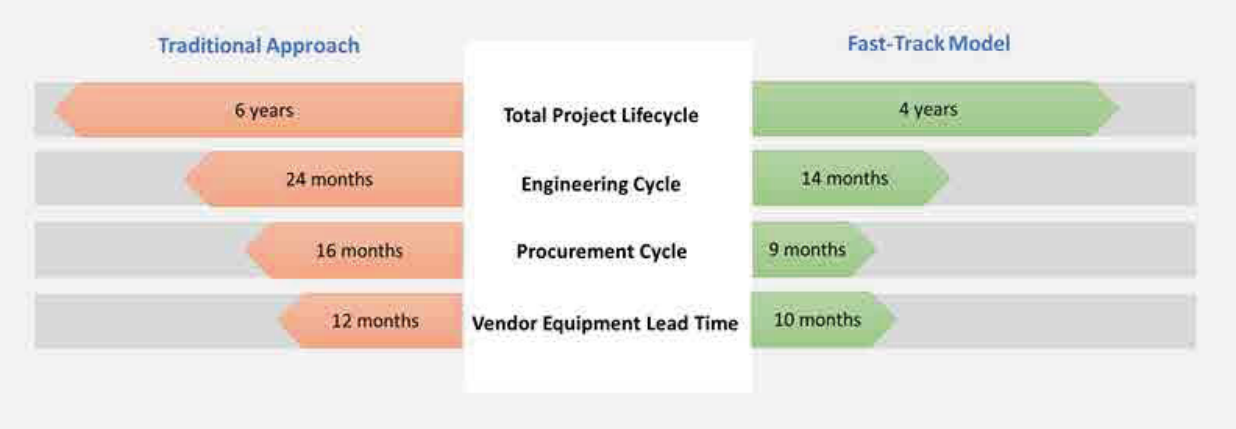
- **Deliverable Review Waivers for Reused Designs:**

Given the high confidence in previously approved engineering documents and vendor data, the CMS allowed for waivers or streamlined reviews of standard deliverables for systems that were being directly cloned from the original plant. This included piping specifications, control philosophies, and datasheets for major equipment where no significant changes were made. This approach reduced internal review workloads and accelerated document approvals without compromising technical integrity.

5. OUTCOMES: COST, SCHEDULE, AND QUALITY

The implementation of fast-track strategies in Fadhili Gas Increment Program yielded substantial performance improvements across the core pillars of project delivery: schedule saving up to 12 months, cost optimization up to 10% reduction across total CAPEX, and engineering efficiency. By combining early EPC engagement, strategic design replication (cloning), modularization, and advanced procurement practices, the project achieved a significantly shortened execution window without compromising on quality or safety.

The following chart summarizes key quantitative outcomes, benchmarked against traditional capital project delivery models commonly used in Saudi Aramco and the broader oil and gas industry:



Sources: Project estimates based on internal Fadhili reports and Aramco execution benchmarking data`

6. CHALLENGES AND LESSONS LEARNED

While the Fadhili Gas Increment Program demonstrated the effectiveness of fast-track execution strategies especially design cloning, it also revealed important limitations and areas for improvement.

6.1 CLONING LIMITATIONS

Although design replication significantly accelerated engineering and procurement processes, several constraints impacted its seamless application:

- **Vendor Resistance to Outdated Standards:**

Some vendors challenged the use of legacy specifications from the original Fadhili Gas Plant, such as 2014 versions of the Saudi Aramco Engineering Standards (SAES). This resulted in multiple requests for modifying original design documents to align with current manufacturing capabilities and industry practices.

- **Licensor and Regulatory Changes:**

Cloned process units occasionally required revalidation due to updated licensor technologies or changes in regulatory compliance criteria. These revisions diluted the extent of true replication and required targeted reengineering.

As a lesson learned, design cloning must be complemented by an upfront gap assessment between legacy and current standards to preempt rework during execution.

6.2 STANDARDIZATION GAPS

Fast-tracking through cloning exposed systemic limitations in the current governance framework and technical documentation:

- **Misalignment with Existing Procedures:**

Key procedural documents such as SAEP-303 (Engineering Reviews of Project Documentation), SAEP-12 (Project Execution Plan), and SAEP-14 (Project Proposal) were not originally crafted to accommodate fully cloned project scopes. This led to unnecessary deliverables and duplicate reviews.

- **Lessons Learned Integration:**

In response, a structured lesson learned exercise has been completed, and updates to SAEPs and relevant Schedule B/Q criteria are underway to enable seamless cloned project execution.

As a lesson learned, institutionalizing cloning requires clear procedural pathways that reflect reduced documentation needs and pre-approved designs.

6.3 REVIEW AND APPROVAL BOTTLENECKS

Despite the use of pre-approved designs and cloned specifications, several internal stakeholders continued to mandate conventional, full-cycle technical reviews:

- **Execution Delays Due to Review Cycles:**

Some discipline reviewers treated cloned packages as novel designs, leading to repeated iterations, even when the technical content was unchanged from the baseline design

- **Recommended Process Improvement:**

A formal tabletop review approach should be mandated for cloned design where verification is limited to variances from the base design. Additionally, standardizing review protocols to a single review cycle can avoid rework and reduce schedule drag. As a lesson learned, change management and stakeholder alignment are critical to realizing the full benefits of design reuse.

7. FUTURE RECOMMENDATIONS

To institutionalize fast-tracking in mega projects, the following are recommended:

- Develop a Cloning Best Practice Framework by 2027
- Revise key engineering procedures to recognize and support cloned facilities
- Expand modularization to more systems, especially in brownfield and constrained environments
- Create vendor alignment guidelines to allow use of previously accepted deviations and NMRs
- Incentivize reuse of existing licensor and supplier relationships where performance was proven

8. CONCLUSION

Fadhili Gas Increment Program stands as a model of how large-scale oil and gas infrastructure projects can be delivered faster, more cost-effectively, and with reduced execution risk through the strategic application of innovative methodologies. By integrating advanced execution strategies including design cloning, modular construction, early EPC engagement, and pre-FEED procurement of long-lead items, the project achieved significant schedule compression without compromising on quality or safety.

The main contributor to achieve this remarkable success was the agile application of Saudi Aramco's Capital Management System (CMS), which enabled governance flexibility while maintaining alignment with corporate assurance standards. The project's ability to bypass early gate reviews, replication of standardized deliverables, and align vendors early in the cycle demonstrated how procedural adaptation can unlock efficiency in complex, capital-intensive environments.

As global energy demand accelerates and the imperative for capital efficiency intensifies, the lessons from Fadhili offer a scalable blueprint for future mega-projects. If implemented with rigor, governance alignment, and a commitment to cross-functional collaboration, fast-track methodologies have the potential to redefine industry norms and enabling delivery of complex infrastructure at the pace and cost required by today's energy landscape.

Fadhili experience affirms that fast-tracking is not just a scheduling tactic but a disciplined execution philosophy that, when institutionalized, can transform project delivery across the oil and gas sector.