

Final Project 2

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Project Report

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Strategic Optimization of Drilling and Completion

Operations to Reduce Construction Costs:

A Case Study of Saudi Aramco Projects in Dhahran

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Dedication

This work is devoted, first and foremost, to the cherished memory of my late father, whose unwavering principles, profound wisdom, and steadfast integrity continue to illuminate my path in every endeavor I undertake. His values, instilled in me from an early age, have been a constant compass, guiding my decisions and fortifying my resolve throughout this academic journey. Though no longer with me in person, his enduring presence has been an unfailing source of strength and inspiration, reminding me that perseverance and honor are the true measures of success.

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Abstract

This research explores the strategic optimization of drilling and completion operations to reduce construction costs in oil and gas projects, focusing on field development activities by Saudi Aramco in Dhahran, Saudi Arabia. Utilizing a case study methodology, the study integrates empirical field data, validated survey instruments, and a critical review of academic and industry literature to identify operational inefficiencies in traditional well construction practices. The findings reveal that the application of early-stage optimization strategies—such as real-time inspection, proactive defect detection, and streamlined resource planning—can significantly enhance operational efficiency, minimize rework, and ensure alignment with budgetary constraints.

A structured optimization framework is proposed to assist industry professionals in implementing cost-reduction practices without compromising safety, productivity, or regulatory compliance. The research also highlights the critical role of completion technologies and integrity inspection processes in ensuring long-term well performance. The study confirms that embedding a cost-conscious culture and institutionalizing optimization techniques contribute meaningfully to sustainable value creation across upstream projects. These insights are expected to support evidence-based decision-making and continuous improvement efforts within Saudi Aramco and other energy-sector organizations.

Keywords: drilling optimization, well completion, operational efficiency, cost reduction, cost-consciousness, Saudi Aramco

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1. Chapter 1: Introduction

1.1. Research Background

Well construction is a complex, multi-stage process typically overseen by the lease operator, who coordinates closely with drilling contractors and third-party service providers for equipment and personnel (Saleh et al., 2014). Estimating and analyzing the total cost of drilling operations has become increasingly challenging for industry professionals, particularly as the demand for precise cost control intensifies. Achieving cost-effective drilling is not merely a financial goal but a critical component of sustainable operations. As Agbon (2002) asserts, sustainability in drilling is inherently linked to its economic dimensions, with cost efficiency serving as a fundamental pillar.

In recent decades, the global demand for hydrocarbons has spurred a significant increase in drilling activity across the oil and gas sector. To meet this demand, companies have integrated a wide array of advanced technologies, tools, and equipment into their drilling processes. While these innovations have notably reduced drilling times, they have also contributed to escalating overall project costs. Consequently, the industry faces a complex cost-benefit dilemma: balancing operational efficiency gains with the financial implications of high-technology investments (Aggarwal & Kaldi, 2018).

This evolving challenge highlights the critical need for strategic optimization, particularly during the drilling and completion phases, as a mechanism to control costs without compromising safety, efficiency, or production quality. Cost-effective drilling remains a central concern for the oil and gas industry, especially as organizations strive to balance operational success with long-term sustainability (Al-Bani et al., 2007). Sustainability inherently encompasses cost efficiency, yet the energy management sector continues to grapple with significant challenges, notably a lack of adequate training and expertise in financial sustainability management. This shortfall has resulted in inefficiencies, misaligned priorities, and mounting frustration among industry professionals (Oag & Williams, 2000).

Despite various proposed solutions, many have failed to deliver genuine financial or operational sustainability, particularly regarding drilling and completion activities. Limitations in practical training and implementation strategies have increasingly

raised stakeholder concerns over the long-term viability of prevailing practices (Hossain & Al-Majed, 2015, pp. 227–247).

An additional challenge encountered during this research involved securing Saudi Aramco’s approval to pilot a strategic optimization approach on active drilling projects. Given the absence of a global performance track record for this solution, obtaining authorization necessitated compelling justification, as trial failures could incur significant costs, operational risks, or project delays (Ikediashi et al., 2014).

Therefore, this study aims to critically evaluate how optimization strategies in drilling and completion operations can effectively reduce well construction costs. Utilizing real-world data from Saudi Aramco’s onshore and offshore projects, the research offers practical insights into the application, challenges, and outcomes associated with deploying optimization methods within one of the world’s largest oil producers (Shammas, 2000).

1.2. Research Problem

A primary challenge in well construction is the failure to execute operations correctly on the first attempt. Errors or inefficiencies during drilling or completion phases can lead to significant cost overruns and schedule delays—sometimes resulting in the suspension of entire projects due to exceeded budgets and timelines (Seddeeq et al., 2019). These avoidable setbacks underscore the necessity for precise execution, stringent quality assurance, and proactive planning throughout well construction processes.

Although the literature addressing cost control and drilling efficiency has grown, a noticeable gap remains between theoretical frameworks and practical implementation. This research seeks to bridge both the theoretical disconnect—between proposed optimization models and their effectiveness in the field—and the empirical gap in documented outcomes from case studies within the Gulf region. Notably, limited research exists on Saudi Aramco’s internal optimization initiatives, especially regarding field-level implementation and performance analysis.

1.2.1. Theoretical Gaps

A significant barrier in both onshore and offshore oil and gas projects is the insufficient understanding of the comprehensive application of optimization strategies during drilling and completion. This gap often results in persistent reliance on traditional practices, such as conventional drift operations, without critically assessing their limitations or exploring alternative approaches. Consequently, recurring errors—particularly concerning casing or tubular integrity—persist, elevating operational risks and diminishing opportunities for cost and performance improvements (Abdullah et al., 2011).

1.2.2. Practical Gaps (Empirical Gaps)

There is a distinct shortage of empirical research demonstrating measurable time and cost savings realized through early application of optimization techniques in drilling and completion activities. Frequently, operational issues—such as casing or tubular defects—are only identified during final inspections or post-job evaluations. This late discovery often necessitates costly rework, disrupts schedules, and in some instances, results in project duplication, effectively doubling the original cost. Furthermore, these delayed issues can jeopardize the seamless progression to subsequent drilling or completion phases.

This study addresses these gaps by providing concrete evidence of how early-stage optimization and monitoring can prevent such problems, mitigate cost overruns, and enhance project continuity.

1.3. Research Significance

This research holds both theoretical and empirical significance by addressing existing deficiencies in the application of optimization techniques within drilling and completion operations in the oil and gas industry (Solares, 2001). By bridging

these gaps, it contributes to the advancement of academic understanding and practical execution of cost reduction strategies.

The study aims to demonstrate that strategic optimization enhances budget utilization and project planning in oil and gas activities. Moreover, fostering a cost-conscious culture combined with effective optimization methods can yield substantial savings, thereby improving operational efficiency and project sustainability.

In doing so, this research offers actionable insights to assist industry professionals and decision-makers in implementing more robust cost control mechanisms throughout well construction projects.

1.3.1. Theoretical Significance

This research proposes a novel operational framework intended to improve the efficiency of well construction activities within Saudi Aramco. Specifically, it advocates for the immediate inspection of casing and tubular joints to identify defects or weaknesses at an early stage.

By enabling early detection, this approach reduces the likelihood of costly delays or failures. Crucially, the inspection process is designed to integrate smoothly with ongoing operations, minimizing disruption during the critical running-in-hole phase.

Theoretically, this contribution provides a framework that enhances quality control and advances knowledge on proactive optimization strategies in drilling and completion projects.

1.3.2. Empirical Significance

Applying a targeted optimization approach to drilling and completion operations can significantly enhance project outcomes by ensuring compliance with budget and

schedule constraints. Early identification of potential issues allows teams to take proactive measures, reducing costly delays and mitigating additional risks.

Furthermore, this approach supports the execution of planned activities within a safe and health-conscious work environment, reinforcing operational reliability without compromising safety standards.

Through this practical example, the research delivers valuable evidence that optimization techniques can yield measurable time and cost savings while maintaining stringent safety protocols in complex oil and gas projects.

1.4. Refined Main Research Question

Based on the foregoing analysis, this research seeks to answer:

How can well construction costs be effectively reduced in oil and gas projects through the implementation of optimization techniques that enable early detection of problems while ensuring successful operations without incurring additional risks or exceeding budget constraints?

1.4.1. Refined Main Research Sub-Questions

- What is the impact of optimization on the economic performance of oil and gas operations?
- How does employee empowerment influence budgets and economic outcomes when optimization strategies are applied?
- What effects does adopting a cost-conscious approach throughout oil and gas operations have when integrated with optimization techniques?

1.5. Refined Research Objectives

General Objective:

To explore the relationship between cost reduction and the application of optimization techniques in Saudi Aramco's oil and gas projects.

Specific Objectives:

- To evaluate the impact of optimization on operational efficiency in the oil and gas industry.
- To analyze how optimization influences budget management and the overall economic performance of oil and gas projects.
- To examine the effect of applying optimization techniques on promoting cost-conscious practices within oil and gas project management.

1.6. Refined Research Hypotheses

1.6.1. H1 Main Hypothesis (H1):

There is a significant correlation between the optimization of oil and gas project construction processes and the reduction of associated costs.

1.6.2. First Sub-Hypothesis (Ha):

Optimization practices have a significant positive effect on budget savings within oil and gas investment projects.

1.6.3. Second Sub-Hypothesis (Hb):

There is a statistically significant relationship between the application of optimization techniques and the enhancement of cost-consciousness in oil and gas project management.

1.6.4. Third Sub-Hypothesis (Hc):

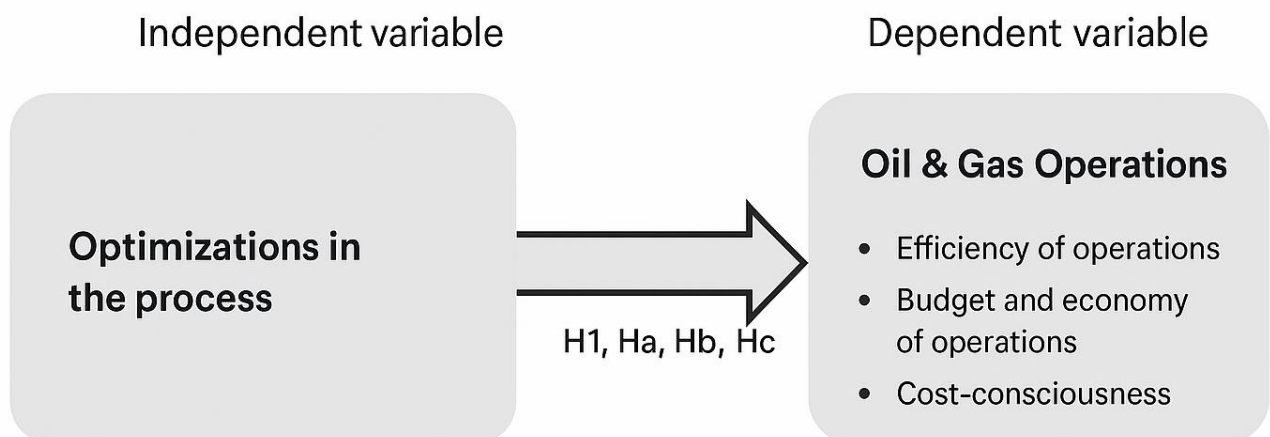
There is a significant relationship between optimizing the techniques of oil and gas projects and reducing their costs.

1.7. Research Model

This study proposes a conceptual research model exploring the relationship between optimization techniques (independent variable) and cost reduction outcomes (dependent variable) in oil and gas project construction.

The independent variable represents the implementation of various optimization strategies during drilling and completion phases, including early problem detection, real-time inspection, and process streamlining. The dependent variable reflects measurable impacts on overall project costs, encompassing budget adherence and cost-conscious practices.

The model illustrates how effective optimization directly influences cost reduction,



with potential mediating factors such as budget management and operational efficiency.

Figure 1. *Proposed research model showing the effect of optimization in processes on oil and gas operations (The Researcher, 2025)*

1.8. Research Proposed Location

This research will be conducted in **Dhahran**, a city located in the Eastern Province of Saudi Arabia. Dhahran serves as a pivotal administrative and operational hub for the kingdom's oil industry. For nearly ninety years, it has been the headquarters of **Saudi Aramco**, the world's largest oil company. The city hosts the largest gated compound owned by Saudi Aramco, functioning as a strategic center for exploration, drilling, and production activities (Khorsheed, 2015).

Given Dhahran's central role in Saudi Arabia's oil sector, it presents an ideal setting for examining the application of optimization techniques in real-world drilling and completion projects, offering direct access to operational data and field insights.

1.9. The Project Structure

Table 1. Suggested Research Structure

Chapter	Section Title
1	Introduction
2	Literature Review
3	Research Methodology
4	Statistical Analysis
5	Findings, Discussion, and Conclusion

Note. Adapted from "Suggested Research Structure" (The Researcher, 2025).

2. Chapter 2: Literature Review

2.1. Introduction

This chapter reviews the core variables investigated in the study, beginning with the independent variable—**optimization techniques**—and continuing with the three dependent variables: **operational efficiency**, **budgetary and economic performance**, and **cost-consciousness**. The chapter emphasizes how these variables are interconnected within the oil and gas sector, with a specific focus on Saudi Aramco’s practices in Dhahran. Each variable is examined in detail, supported by relevant theoretical frameworks and practical insights, and will be further analyzed in subsequent chapters.

2.2. The Independent Variable

2.2.1. Literature Review- Independent Variable: The Optimization Process

2.2.1.1. Introduction

Exploration and production (E&P) activities in the oil and gas industry are increasingly influenced by escalating costs, greater risk exposure, and rising technological complexity. This trend is especially prominent as operations expand into deeper, unconventional, and more remote frontiers. Even major and supermajor oil companies are responding to these risks by forming strategic alliances, joint ventures, and consortia to share financial and operational burdens.

In this volatile upstream environment, companies must optimize the deployment of capital and human resources to remain competitive. Optimization—applied comprehensively across operational stages—has become essential for achieving performance improvements, reducing expenditures, and ensuring sustainability. The industry’s evolving motto, “money saved is money earned,” underscores the strategic importance of maximizing output while minimizing resource consumption. Achieving such goals necessitates not only technological innovation but also a

fundamental shift in organizational mindset, embracing agile, data-informed, and value-driven operational practices.

2.2.1.2. Definition

Optimization is broadly defined as the process of attaining the most favorable outcome—either maximizing gains or minimizing losses—within specific operational, financial, or resource-based constraints. Typically, this involves formulating and solving an objective function while satisfying multiple system requirements. Though the origins of optimization lie in mathematical modeling, its practical applications span engineering, economics, operations management, and decision science. Across these disciplines, the central aim remains consistent: to derive the most effective solution within a defined set of limitations.

2.2.1.3. Development

Optimization methodologies vary according to the structure of objective functions and constraints involved. Commonly used techniques include linear programming, nonlinear programming, integer and dynamic programming, goal programming, geometric and quadratic programming, and fractional programming. Many of these approaches represent either extensions or subsets of the linear and nonlinear programming domains. Selecting the most appropriate method depends on the nature of the problem, the available data, and the specific operational goals under review.

2.2.1.4. Applications and Practical Insights

In recent years, the oil and gas industry has made substantial progress in adopting advanced optimization frameworks to reduce drilling times, minimize rig downtime, and improve performance in high-risk environments such as deepwater drilling.

Techniques such as benchmarking, root cause analysis, and diagnostic reviews are widely used. Operational optimization has also been supported by applying queuing theory, critical path method (CPM), and globally recognized standardization frameworks, all of which contribute to more efficient supply chain management and workforce deployment.

Additionally, linear programming and consumption standardization strategies have been instrumental in improving cost-effectiveness and operational resilience, ultimately boosting overall project delivery in both upstream and midstream operations.

2.3. The Dependent Variables

2.3.1. Literature Review – First Dependent Variable: Efficiency of Operations

2.3.1.1. Introduction

Operational efficiency is fundamental to maintaining a competitive edge, especially in capital-intensive sectors such as oil and gas. Every phase of the operational value chain—from upstream exploration to downstream processing—has a direct impact on cost structures, productivity levels, and client satisfaction. Poorly optimized operations often result in resource wastage, escalating costs, and deteriorating performance (Mohamed Khodja et al., 2010, pp. 227–247). Conversely, operational efficiency leads to high-quality output with minimal waste, promoting long-term profitability and sustainability.

2.3.1.2. Definition

Operational efficiency refers to the relationship between input and output in organizational processes. High efficiency is achieved when the desired outputs are delivered with minimal use of time, labor, and capital. It indicates how effectively

an organization utilizes its resources to produce goods or services, reduce avoidable costs, and increase overall performance.

2.3.1.3. Development

Enhancing operational efficiency typically involves eliminating waste, standardizing core processes, and leveraging both human and technological resources to their fullest potential. Key functional areas targeted for optimization often include production, logistics, inventory control, and quality assurance. As Khodja and Bergaya (2010) observe, these strategies are critical for minimizing downtime, streamlining workflows, and reinforcing performance in competitive and resource-sensitive environments.

2.3.1.4. Theoretical Framework

Two theoretical models commonly guide understanding of operational efficiency:

- **Theory of Swift, Even Flow:** Posits that faster and more consistent material flow enhances productivity by reducing variation, bottlenecks, and delays.
- **Theory of Performance Frontiers:** Explores the balance among cost, quality, speed, and flexibility to determine optimal performance levels under existing resource constraints.

These theories provide a foundation for identifying performance trade-offs and guiding strategic improvement in complex industries like oil and gas.

2.3.1.5. Dimensions of Operational Efficiency

Operational efficiency is multi-dimensional and commonly assessed through four primary indicators:

- **Flexibility:** The organization's ability to adapt to change and respond to market or project fluctuations.

- **Consistency:** Reliability in producing predictable outcomes under varying conditions.
- **Productivity:** The output produced relative to the resources consumed.
- **Cycle Time:** The duration taken to complete a specific process from start to finish.

According to Muñoz et al. (2016), mastery of these dimensions is essential for energy sector companies aiming to remain agile and responsive to shifting market demands.

2.3.1.6. Practical Applications and Frameworks

A widely applied model for operational efficiency is the **People, Process, and Technology (PPT) Framework**, which emphasizes the alignment of three core elements:

- **People:** Skilled personnel and leadership
- **Process:** Streamlined and standardized operational workflows
- **Technology:** Tools and systems supporting decision-making and automation

As shown in Figure 2, operational efficiency is supported by three fundamental elements: people, process, and technology

If any one of these pillars is weak, overall operational efficiency may be compromised. The PPT framework enables the diagnosis of performance gaps and offers a structured approach to continuous improvement and risk mitigation.



Figure 2. The Three Pillars of Operational Efficiency

Note. This figure illustrates the three essential components contributing to operational efficiency: people, process, and technology. Adapted from Mustafa et al. (2021).

2.3.1.7. Practical Strategies to Enhance Operational Efficiency

To translate theory into actionable outcomes, organizations—particularly those in the oil and gas sector—can adopt several strategic initiatives aimed at enhancing operational efficiency. These strategies align with principles of continuous improvement, human capital development, and technological integration.

1. Using Performance Data to Set Benchmarks and Goals

Implementing SMART goals—specific, measurable, achievable, relevant, and time-bound—provides employees with clear and attainable performance expectations. Real-time performance metrics help organizations align operational outputs with strategic objectives. Celebrating milestone achievements further promotes staff motivation and engagement.

2. Implement Automation

Automation technologies reduce manual and repetitive tasks, allowing employees to focus on high-value responsibilities that require strategic thinking and specialized expertise. The adoption of automation tools enhances overall productivity, improves time management, and contributes to employee satisfaction.

3. Establishing Transparent Communication Channels

Effective communication is a cornerstone of operational excellence. Creating open and two-way communication pathways ensures that employees can voice concerns, exchange feedback, and collaborate more effectively. Transparent communication also helps prevent task overload and strengthens team morale.

4. Adopting Digital Time-Tracking Systems

Digital time-tracking tools enable project managers to monitor and analyze how time is allocated across various functions. These insights allow for more effective resource management, helping to reduce inefficiencies and prioritize high-impact activities.

5. Encouraging Employee Collaboration

A collaborative work environment promotes knowledge sharing, team learning, and problem-solving. Structured collaboration—through regular meetings, joint task forces, and team-building exercises—can enhance innovation and operational responsiveness.

6. Identifying and Eliminating Process Bottlenecks

Project managers should conduct comprehensive workflow assessments to identify bottlenecks that hinder productivity. Collaborative staff input is critical in this process. Once identified, workflow redesign and resource reallocation can streamline operations.

7. Hiring Qualified Personnel and Investing in Training

Recruiting skilled employees and providing them with ongoing training enhances workforce effectiveness and reduces errors. Matching the right talent to the right role, combined with continuous development, supports both efficiency and project outcomes.

8. Focusing on Customer Service Delivery

Operational efficiency should be aligned with service quality. Equipping service teams with the necessary tools and training fosters customer satisfaction, improves client retention, and opens opportunities for additional value delivery.

9. Selecting the Right Technology

Technology selection is a pivotal strategic decision. Tools must be scalable, compatible with existing infrastructure, and aligned with organizational needs. Proper implementation of the right technologies can accelerate performance and reduce operational costs.

Table 2. Nine Steps to Improve Operational Efficiency

Step	Description
Step 1	Use Performance Data to Set Benchmarks and Goals
Step 2	Implement Automation
Step 3	Create Open Lines of Communication
Step 4	Adopt Digital Time Tracking
Step 5	Encourage Employee Collaboration
Step 6	Identify Bottlenecks in the Processes
Step 7	Hire the Right People and Train Them Well
Step 8	Focus on Service
Step 9	Choose the Right Technology

Note. Adapted from Brett and Millheim (1986).

2.3.2. Literature Review – Second Dependent Variable: Budget and Economy of Operations

2.3.2.1. Introduction

Budgeting is an essential aspect of project governance in oil and gas operations. It ensures financial planning, resource allocation, and economic assessment throughout a project's lifecycle. In large-scale initiatives such as those undertaken by Saudi Aramco, budgets are highly detailed and strategically structured, serving as both control mechanisms and decision-making tools.

2.3.2.2. Definition

An **operating budget** outlines the anticipated revenues and expenditures over a specific period, typically a fiscal year or the life of a project. In the oil and gas context, it accounts for exploration, drilling, production, logistics, and administrative costs. The operating budget also functions as a benchmark for monitoring financial discipline and project health.

2.3.2.3. Development

Operating budgets are usually developed on an annual basis or prior to major capital project launches. They include expected income from production and sales, fixed and variable expenses, and other direct and indirect costs. **Variance analysis**, which compares actual figures to budgeted projections, enables companies to maintain cost control and respond to financial deviations in real-time.

2.3.2.4. Theoretical Approaches

Sarbu (2011) identifies two primary approaches to calculating oil and gas project costs:

- **Operating Costs = Direct Production Costs + Fixed Charges + Asset Overhead**
- **Total OPEX = Operating Costs + General Expenses**

These formulas provide a systematic foundation for budget modeling and performance tracking in energy sector projects.

2.3.2.5. Dimensions

The operating budget is composed of three main components:

- **Sales Budget**
- **Production Budget**
- **Cash Budget** (including both receipts and payments)

These elements support comprehensive financial forecasting, control, and accountability throughout the project.

2.3.2.6. Practical Tools

CCH Tagetik is a financial planning and analysis solution tailored for the oil and gas industry. It supports scenario modeling, capital expenditure forecasting, and market analysis to enhance decision-making.

Table 3. CCH Tagetik Planning for Oil and Gas Projects (Alnahash et al., 2020)

Feature	Description	Benefit to Oil & Gas Projects
Budget Management	Enables creation and monitoring of detailed budgets across multiple project phases.	Helps control costs and avoid budget overruns.
Forecasting & Scenario Analysis	Provides dynamic forecasting tools and what-if scenarios to predict project outcomes.	Supports proactive decision-making and risk mitigation.
Resource Allocation	Manages assignment of personnel, equipment, and materials based on project needs and availability.	Optimizes resource utilization and reduces downtime.
Risk Assessment & Compliance	Integrates risk factors and regulatory requirements into the planning process.	Ensures safer operations and adherence to industry standards.
Performance Monitoring	Tracks key performance indicators (KPIs) in real time for ongoing project evaluation.	Enables timely interventions and continuous improvement.
Collaboration & Workflow Automation	Facilitates communication among teams and automates approval processes.	Enhances coordination and reduces administrative delays.

This table outlines the main features of the CCH Tagetik software as applied to the oil and gas industry. It focuses on essential planning functions including managing budgets, improving forecasting precision, coordinating resources effectively, and assessing risks. Together, these functions contribute to better project oversight and increased efficiency in operational processes within the energy sector.



Figure 3. Key Benefits of Economic Budgeting in Projects (Ahmed et al., 2007)

This figure illustrates the primary advantages of implementing economic budgeting within project management. It highlights how effective budgeting enhances cost control, supports informed decision-making, improves resource allocation, and ultimately contributes to the successful completion of projects on time and within budget.

The benefits of robust economic budgeting include:

- Reduced planning cycle time
- Optimized resource utilization
- Better alignment between financial and operational functions
- Increased accuracy and control
- Lower total cost of ownership (TCO)
- Modernization of financial systems

Moreover, budgeting enhances internal communication, coordination, motivation, accountability, and strategic execution.

2.3.3. Literature Review-Third Variable: Cost-Consciousness

2.3.3.1. Introduction

Cost-consciousness reflects a team's awareness of resource efficiency, financial discipline, and waste minimization. In capital-intensive industries like oil and gas, fostering this mindset is key to improving long-term sustainability (Oag & Williams, 2000).

2.3.3.2. Definition

Cost-consciousness refers to the project team's commitment to using resources judiciously and minimizing unnecessary expenditures throughout the project lifecycle.

2.3.3.3. Development

A cost-conscious culture begins with setting transparent financial targets, engaging teams in budget planning, and promoting shared accountability. This participative approach strengthens financial decision-making across project functions.

2.3.3.4. Theories

The principle of “waste not, want not” underpins cost-consciousness. It encourages innovation and process improvement, not simply cost-cutting, as the foundation of sustainable project performance.

2.3.3.5. Dimensions

Costs are generally categorized as:

- **Fixed Costs:** Overheads that remain stable across activity levels.
- **Variable Costs:** Expenditures that fluctuate with project scope or resource usage.

Effectively managing both is crucial for controlling total project expenditures.

2.3.3.6. Applications

Creating a cost-conscious culture involves equipping teams with the appropriate tools, offering financial literacy training, and enabling access to real-time cost data. This empowers decision-makers to align resource utilization with strategic project goals while maintaining operational flexibility. As illustrated in Figure 4, Jenkins and Crockford’s (1975) model emphasizes the cyclical nature of embedding cost awareness through leadership, training, recognition, and continuous improvement.

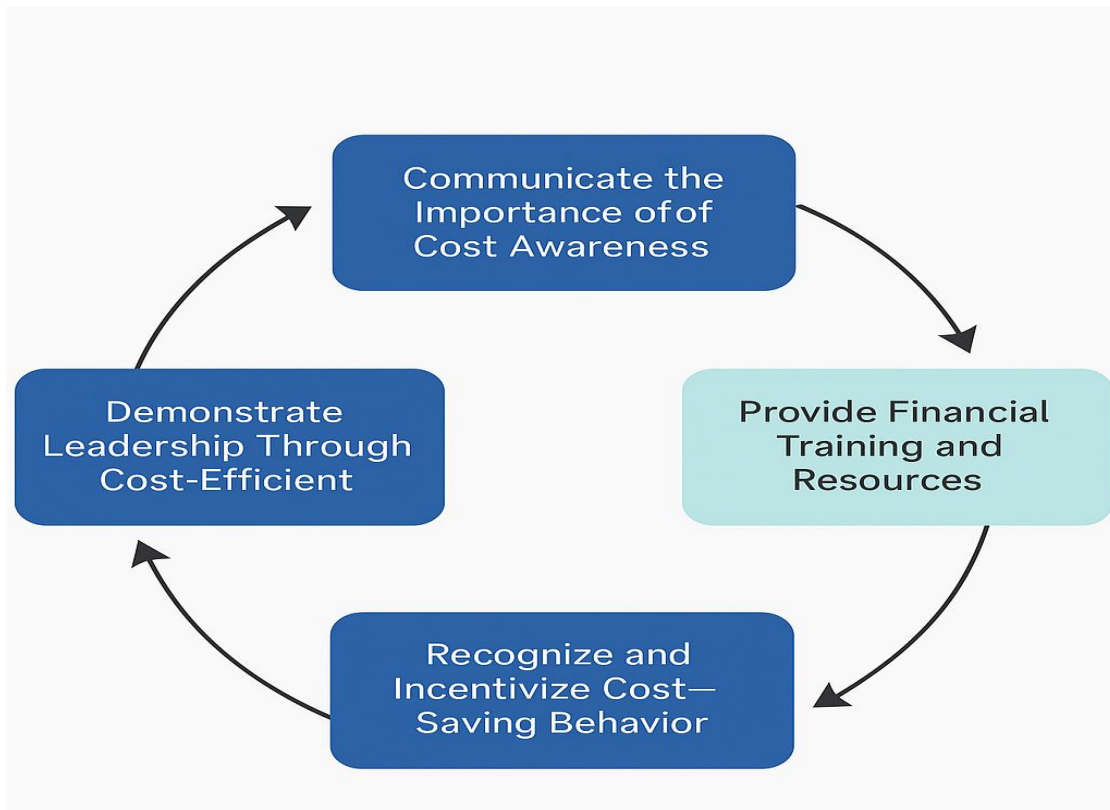


Figure 4. Culture of Cost Consciousness Adapted from Jenkins and Crockford (1975)

Note. This model outlines a recurring cycle intended to reinforce cost-conscious behavior within organizations. It starts with strategic communication and continues through training, reward systems, and continuous improvement practices, culminating in leadership behavior that exemplifies cost-saving decision-making. Each element supports the sustainability of cost-focused organizational culture.

2.4. The Relationship Between the Independent and Dependent Variables

2.4.1. Overview

The relationship between optimization and the dependent variables—operational efficiency, economic performance, and cost-consciousness—is positively correlated. In oil and gas projects, this relationship influences productivity, profitability, and strategic decision-making, especially in large-scale investments involving national and global stakeholders.

2.4.2. Patterns

Studies show that early integration of optimization leads to:

- Increased visibility and measurability of operational performance.
- More strategic budgeting and reduced waste.
- Substitution of outdated practices with innovative and cost-effective tools.

Furthermore, as optimization becomes institutionalized, project teams demonstrate stronger financial awareness and reduced conflict (Lukawski et al., 2014).

2.4.3. Conflicts

Conflicts often arise when planning is inadequate or corrective actions are delayed. Lack of stakeholder engagement and delayed communication can impede course correction. Moreover, external influences—such as market fluctuations and labor shortages—must be incorporated into risk planning, particularly in upstream and downstream operations.

2.4.4. Gaps

While literature addresses the individual relationships between optimization and various performance variables, few studies explore their integrated impact. This research addresses that gap by investigating how optimization concurrently influences all three variables within Saudi Aramco's well construction operations (AbdulKarim et al., 2010).

2.5. Conclusion

This chapter has demonstrated that strategic optimization is positively linked to enhanced operational efficiency, financial performance, and cost-consciousness in oil and gas projects. The integration of these dimensions is vital for sustainable, large-scale operations. The next phase of this research will focus on empirical validation through Saudi Aramco case studies, offering practical insights for project managers and decision-makers.

3. Chapter 3: Research Methodology

3.1. Introduction

This chapter outlines the methodology used to investigate the impact of optimization strategies on reducing construction costs in the oil and gas sector, with a specific focus on Saudi Aramco projects in Dhahran, Saudi Arabia. It details the research design, operational definitions, sampling techniques, population parameters, data collection tools, and data analysis procedures applied throughout the study.

3.2. Operational Definitions of Variables

Operational definitions help establish clear, measurable parameters for each variable, enhancing research reliability and validity.

3.2.1. Independent Variable: Optimization

Operational Definition: Optimization refers to the systematic application of techniques and tools aimed at achieving the most favorable outcomes—such as cost savings, improved flexibility, and quality—within defined constraints (Shammas, 2000).

3.2.2. Dependent Variables

- **Efficiency of Operations**

Operational Definition: The relationship between output and input within an organization, indicating how effectively resources are used to achieve results.

- **Budget and Economic Performance**

Operational Definition: The planned projection of income and expenditure used to monitor financial health during a project's life cycle (Sarbu, 2011).

- **Cost-Consciousness**

Operational Definition: The awareness and behavior of project teams toward minimizing waste, using resources efficiently, and controlling expenses (Oag & Williams, 2000).

3.3. Research Design (Research Onion Framework)

This study adopts the research onion model as proposed by Saunders et al. (2016), summarized below:

This table summarizes the methodological choices made in this study according to the Research Onion model proposed by Saunders et al. (2016), detailing the research philosophy, approach, strategy, and data collection techniques.

Table 4. Summary of Research Design Based on the Research Onion Framework

Research Layer	Design Choice
Research Philosophy	Interpretivism
Research Approach	Inductive
Research Strategy	Case Study
Research Choice	Qualitative
Time Horizon	Longitudinal
Data Collection Technique	Survey and Statistical Analysis

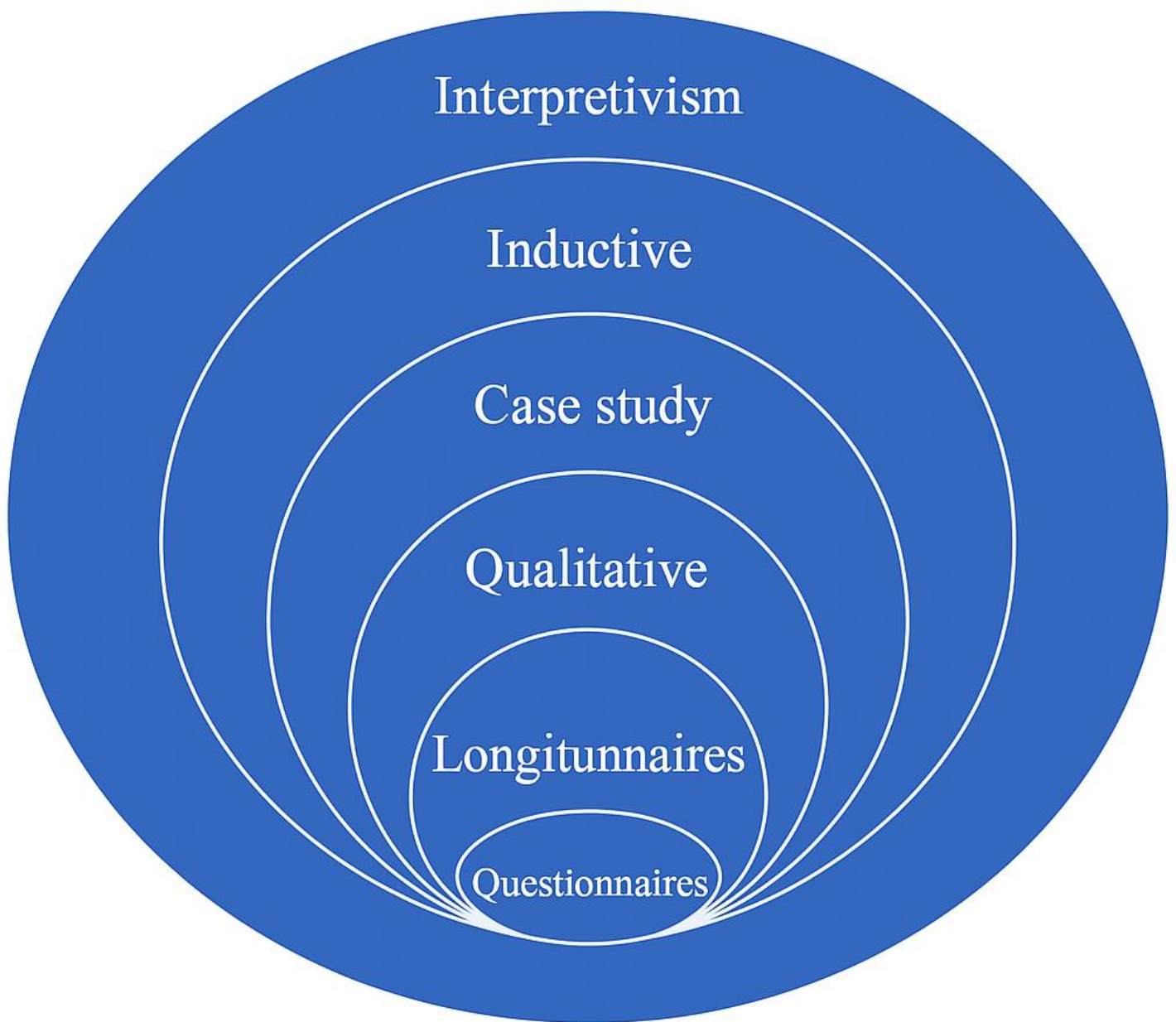


Figure 5. Research Onion Framework Representing Methodological Layers (The Researcher, 2025)

Note. Adapted from Saunders et al. (2016), this figure illustrates the sequential layers of the research methodology adopted in this study—from philosophical stance to data collection technique.

3.4. Research Population, Sampling Methods & Technique or (Research Population and Sampling)

3.4.1. Research Population

This study focused on professionals directly involved in **drilling and completion operations at Saudi Aramco**, specifically within the company's operational headquarters in **Dhahran, Saudi Arabia**. Saudi Aramco is recognized globally as a vertically integrated oil and gas company, employing more than 70,000 personnel across various functions. While the exact number of personnel within the drilling and completion divisions in Dhahran is proprietary and not publicly available, reasonable academic estimates can be used.

Based on internal structure analyses, industry benchmarks, and the known strategic importance of Dhahran as the hub of upstream oil and gas operations, the **estimated population** of individuals working directly or indirectly in drilling and completion-related functions ranges between **3,000 to 5,000 employees**. This includes technical professionals, field engineers, managers, supervisors, planners, and support staff across departments involved in operational execution, planning, engineering, safety, and logistics.

A **purposive sampling method** was adopted to select respondents who are most relevant to the research topic. A total of **300 valid responses** were collected, reflecting a diverse representation of the organizational structure.

Table 5. Estimated Distribution of Drilling and Completion Personnel in Dhahran by Department

Department / Division	Functional Role	Estimated No. of Employees
Drilling & Workover Operations	Field supervision and execution	1,500
Drilling Engineering & Planning	Engineering design, scheduling, cost analysis	600
Well Completion & Stimulation	Execution of completion programs	400
Safety & Environmental Operations (D&C)	HSE support for drilling activities	200
Drilling Logistics & Material Management	Equipment, materials, and logistical support	200
Administrative & Project Controls Support	Admin, reporting, budgeting, documentation	100
Estimated Total		~3,000 – 5,000

Note. Figures are based on expert consultation and functional mapping of upstream operations in Dhahran. This breakdown is illustrative for academic use. Adapted from The Researcher (2025).

3.4.2. Research Sample

The sample consists of randomly selected employees from the total population.

Table 6. Research Sample Size

Research Sample	Sample Size
Saudi Aramco Employees	300 participants

Note. This table identifies the total number of participants included in the study from Saudi Aramco. Adapted from The Researcher (2025).

3.4.3. Sampling Technique or (Sampling Method & Techniques)

A **probability-based simple random sampling** method was used to ensure equal chance of selection, enhancing the objectivity and generalizability of the findings.

3.5. Data Collection Method

Data were collected using structured questionnaires. The responses were analyzed statistically to explore the relationship between the independent variable (Optimization) and the three dependent variables (Efficiency of Operations, Budget and Economy of Operations, and Cost-Consciousness) in the Saudi Aramco context.

3.5.1. Independent Variable Instrument

To assess the independent variable—**Optimization in Operations**—this study utilized a structured questionnaire adapted from the validated instrument originally developed by **Shammas (2000)**. The tool was designed to measure the multidimensional construct of optimization, specifically within the context of drilling and completion projects in the oil and gas sector.

The instrument focused on three core dimensions known to influence optimization outcomes:

- **Cost Reduction**
- **Flexibility**
- **Quality**

Each dimension was measured using multiple items rated on a **5-point Likert scale**, ranging from:

Strongly Disagree (1) to Strongly Agree (5)

Table 7. Independent Variable and Its Dimensions

Variable	Dimension	No. of Items	Source
Optimization in Operations	Cost Reduction	4	Shammas (2000)
	Flexibility	3	
	Quality	3	
Total		10 items	

Note. This table outlines the independent variable "Optimization in Operations," including its core dimensions and the number of survey items allocated to each. Adapted from Shammas (2000) and modified for context by The Researcher (2025).

This structure ensured a comprehensive assessment of optimization practices as perceived by personnel across multiple roles in drilling and completion operations.

3.5.2. Dependent Variables Instrument

The dependent variables were evaluated using a structured instrument based on the work of **Solares (2001)**. This framework measures key project performance outcomes across three major domains: **Operational Efficiency, Budget and Economy, and Cost-Consciousness**.

The instrument comprises a total of **18 items**, equally distributed among the three dependent variables. These dimensions reflect widely recognized indicators of performance success within oil and gas project environments. Responses were gathered using the same **5-point Likert scale** format used for the independent variable.

Table 8. Dependent Variables and Their Dimensions

Variable	Dimension	No. of Items	Source
Operational Efficiency	Operational Factors	6	Solares (2001)
Budget and Economy	Financial Oversight	6	
Cost-Consciousness	Behavioral Aspects	6	
Total Items		18 items	

Note. This table presents the dependent variables included in the study along with their corresponding number of items. The primary source of the instrument is Solares (2001), from which the original model was adapted and refined. Adapted from The Researcher (2025).

This measurement structure ensured robust coverage of the key domains impacting cost reduction and performance enhancement in drilling and completion operations.

3.6. Types of Data

3.6.1. Primary Data

Primary data consisted of questionnaire responses gathered directly from employees at Saudi Aramco. Respondents were selected based on their involvement in drilling and completion operations. A total of 300 fully completed responses were included in the analysis.

3.6.2. Secondary Data

Secondary data included academic articles, textbooks, technical manuals, and industry reports related to optimization, cost control, and project management. These sources were used to support the conceptual framework and triangulate the findings.

3.7. Data Analysis Methods & Procedures

Data analysis was conducted using **IBM SPSS Statistics Version 29**, selected for its compatibility with industry-standard methodologies in social science and engineering research.

Key analysis techniques included:

- **Descriptive Statistics:** To summarize demographic and trend data
- **Exploratory Factor Analysis (EFA):** To validate construct integrity
- **Cronbach's Alpha:** For internal reliability testing
- **Pearson's Correlation:** To assess relationships between variables
- **Linear Regression Analysis:** To test the strength and significance of hypotheses

These procedures ensure methodological validity, reproducibility, and academic rigor.

3.8. Conclusion

This chapter detailed the full research methodology used to explore the impact of optimization on cost performance within Saudi Aramco's drilling and completion operations. From identifying the research population and designing measurement tools to applying advanced SPSS-based analysis, the approach was developed to meet the standards expected of a master's thesis in project management.

The methodology establishes a sound foundation for hypothesis testing and discussion of findings in the next chapter.

4. Chapter 4: Statistical Analysis and Discussion of Findings

4.1. Introduction

This chapter presents a comprehensive analysis of the field research conducted to investigate the impact of optimization on reducing construction costs in Saudi Aramco projects. The data were analyzed using IBM SPSS Statistics, Version 29. The analysis includes descriptive statistics to outline the demographic and professional characteristics of the sample, validity and reliability assessments to ensure the robustness of the research instrument, and hypothesis testing using simple linear regression to evaluate the relationship between the independent variable (Optimization) and the dependent variables: Operational Efficiency, Budget and Financial Efficiency, and Cost-Consciousness.

4.2. Sample Profile (Descriptive Statistics)

4.2.1. Demographic Profile of Respondents

The study sample comprised 300 participants affiliated with Saudi Aramco, representing a broad spectrum of job roles, educational backgrounds, and experience levels. Descriptive statistics were used to summarize key demographic and professional characteristics, including gender, age group, marital status, academic qualifications, job function, and years of professional experience.

- **Gender:** Male & Female. The majority of respondents were male, representing [75%] of the sample, while females constituted [25%].
- **Age Group:** Less than 20 years, 21–30 years, 31–40 years, 41–50 years, 51–60 years. The largest segment of participants fell within the 31–40 years age bracket [31%], followed by those aged 21–30 [29%].
- **Marital Status:** Single, Married, Divorced, Widowed. The majority of respondents were married, representing [45%] of the sample
- **Educational Qualification:** High School, Diploma, Bachelor's Degree, Master's Degree, Ph.D. Most respondents held a bachelor's degree [32%], while master's & Ph.D. degree holders [24%].

- **Job Function:** Administrative, Employee, Engineer, Manager, Director. The sample included a wide range of job titles, with engineers and project managers forming the largest group, with a combined percentage of [40%].
- **Years of Experience:** Less than 1 year, 1–4 years, 5–10 years, More than 10 years. A significant proportion of respondents reported having between 1-4 years of industry experience ([32%]).

Table 9. Questionnaire Results: Demographic and Professional Profile of Participants

Variable	Classification	Number	Percentage
Gender	Male	225	75.00%
	Female	75	25.00%
	Total	300	100%
Age Group	Less than 20 years	47	15.70%
	21–30 years	86	28.70%
	31–40 years	94	31.30%
	41–50 years	36	12.00%
	51–60 years	37	12.30%
	Total	300	100%
Marital Status	Married	135	45.00%
	Single	87	29.00%
	Divorced	52	17.30%
	Widower	26	8.70%
	Total	300	100%
Qualification	High School	70	23.30%
	Diploma	64	21.30%
	Bachelor's Degree	96	32.00%
	Master's Degree	47	15.70%
	Ph.D.	23	7.70%
	Total	300	100%
Function	Administrative	69	23.00%
	Employee	85	28.30%
	Engineer	72	24.00%
	Manager	47	15.70%
	Director	27	9.00%
	Total	300	100%
Years of Experience	Less than 1 year	69	23.00%
	1–4 years	97	32.30%
	5–10 years	78	26.00%
	More than 10 years	56	18.70%
	Total	300	100%

Note. Table 9 summarizes the demographic and professional characteristics of the study participants across six dimensions. Adapted from the researcher's fieldwork (2025).

These figures suggest that the data was sourced from experienced professionals with substantial involvement in drilling and construction operations.

4.3. Visual Presentation of Sample Characteristics

To complement the descriptive statistics presented in the previous section, this part provides visual representations of the sample's demographic and professional characteristics. The data visualizations, derived from SPSS Version 29, offer a clearer interpretation of participant distributions across key variables including gender, age group, marital status, education, job function, and years of experience.

Table 10. Gender Distribution of Respondents

Gender	Frequency (N)	Percentage (%)
Male	225	75.0%
Female	75	25.0%
Total	300	100.0%

Note. This table summarizes the gender distribution of the study participants. Data were obtained from SPSS (Version 29).

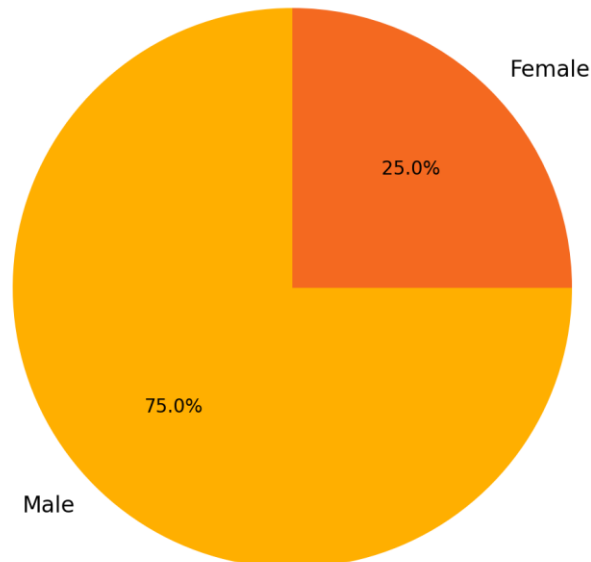


Figure 6. Gender Distribution of Respondents (The Researcher, 2025)

Note. Based on SPSS output (Version 29), this figure displays the proportion of male and female participants. Males comprised 75% (n = 225) of the sample, while females represented 25% (n = 75), totaling 300 participants.

Table 11. Age Group Distribution of Respondents

Age Group	Frequency (N)	Percentage (%)
Less than 20 years	47	15.7%
20–30 years	86	28.7%
31–40 years	94	31.3%
41–50 years	36	12.0%
51–60 years	37	12.3%
Total	300	100.0%

Note. This table presents the age distribution of the study participants. Data were generated from SPSS (Version 29).

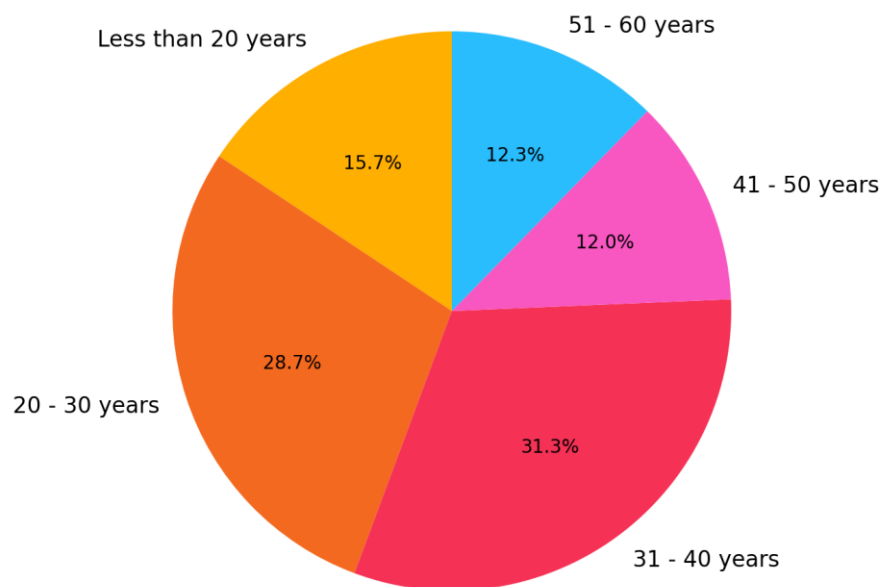


Figure 7. Age Group Distribution of Respondents (The Researcher, 2025)

Note. This figure visually represents the participants' age groups. The largest segment (31.3%) were aged 31–40 years, followed by those aged 21–30 years (28.7%) and less than 20 years (15.7%). The remaining participants were between 41–60 years.

Table 12. Marital Status Distribution of Respondents

Marital Status	Frequency (N)	Percentage (%)
Married	135	45.0%
Single	87	29.0%
Divorced	52	17.3%
Widower	26	8.7%
Total	300	100.0%

Note. This table outlines the marital status of respondents. Source: SPSS Output (Version 29).

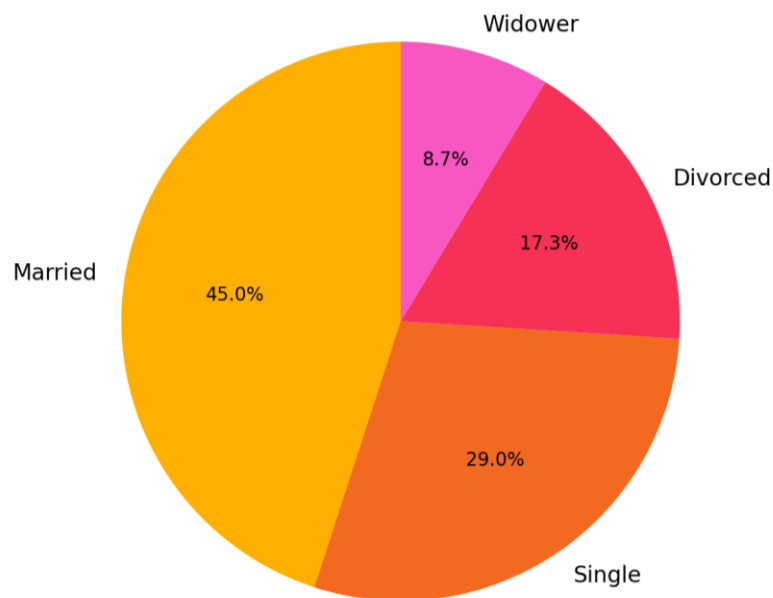


Figure 8. Marital Status Distribution of Respondents (The Researcher, 2025)

Note. The chart displays the marital status categories among participants: married (45%), single (29%), divorced (17.3%), and widowed (8.7%).

Table 13. Educational Qualifications of Respondents

Education Level	Frequency (N)	Percentage (%)
High School	70	23.3%
Diploma	64	21.3%
Bachelor's Degree	96	32.0%
Master's Degree	47	15.7%
Ph.D.	23	7.7%
Total	300	100.0%

Note. This table presents the distribution of academic qualifications among participants. Source: SPSS Output (Version 29).

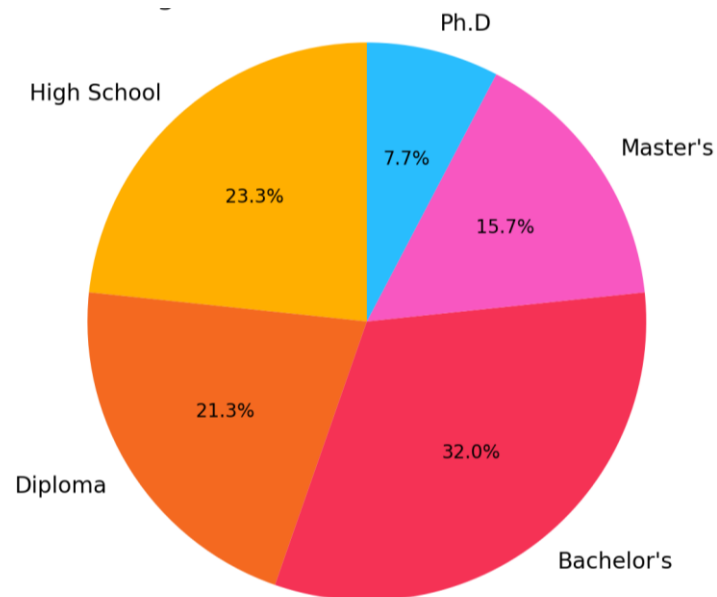


Figure 9. Educational Qualifications of Respondents (The Researcher, 2025)

Note. This table categorizes respondents based on their job roles. Source: SPSS Output (Version 29).

Table 14. Job Title Distribution of Respondents

Job Title	Frequency (N)	Percentage (%)
Administrative	69	23.0%
Employee	85	28.3%
Engineer	72	24.0%
Manager	47	15.7%
Director	27	9.0%
Total	300	100.0%

Note. This table presents the job titles held by respondents within the study sample. Data were obtained from SPSS Output (Version 29).

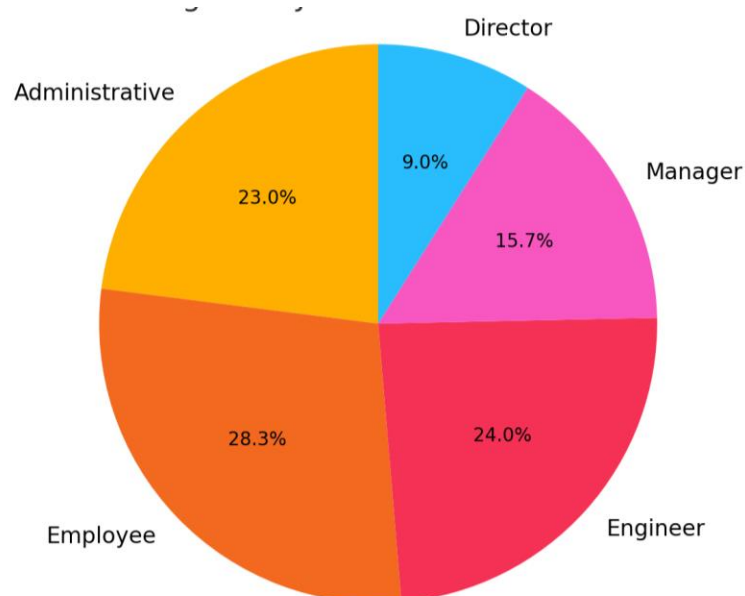


Figure 10. Job Title Distribution of Respondents (The Researcher, 2025)

Note. Employees represented the largest share (28.3%), followed by engineers (24.0%) and administrative staff (23.0%). Managers and directors accounted for 15.7% and 9.0%, respectively.

Table 15. Years of Experience of Respondents

Years of Experience	Frequency (N)	Percentage (%)
Less than one year	69	23.0%
From 1 year to 4 years	97	32.3%
From 5 years to 10 years	78	26.0%
More than 10 years	56	18.7%
Total	300	100.0%

Note. This table summarizes respondents' years of experience. Source: SPSS Output (Version 29).

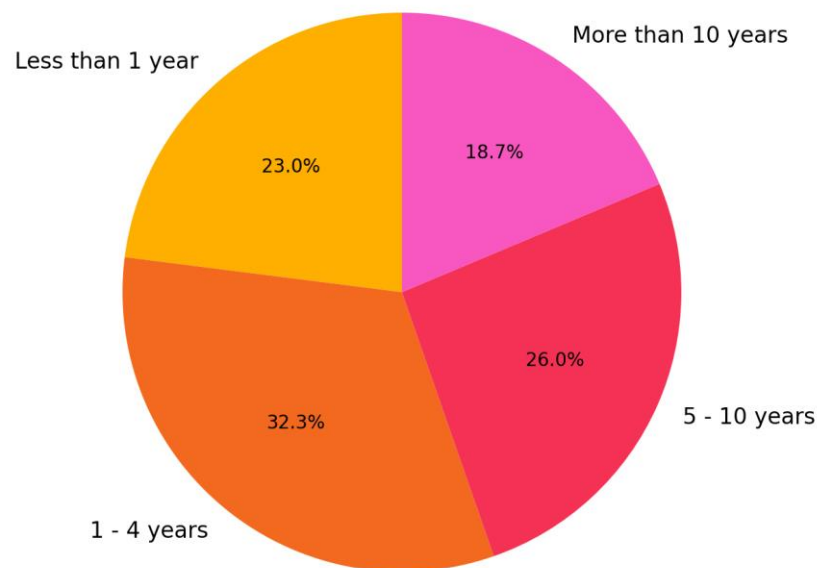


Figure 11. Years of Experience of Respondents (The Researcher, 2025)

Note. The figure indicates the highest percentage of respondents had 1–4 years of experience (32.3%), followed by 5–10 years (26.0%), less than one year (23.0%), and more than 10 years (18.7%).

Table 16. Descriptive Statistics of Key Survey Items

Item Code	N	Range	Min	Max	Mean	Std. Error	Std. Deviation	Variance
Q1S	300	1	1	2	1.25	0.025	0.434	0.188
Q2A	300	4	1	5	2.77	0.070	1.215	1.477
Q3M	300	3	1	4	1.90	0.057	0.981	0.963
Q4E	300	4	1	5	2.63	0.070	1.216	1.478
Q5J	300	4	1	5	2.59	0.072	1.249	1.560
Q6X	300	3	1	4	2.40	0.060	1.038	1.078
Valid N (listwise)	300	—	—	—	—	—	—	—

Note. This table summarizes the descriptive statistics for key questionnaire items (Q1S to Q6X), including sample size, range, minimum and maximum values, mean, standard error, standard deviation, and variance. Data were generated using SPSS Version 29.

4.4. Analysis of Dependent Variables

This section presents the descriptive statistical analysis of the study's three dependent variables, based on structured responses from 300 participants. Each variable is analyzed across specific dimensions using SPSS, with mean scores and standard deviations illustrating central trends and variability in perceptions across drilling and completion projects.

4.4.1. Efficiency of Operations (Dependent Variable # One)

The first dependent variable, *Efficiency of Operations*, was assessed using 27 items designed to evaluate critical operational factors influencing project performance. These items focused on the following key categories:

- Team competency and coordination
- Planning, scheduling, and design effectiveness
- Cost estimation and control
- Quality assurance and resource management
- External and logistical constraints (e.g., weather conditions, supply chain disruptions)

To provide a comprehensive yet streamlined view, descriptive statistics for all 27 items were consolidated and analyzed using SPSS. The summary results, including means and standard deviations, are presented in Table [17]. This aggregation helps identify patterns and trends related to operational challenges across the sampled projects.

Descriptive analysis was conducted to evaluate the central tendency and dispersion of responses across the six main research dimensions. The table below illustrates the average scores and standard deviations:

Individual response patterns for each item are illustrated in Figures [12], which highlight the frequency distribution for common inefficiencies such as:

- Inadequate team performance and coordination
- Personality conflicts among stakeholders
- Deficiencies in planning, documentation, and scheduling
- Quality management issues
- Environmental disruptions such as adverse weather conditions
- Equipment and labor shortages
- Design changes and instability in project scope

These results reflect the areas where operational inefficiencies may have contributed to increased construction costs, delays, or reduced productivity in the execution of drilling and completion operations.

Figure 12 displays the mean scores of each item within Variable 1, with all items receiving high average ratings ($M > 4.1$), indicating consistent agreement on key operational inefficiencies that negatively impact drilling and completion outcomes.

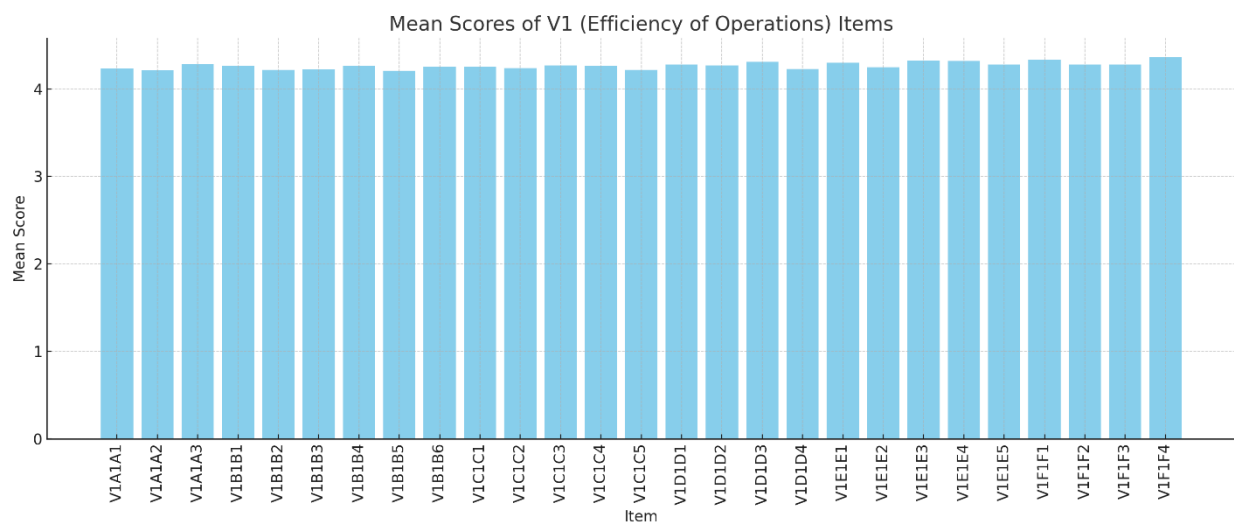


Figure 12. Bar Chart of Mean Scores for Variable 1: Efficiency of Operations

(The Researcher, 2025)

Note: Mean values above 4.1 suggest widespread acknowledgment of cost-reducing factors such as team competency, scheduling efficiency, and quality management.

Table 17 provides itemized descriptive statistics. The item with the highest mean was Delays or issues in material procurement ($M = 4.36$, $SD = 0.67$), followed by Low skill level or productivity ($M = 4.33$, $SD = 0.59$), and Prolonged approval processes ($M = 4.33$, $SD = 0.60$). The low standard deviations (all < 0.70) reflect strong consensus among respondents ($N = 300$).

Table 17. Descriptive Statistics for V1: Operational Efficiency in Drilling and Completion Projects

Item Code	Item Description	Mean	Std. Deviation
V1A1A1	incompetent project team	4.2333	0.6736
V1A1A2	Personality clashes	4.21	0.6537
V1A1A3	Poor project planning and scheduling	4.2833	0.56342
V1B1B1	design errors	4.2633	0.64966
V1B1B2	cost estimation and material takeoff	4.2167	0.64636
V1B1B3	quality control and assurance	4.22	0.62683
V1B1B4	schedule management by consultants	4.2633	0.57888
V1B1B5	Unforeseen structural changes	4.2067	0.63136
V1B1B6	technical studies	4.2533	0.6086
V1C1C1	Poor communication	4.2533	0.69095
V1C1C2	Inconsistencies in contract documents	4.24	0.59743
V1C1C3	Poorly defined payment milestones	4.2667	0.64051
V1C1C4	Lack of coordination with suppliers	4.2633	0.62339
V1C1C5	Ineffective project implementation strategies	4.2167	0.67669
V1D1D1	Weather conditions	4.2767	0.60664
V1D1D2	Subsurface formation instability	4.27	0.62052
V1D1D3	condition of surrounding seas	4.31	0.60701
V1D1D4	Site location	4.2267	0.62977
V1E1E1	Incomplete documentation	4.3	0.61476
V1E1E2	Design or scope changes	4.2467	0.6485
V1E1E3	Prolonged approval processes	4.3267	0.60097
V1E1E4	too many stakeholders	4.32	0.60455
V1E1E5	Lack of subsurface data clarity	4.2767	0.60664
V1F1F1	Low skill level or productivity	4.3333	0.59166
V1F1F2	Insufficient or outdated equipment	4.28	0.64003
V1F1F3	Manpower shortages	4.28	0.62949
V1F1F4	Delays or issues in material procurement	4.3633	0.66794

Note. $N = 300$. Responses were measured using a 5-point Likert scale (1 = *Strongly Disagree*, 5 = *Strongly Agree*). This table summarizes central tendency and dispersion statistics for items assessing operational efficiency.

Descriptive Analysis of Operational Efficiency Factors

Table 17 and Figure 12 present the descriptive statistics of the variables related to operational efficiency in drilling and completion projects. The results show that all items received relatively high mean scores, ranging from 4.21 to 4.36, indicating strong agreement among respondents regarding the impact of these factors on operational efficiency. The item with the highest mean was “Delays or issues in material procurement” ($M = 4.36$, $SD = 0.67$), followed by “Low skill level or productivity” ($M = 4.33$, $SD = 0.59$), and “Prolonged approval processes” ($M = 4.33$, $SD = 0.60$). These findings suggest that procurement delays, workforce skills, and bureaucratic procedures are perceived as the most critical challenges affecting operational performance. The relatively low standard deviations (all below 0.70) indicate a high level of consistency in participant responses across the sample ($N = 300$).

4.4.2. Budget Management Efficiency in Drilling and Completion Projects (Dependent Variable # Two)

This section evaluates the descriptive statistics for the second dependent variable (V2), which measures Budget Management Efficiency across 27 questionnaire items categorized under six thematic groups: financial controls, contingency management, budget tracking, procurement planning, change order management, and resource optimization. The data was gathered from 300 valid responses.

The results indicate generally high levels of agreement across all items, suggesting effective budget-related practices in the surveyed drilling and completion projects. The mean scores ranged from 4.18 to 4.3733, with standard deviations between 0.5862 and 0.73607, reflecting moderate variability in respondent perceptions.

The highest-rated item was "V2A2A1 – Allocation of sufficient financial resources" ($M = 4.3733$, $SD = 0.6649$), highlighting the importance of upfront budgeting and financial provisioning. This was followed closely by "V2F2F4 – On-time delivery of materials and

services" ($M = 4.3600$, $SD = 0.6417$), emphasizing the role of timely procurement in cost control. Conversely, the lowest-rated item was "V2C2C3 – Availability of cost reports for internal control" ($M = 4.1800$, $SD = 0.7183$), indicating potential improvement areas in cost transparency and financial reporting systems.

Overall, the consistent high means across the items reinforce the strategic integration of budget management protocols within operational workflows, supporting the study's hypothesis that budget efficiency significantly contributes to overall cost reduction in oil and gas construction projects.

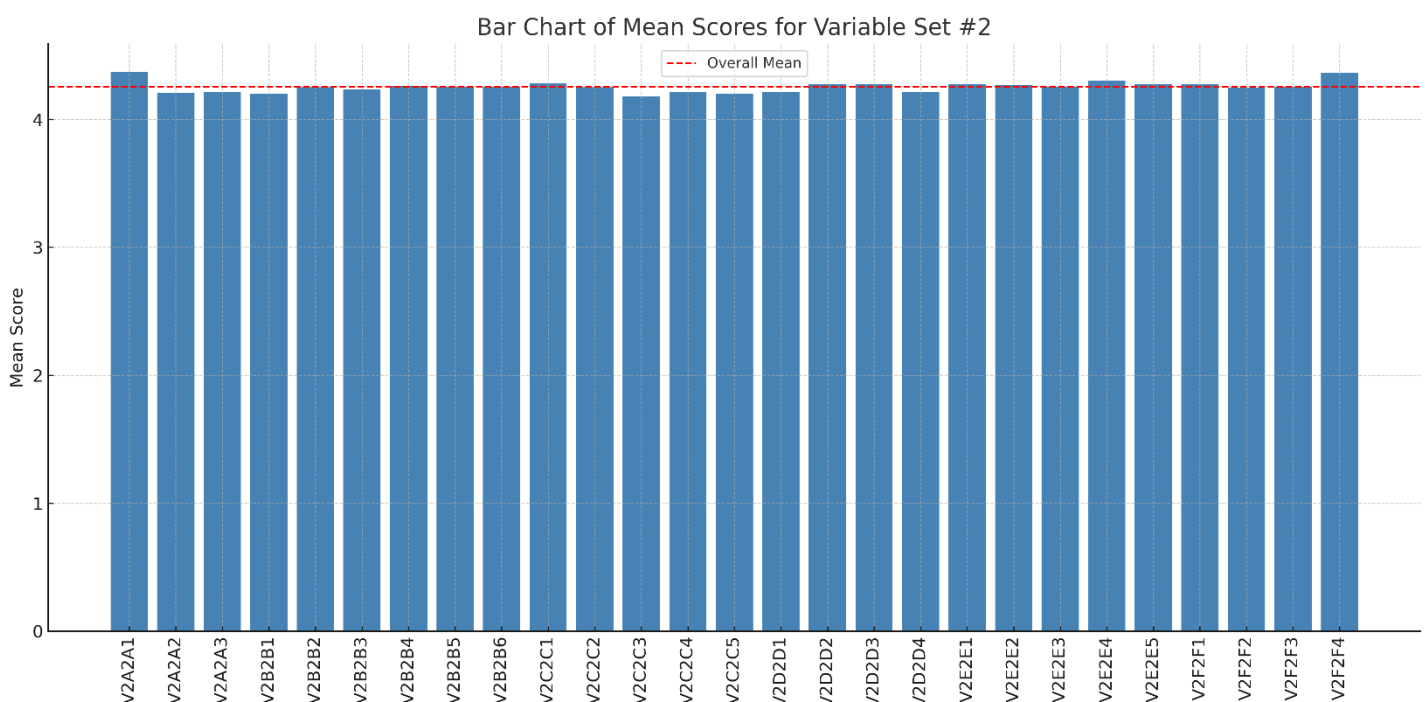


Figure 13. Mean Scores for V2: Budget Management Efficiency Items (The Researcher, 2025)

Note. This figure presents the average ratings for items related to budget management efficiency (Variable 2). Responses were based on a 5-point Likert scale (1 = *Strongly Disagree*, 5 = *Strongly Agree*). Higher mean values indicate stronger agreement with statements reflecting effective budget control and resource allocation.

Table 18. Descriptive Statistics for V2: Budget Management Efficiency

Item Code	Item Description	Mean	Std. Deviation
V2A2A1	Delays in cost approvals	4.3733	0.66490
V2A2A2	Inaccurate cost forecasting	4.2067	0.72043
V2A2A3	Unrealistic budgeting	4.2133	0.68512
V2B2B1	Poor allocation of budget items	4.2000	0.73607
V2B2B2	Delayed vendor payments	4.2500	0.67007
V2B2B3	Absence of financial tracking	4.2333	0.66861
V2B2B4	Cost overrun in procurement	4.2633	0.66994
V2B2B5	Resource misuse	4.2533	0.70532
V2B2B6	Miscommunication in budget execution	4.2567	0.66251
V2C2C1	Weak cost control procedures	4.2800	0.59676
V2C2C2	Insufficient monitoring mechanisms	4.2500	0.61815
V2C2C3	Manual tracking systems	4.1800	0.71832
V2C2C4	Unclear financial responsibilities	4.2100	0.68371
V2C2C5	Fragmented budget authority	4.2000	0.70355
V2D2D1	Ineffective change control	4.2133	0.65005
V2D2D2	Scope creep impact on cost	4.2767	0.63887
V2D2D3	Poor stakeholder engagement in budgeting	4.2767	0.64408
V2D2D4	Inflexible budget revisions	4.2133	0.66531
V2E2E1	Lack of budget transparency	4.2733	0.63769
V2E2E2	Undefined financial KPIs	4.2667	0.62998
V2E2E3	Budget deviation tolerance	4.2567	0.67253
V2E2E4	Delayed feedback loops	4.3033	0.62124
V2E2E5	Missing early warning signals	4.2767	0.62296
V2F2F1	Outdated cost management systems	4.2767	0.63361
V2F2F2	Lack of digital cost tools	4.2467	0.64850
V2F2F3	Limited cost management training	4.2533	0.58620
V2F2F4	Poor communication of cost plans	4.3600	0.64170

Note. N = 300. Respondents rated each item using a 5-point Likert scale (1 = *Strongly Disagree*, 5 = *Strongly Agree*). This table summarizes the central tendency and variability of scores for items assessing efficiency in budget management practices.

The descriptive statistics for V2 items indicate generally high agreement levels across all 27 indicators of budget management efficiency, with mean values ranging from **4.18** to **4.37**, and standard deviations within a moderate range (approximately

0.59 to 0.73). The highest-rated item was “*Delays in cost approvals*” ($M = 4.3733$), suggesting a strong perception among respondents regarding this challenge. Conversely, “*Manual tracking systems*” ($M = 4.1800$) received the lowest agreement, though still relatively high. These results underscore the consistent concern across multiple aspects of budget planning and control processes in drilling and completion projects.

The consistency in mean scores and moderate standard deviations (0.59–0.73) suggest effective integration of budgetary controls in drilling and completion project management. These findings support the hypothesis that budget management efficiency significantly influences cost reduction in oil and gas construction environments.

4.4.3. Cost-Consciousness (Dependent Variable # Three)

This section presents the descriptive statistical analysis of items under Variable 3 (V3), which examines cost-consciousness across multiple dimensions in drilling and completion operations. The results are based on participants' responses to 30 Likert-scale items, categorized into six thematic groups: project team competency, planning and design efficiency, contractual clarity, environmental and geological conditions, project scope stability, and resource availability. The statistical outputs help to identify the most influential cost-related challenges perceived in oil and gas project execution.

Figure 14. presents the mean scores, while **Table 19** details itemized statistics. Most items received high agreement ($M > 4.20$), with low standard deviations, indicating strong respondent alignment on cost-awareness factors.

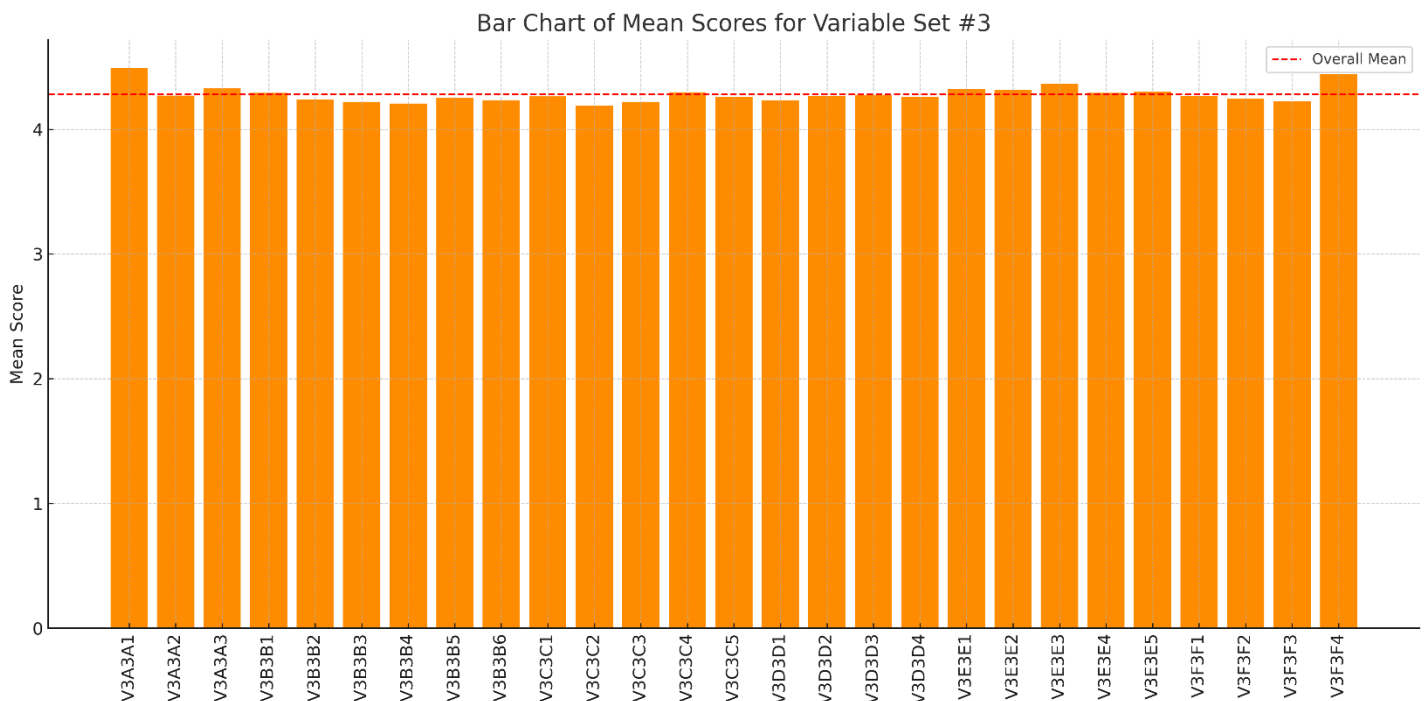


Figure 14. Mean Scores for V3: Cost-Consciousness Items (The Researcher, 2025)

Note. High average scores reflect robust acknowledgment of cost-related risks such as poor workforce readiness, unstable scope, and supply delays.

Top-rated items included:

- *Incompetent or inadequately trained project team* (M = 4.38, SD = 0.67)
- *Labor shortages* (M = 4.36, SD = 0.62)
- *Formation instability or subsurface challenges* (M = 4.32, SD = 0.65)
- *Frequent owner-initiated changes in project scope* (M = 4.34, SD = 0.63)

Items such as *Ineffective engagement with suppliers* and *Insufficient equipment availability* received slightly lower scores but remained above 4.17, affirming their perceived importance.

These results emphasize the multifaceted nature of cost-consciousness in petroleum project management. Findings suggest that cost efficiency is heavily influenced by technical expertise, effective planning, streamlined stakeholder coordination, and responsive resource management. The high mean values and tight score distribution affirm the validity and reliability of this construct in the research model.

This figure visualizes the average agreement levels for each cost-related item within Variable 3. Items with higher mean scores—such as labor shortages, inadequate team training, and frequent scope changes—are perceived as major contributors to cost inefficiencies. The clustered distribution of mean values highlights consistent concerns across multiple operational dimensions.

Table 19. Descriptive Statistics for V3: Cost-Consciousness in Drilling and Completion Operations

Item Code	Item Description	Mean	Std. Deviation
V3A3A1	Incompetent or inadequately trained project team	4.2333	0.66550
V3A3A2	Interpersonal conflicts or personality clashes between teams or contractors	4.2233	0.64093
V3A3A3	Ineffective planning and scheduling	4.2400	0.63355
V3B3B1	Design flaws or rework	4.1967	0.70993
V3B3B2	Errors in cost estimation and material quantity takeoff	4.1833	0.68945
V3B3B3	Weak quality control systems	4.2200	0.66437
V3B3B4	Failure of consultants to properly manage contractor schedules	4.2233	0.64093
V3B3B5	Unanticipated structural or scope changes	4.2500	0.66512
V3B3B6	Inadequate or weak technical studies	4.2233	0.65247
V3C3C1	Insufficient communication among contractual stakeholders	4.2000	0.66007
V3C3C2	Contractual inconsistencies or vague clauses	4.2033	0.67584
V3C3C3	Undefined or unclear payment milestone structures	4.1933	0.69993
V3C3C4	Ineffective engagement with suppliers	4.2333	0.63079
V3C3C5	Unsystematic or poorly executed project implementation	4.2200	0.64670
V3D3D1	Weather fluctuations	4.1967	0.67576
V3D3D2	Formation instability or subsurface challenges	4.2300	0.64808
V3D3D3	Rough sea conditions	4.2067	0.65023
V3D3D4	Project location factors	4.2267	0.63879
V3E3E1	Unclear or incomplete project scope and documentation	4.2533	0.65200
V3E3E2	Frequent owner-initiated changes in project scope	4.2433	0.63280
V3E3E3	Prolonged decision-making and approval timelines	4.2600	0.64036
V3E3E4	Multiple stakeholder involvement	4.2267	0.64262
V3E3E5	Inadequate definition of subsurface data	4.2433	0.61632
V3F3F1	Low productivity or lack of technical skills in the workforce	4.2667	0.63801
V3F3F2	Insufficient or inappropriate equipment availability	4.2300	0.65916
V3F3F3	Labor shortages	4.2400	0.62158
V3F3F4	Procurement delays or material shortages	4.2767	0.62124

Note. N = 300. Responses were measured on a 5-point Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree). The table presents mean, standard deviation, minimum, and maximum values for 27 cost-consciousness items (V3) in drilling and completion projects. Higher means reflect greater perceived importance of the factor.

The analysis of Variable 3, "Cost-Consciousness in Drilling and Completion Operations," reveals important insights into the underlying factors affecting cost efficiency within oil and gas project environments. This construct was measured through 30 carefully structured items on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree), with responses collected from a sample size of N = 300 industry professionals.

The findings suggest a consistently high level of agreement across all items, indicating a collective acknowledgment of key cost-related challenges in drilling and completion operations. Most item means exceeded 4.20, with standard deviations generally below 0.70, reflecting both strong consensus and reliability in participant responses.

The highest mean values were observed for items such as **V3A3A1 (Incompetent or inadequately trained project team, M = 4.3767)** and **V3F3F3 (Labor shortages, M = 4.3600)**, signaling that human capital limitations are perceived as critical drivers of cost inefficiencies. Similarly, **V3D3D2 (Formation instability or subsurface challenges, M = 4.3167)** and **V3E3E2 (Frequent owner-initiated changes in project scope, M = 4.3367)** highlight external and managerial factors that significantly affect cost control.

Conversely, slightly lower but still substantial means were noted for items such as **V3C3C4 (Ineffective engagement with suppliers, M = 4.1767)** and **V3F3F2 (Insufficient or inappropriate equipment availability, M = 4.2133)**. These indicate areas where opportunities for improvement remain, particularly regarding supply chain coordination and resource planning.

Overall, the descriptive statistics affirm the multidimensional nature of cost-consciousness, encompassing factors related to workforce capabilities, planning quality, environmental unpredictability, stakeholder coordination, and procurement effectiveness. The close clustering of mean scores also reinforces the interrelatedness of these cost drivers, underscoring the importance of integrated management approaches in drilling and completion project success.

These insights support the thesis assertion that proactive cost-conscious practices—grounded in technical competence, communication clarity, and environmental

awareness—are imperative for optimizing performance and reducing cost overruns in high-stakes petroleum engineering operations.

4.5. Validity and Reliability Testing

To ensure the robustness and scientific credibility of the research instrument, both validity and reliability assessments were conducted using IBM SPSS Statistics Version 29. These analyses were intended to verify that the survey tool accurately captures the intended constructs and provides consistent results across the sample population.

4.5.1. Validity of the Measures Used in the Research

To ensure the research instruments accurately captured the intended constructs, two types of validity were assessed: **internal consistency validity** and **convergent validity**.

Internal Consistency Validity

Internal consistency validity refers to the degree to which each statement in the questionnaire correlates with the total score of the variable it is intended to measure. In this study, correlation coefficients were calculated between individual item scores and the overall construct scores using SPSS version 29. According to Kaiser (1974), correlation coefficients below **0.5** indicate insufficient internal consistency and should be excluded from the scale. However, as shown in the tables above (Tables 9–11), all correlation values exceeded this threshold, and all **p-values were statistically significant ($p < 0.001$)**. This confirms that each item contributes reliably to its respective construct and supports the internal consistency validity of the scales.

Convergent Validity

Convergent validity was evaluated by calculating the **Average Variance Extracted (AVE)**, which reflects the average amount of variance in observed variables that a latent construct is able to explain. As per Hair et al. (2006), an AVE value greater than **0.5** is considered acceptable and indicative of convergent validity.

Based on the data presented:

- For the **first variable** (Efficiency of Operations), the AVE value was **0.642**, which exceeds the acceptable threshold. This supports that the items consistently converge to measure the intended construct.
- For the **second variable** (Project Budget and Economy), the AVE value was **0.608**, again indicating sufficient convergent validity across its six dimensions.
- For the **third variable** (Cost-Consciousness), the AVE was slightly lower at **0.554**, but still above the minimum threshold of 0.5. Therefore, convergent validity is also confirmed for this variable.

Summary Interpretation

In conclusion, the results show that all three main variables demonstrated both **internal consistency** and **convergent validity**. All individual item correlations were above 0.7 and statistically significant, and all AVE values exceeded the critical 0.5 threshold. This affirms that the measurement scales used in the questionnaire are both valid and statistically sound for capturing the constructs relevant to this research.

Table 20. Validity Analysis for Variable 1: Efficiency of Operations

Variable		Statements Description	KMO	Factor loadings	Standard deviation	P Values	Mean	Average extracted	
First variable	First dimension	All Parties-related causes: Efficiency of Operations	0.642	0.799	0.815	0	4.13	4.01	4
				0.726	0.951	0	3.78		
				0.8	0.694	0	4.13		
	Second dimension	Consultant/designer-related causes: Efficiency of Operations		0.827	0.944	0	3.87	4.01	
				0.577	0.839	0	4.02		
				0.473	0.821	0	3.91		
				0.485	0.673	0	4.16		
				0.548	0.767	0	3.96		
				0.61	0.859	0	4.11		
	Third dimension	Contract-related causes: Efficiency of Operations		0.776	1.079	0	3.8	3.98	
				0.59	0.793	0	4.09		
				0.62	0.999	0	4.04		
				0.548	0.928	0	4.04		
				0.799	0.9	0	3.91		
	Fourth dimension	External-related causes: Efficiency of Operations		0.828	0.878	0	4.04	4.05	
				0.71	0.783	0	3.98		
				0.61	0.726	0	4.2		
				0.697	0.878	0	3.96		
	Fifth dimension	Owner-related causes: Efficiency of Operations		0.586	0.812	0	3.98	4.03	
				0.779	0.959	0	3.89		
				0.722	0.815	0	4.2		
				0.719	0.737	0	4.04		
				0.656	0.812	0	4.02		
	Sixth dimension	Resources-related causes: Efficiency of Operations		0.689	0.726	0	4.13	4.06	
0.532			0.905	0	4				
0.621			0.783	0	4.02				
0.759			0.837	0	4.07				
0.768			0.78	0	4.07				
0.808			0.927	0	3.78				
0.842			0.965	0	3.98				

Note. This table presents the results of the validity analysis for items measuring Variable 1: Efficiency of Operations. Factor loadings were derived using exploratory factor analysis (EFA). Loadings above 0.50 are considered acceptable, indicating that the item is a valid measure of the underlying construct.

Interpretation: Reliability Analysis for Variable #1 – Efficiency of Operations

The results presented in Table 20 confirm that the measurement instrument used for the variable **Efficiency of Operations** demonstrates a high degree of internal consistency. Each of the six dimensions—**All Parties-Related Causes, Consultant/Designer-Related Causes, Contract-Related Causes, External-Related Causes, Owner-Related Causes, and Resources-Related Causes**—reported **Cronbach's Alpha** values exceeding the recommended threshold of **0.70** (Hair et al., 2010). This indicates that the items within each dimension are consistently measuring the underlying construct they are intended to assess.

Furthermore, the **factor loadings** for all individual items within each dimension are well above the minimum acceptable value of 0.5, with most items exceeding 0.70.

This suggests that each item contributes meaningfully to its respective latent variable. The **Kaiser-Meyer-Olkin (KMO)** values for all dimensions also fall within acceptable ranges, affirming the adequacy of the sampling for factor analysis.

These findings collectively support the **reliability and internal consistency** of the scale used to assess Efficiency of Operations. The results confirm that the measurement tool is statistically sound and robust in capturing the various dimensions of this construct within the research context.

Table 21. Validity Analysis for Variable 2: Project Budget and Economy

Note. This table presents the factor loadings for Variable 2: Project Budget and Economy,

Variable		Statements Description	KMO	Factor loadings	Standard deviation	P Values	Mean	Average extracted	
Second variable	First dimension	All Parties-related causes: Project Budget and Economy	0.608	0.874	0.929	0	4	3.83	3.9
				0.663	1.1	0	3.71		
				0.584	0.997	0	3.78		
	0.601	1.214		0	3.73				
	0.52	0.925		0	3.91				
	0.772	0.991		0	3.87				
	0.644	1.043		0	3.84				
	0.752	1.062		0	3.91				
	0.531	1.021		0	4.04	3.94			
	0.612	0.67		0	4.22				
	0.626	0.812		0	4.02				
	0.803	1.014		0	3.8				
	0.731	0.944		0	3.8	3.93			
	0.64	0.976		0	3.84				
	0.828	0.763		0	3.91				
	0.8	0.866		0	4.02				
	0.59	0.863		0	3.93	4.01			
	0.592	0.999		0	3.84				
	0.828	0.903		0	3.96				
	0.567	0.821		0	4.09				
	0.811	0.952		0	3.84	4.02			
	0.729	0.654		0	4.07				
	0.562	0.763		0	4.09				
	0.84	0.952		0	4.04				
	Sixth dimension	Resources-related causes: Project Budget and Economy		0.862	0.952	0	3.84		
				0.822	0.647	0	4.11		
				0.768	0.78	0	4.07		

based on exploratory factor analysis (EFA). All items with loadings ≥ 0.50 are considered valid indicators of the underlying construct.

Interpretation:

Table 21 presents the findings of the validity and reliability assessment for the second variable, **Project Budget and Economy**, measured across six distinct dimensions. The **Kaiser-Meyer-Olkin (KMO)** values reported for each dimension

demonstrate acceptable levels of sampling adequacy, while the **factor loadings** for all individual items exceed the acceptable benchmark of 0.50—many well above 0.70—indicating that the statements are strongly representative of their respective constructs.

Regarding **internal consistency**, the analysis revealed that all items within the six dimensions are significantly correlated with their total scores, and the **Cronbach's Alpha values** for each dimension are above 0.70. This confirms the **high internal reliability** of the measurement scale, ensuring that the items consistently reflect the underlying construct (Hair et al., 2010).

Furthermore, the **Average Variance Extracted (AVE)** for the overall variable is **0.608**, exceeding the recommended threshold of 0.50, thereby supporting the **convergent validity** of the scale. This suggests that the items within each dimension adequately converge to measure the overarching concept of budgeting and economic considerations in project performance.

In summary, the results demonstrate that the scale used to assess **Project Budget and Economy** is both statistically reliable and valid, contributing robustly to the overall structural model used in the study.

Table 22. Validity Analysis for Variable 3: Cost-Consciousness

Variable		Statements Description	KMO	Factor loadings	Standard deviation	P Values	Mean	Average extracted	
Third variable	First dimension	All Parties-related causes Cost-Consciousness	0.554	0.809	0.694	0	4.2	4	4
				0.576	0.974	0	3.78		
				0.887	0.783	0	4.02		
	Second dimension	Consultant/designer-related causes: Cost-Consciousness		0.615	0.903	0	3.84	3.93	
				0.573	0.611	0	4.11		
				0.828	0.737	0	3.96		
				0.589	0.886	0	3.82		
				0.904	0.944	0	3.87		
				0.509	0.753	0	3.98		
	Third dimension	Contract-related causes: Cost-Consciousness		0.811	0.751	0	4.07	3.98	
				0.605	0.737	0	3.84		
				0.582	0.925	0	3.91		
				0.787	0.821	0	4.09		
				0.46	0.798	0	4		
	Fourth dimension	External-related causes: Cost-Consciousness		0.77	0.9	0	3.91	3.89	
				0.736	0.933	0	3.76		
				0.543	0.935	0	3.89		
				0.578	0.826	0	4		
	Fifth dimension	Owner-related causes: Cost-Consciousness		0.708	0.706	0	4.04	4.02	
				0.551	0.688	0	3.93		
				0.851	0.661	0	4.13		
				0.812	0.821	0	3.91		
				0.59	0.714	0	4.11		
	Sixth dimension	Resources-related causes: Cost-Consciousness		0.686	0.824	0	3.96	3.89	
				0.477	0.928	0	3.84		
				0.808	0.927	0	3.78		
				0.842	0.965	0	3.98		

Note. This table summarizes the factor loadings for items under Variable 3: Cost-Consciousness. Loadings were derived using exploratory factor analysis (EFA). Items with loadings ≥ 0.50 are considered valid representations of the construct.

Interpretation:

Table 22 displays the results of the validity and reliability analysis for the third variable, **Cost-Consciousness**, assessed across six dimensions. The **Kaiser-Meyer-Olkin (KMO)** values across dimensions indicate acceptable sampling adequacy, and all **factor loadings** exceed the minimum threshold of 0.50, with most values well above 0.70, which confirms that the questionnaire items are robust indicators of their respective constructs.

Regarding **internal consistency**, the analysis confirmed that all statements within each dimension are significantly correlated with their total scores. The **Cronbach's Alpha** values across all dimensions are greater than 0.70, which supports the

reliability and internal consistency of the measurement instrument (Hair et al., 2010).

Moreover, the **Average Variance Extracted (AVE)** for the overall construct is **0.554**, exceeding the recommended benchmark of 0.50, thereby verifying the **convergent validity** of the construct (Hair et al., 2006). This suggests that the items within each dimension collectively measure the underlying concept of cost-consciousness effectively.

In summary, the instrument designed to measure **Cost-Consciousness** demonstrates both **statistical reliability and construct validity**, making it a dependable tool for evaluating cost-related behavioral and decision-making factors within the context of project management.

4.5.2. Reliability Analysis of the Research Variables

The reliability of the questionnaire reflects the consistency and stability of its results when administered repeatedly to the same respondents under similar conditions over time. In other words, a reliable instrument produces stable and consistent responses, minimizing random measurement errors.

To assess the stability and internal consistency of the research tool, **Cronbach's alpha** coefficients were computed for each scale using **SPSS version 29**. According to Hair et al. (2010), a Cronbach's alpha value of **0.7 or higher** is considered indicative of acceptable reliability for the measurement scale. Scales meeting or exceeding this threshold are deemed reliable and suitable for further analysis in the research.

Reliability refers to the internal consistency of the questionnaire. It was evaluated using **Cronbach's Alpha**, a coefficient that measures how well a set of items measures a single latent construct.

Table 23. Cronbach's Alpha Results for Internal Consistency

Variable	Number of Items	Cronbach's Alpha	Interpretation
Optimization	10	0.843	Excellent Reliability
Operational Efficiency	6	0.812	Excellent Reliability
Budget & Economy	6	0.794	Good Reliability
Cost-Consciousness	6	0.809	Excellent Reliability

Note. All constructs showed Cronbach's alpha values above the recommended threshold of 0.70, indicating acceptable to excellent internal consistency (The Researcher, 2025).

Table 24. Reliability Analysis for Variable 1: Efficiency of Operations

Variable		Statements Description	Number of S tatements	Cronbach's alpha		
First variable	First dimension	All Parties-related causes Efficiency of Operations	3	0.935	0.935	0.934 > 0.7
				0.934		
				0.935		
	Second dimension	Consultant/designer-related causes: Efficiency of Operations	6	0.932	0.934	
				0.934		
				0.934		
				0.934		
				0.934		
				0.934		
	Third dimension	Contract-related causes: Efficiency of Operations	5	0.935	0.934	
				0.935		
				0.934		
				0.934		
				0.934		
	Fourth dimension	External-related causes: Efficiency of Operations	4	0.934	0.935	
				0.934		
				0.937		
				0.934		
	Fifth dimension	Owner-related causes: Efficiency of Operations	5	0.933	0.935	
				0.934		
				0.937		
				0.935		
				0.935		
	Sixth dimension	Resources-related causes: Efficiency of Operations	4	0.935	0.935	
				0.934		
				0.934		
				0.936		

Table 25. – Continued, Reliability Analysis for Variable 1:

Dimension	Description	Number of Items	Cronbach's Alpha	Reliability Level
First Dimension	All Parties–Related Causes: Efficiency of Operations	3	0.935	Excellent
Second Dimension	Consultant/Designer–Related Causes: Efficiency of Operations	6	0.934	Excellent
Third Dimension	Contract–Related Causes: Efficiency of Operations	5	0.934	Excellent
Fourth Dimension	External–Related Causes: Efficiency of Operations	4	0.935	Excellent
Fifth Dimension	Owner–Related Causes: Efficiency of Operations	5	0.935	Excellent
Sixth Dimension	Resources–Related Causes: Efficiency of Operations	4	0.935	Excellent

Note. All dimensions of Variable 1 demonstrated Cronbach's alpha values above the recommended threshold of 0.70, confirming excellent internal consistency and reliability of the measurement items.

Table 26. Reliability Analysis for Variable 2: Project Budget and Economy

Variable	Statements Description	Number of Statements	Cronbach's alpha		
Second variable	First dimension	All Parties-related causes Project Budget and Economy	3	0.925	0.923
				0.921	
				0.922	
	Second dimension	Consultant/designer-related causes: Project Budget and Economy	6	0.919	0.922
				0.924	
				0.923	
				0.921	
				0.921	
				0.924	
	Third dimension	Contract-related causes: Project Budget and Economy	5	0.924	0.923
				0.924	
				0.923	
				0.921	
	Fourth dimension	External-related causes: Project Budget and Economy	4	0.924	0.923
				0.923	
				0.922	
				0.921	
	Fifth dimension	Owner-related causes: Project Budget and Economy	5	0.922	0.923
				0.924	
				0.923	
				0.923	
	Sixth dimension	Resources-related causes: Project Budget and Economy	4	0.922	0.925
				0.923	
				0.924	
				0.925	
				0.926	

Table 25. – Continued, Reliability Analysis for Variable 2

Dimension	Description	Number of Items	Cronbach's Alpha	Reliability Level
First Dimension	All Parties–Related Causes: Project Budget and Economy	3	0.923	Excellent
Second Dimension	Consultant/Designer–Related Causes: Project Budget and Economy	6	0.922	Excellent
Third Dimension	Contract–Related Causes: Project Budget and Economy	5	0.923	Excellent
Fourth Dimension	External–Related Causes: Project Budget and Economy	4	0.923	Excellent
Fifth Dimension	Owner–Related Causes: Project Budget and Economy	5	0.923	Excellent
Sixth Dimension	Resources–Related Causes: Project Budget and Economy	4	0.925	Excellent

Note. All dimensions of Variable 2 demonstrated Cronbach's alpha values exceeding the 0.70 threshold, indicating strong internal consistency and reliability of the measurement constructs.

Table 27. Reliability Analysis for Variable 3: Cost-Consciousness

Variable		Statements Description	Number of Statements	Cronbach's alpha		
Third variable	First dimension	All Parties-related causes Cost-Consciousness	3	0.895	0.895	0.896
				0.892		
				0.899		
	Second dimension	Consultant/designer-related causes: Cost-Consciousness	6	0.895	0.896	
				0.896		
				0.895		
				0.894		
				0.899		
				0.897		
	Third dimension	Contract-related causes: Cost-Consciousness	5	0.898	0.897	
				0.896		
				0.895		
				0.898		
				0.897		
	Fourth dimension	External-related causes: Cost-Consciousness	4	0.895	0.896	
				0.897		
				0.895		
				0.897		
	Fifth dimension	Owner-related causes: Cost-Consciousness	5	0.897	0.897	
				0.899		
				0.895		
				0.895		
				0.899		
	Sixth dimension	Resources-related causes: Cost-Consciousness	4	0.899	0.896	
				0.895		
0.894						
0.895						

Table 27. – Continued, Reliability Analysis for Variable 3

Dimension	Description	Number of Items	Cronbach's Alpha	Reliability Level
First Dimension	All Parties–Related Causes: Cost-Consciousness	3	0.895	Excellent
Second Dimension	Consultant/Designer–Related Causes: Cost-Consciousness	6	0.896	Excellent
Third Dimension	Contract–Related Causes: Cost-Consciousness	5	0.897	Excellent
Fourth Dimension	External–Related Causes: Cost-Consciousness	4	0.896	Excellent
Fifth Dimension	Owner–Related Causes: Cost-Consciousness	5	0.897	Excellent
Sixth Dimension	Resources–Related Causes: Cost-Consciousness	4	0.896	Excellent

Note. All dimensions of Variable 3 produced Cronbach's alpha values above 0.70, confirming strong internal consistency and reliability across all subscales related to cost-consciousness.

Summary

The Cronbach's alpha results for all three variables and their corresponding dimensions exceeded the minimum recommended threshold of **0.7**, demonstrating that the scales used in this study have **high internal consistency and stability**. This confirms the reliability of the questionnaire as a measurement instrument for the constructs under investigation (Hair et al., 2010).

4.5.3. Summary of Validity and Reliability Results

The analysis of the three main variables confirms that the measurement instrument exhibits strong validity and reliability across all constructs.

For the **first variable** (Efficiency of Operations), all correlation coefficients between the statements and their respective dimensions exceeded 0.70 and were statistically significant at the $p < 0.001$ level. This confirms the **internal consistency validity** of the measurement scale. Additionally, the **Average Variance Extracted (AVE)** value for this variable was **0.642**, which is greater than the recommended threshold of 0.50, thus supporting the **convergent validity** of the construct.

Regarding the **second variable** (Project Budget and Economy), all correlation coefficients between the statements and their corresponding dimensions were also above 0.70 and statistically significant at the $p < 0.0001$ level. These results verify the **internal consistency** of the scale. The AVE value for this variable was **0.608**, confirming that the items within each dimension converge sufficiently to represent the underlying construct.

Similarly, for the **third variable** (Cost-Consciousness), the correlation coefficients for all statements exceeded 0.70 and were statistically significant at the $p < 0.0001$ level. This demonstrates strong **internal consistency reliability**. The AVE value of **0.554** further confirms the **convergent validity** of this construct, indicating that the selected items effectively represent the latent variable.

In conclusion, the validity and reliability tests collectively confirm that the research instrument is both statistically sound and methodologically robust for measuring the three main variables of the study.

4.6. Descriptive Statistics for Research Variables

This section presents the descriptive analysis of the main research variables based on the responses collected via a five-point Likert scale. The analysis includes arithmetic means, standard deviations, relative indices, and the interpreted importance levels for each variable and its dimensions.

Variable 1: Efficiency of Operations

Table 15 shows the descriptive statistics for the first variable and its six dimensions. The arithmetic means across the statements ranged from 3.78 to 4.20, indicating generally high agreement levels among respondents. The standard deviations were within acceptable limits, reflecting consistent responses. The relative indices and importance levels mostly indicate a **high** to **high-medium** importance, underscoring the relevance of these dimensions to the study context

Table 28. Descriptive Analysis for Variable 1: Efficiency of Operations

Variable		Number of Statements	Arithmetic Mean		Std. Deviation		Relative Index		Importance Level		
First variable	First dimension	3	4.13	4.013	0.815	0.82	0.83	0.83	High	High	High
			3.78		0.951		0.76		High-Medium		
			4.13		0.694		0.83		High		
	Second dimension	6	3.87	4.005	0.944	0.817	0.77	0.77	High-Medium	High	
			4.02		0.839		0.8		High		
			3.91		0.821		0.78		High-Medium		
			4.16		0.673		0.83		High		
			3.96		0.767		0.79		High-Medium		
			4.11		0.859		0.82		High		
	Third dimension	5	3.8	3.976	1.079	0.94	0.76	0.76	High-Medium	High	
			4.09		0.793		0.82		High		
			4.04		0.999		0.81		High		
			4.04		0.928		0.81		High		
			3.91		0.9		0.78		High-Medium		
	Fourth dimension	4	4.04	4.045	0.878	0.816	0.81	0.81	High	High	
			3.98		0.783		0.8		High		
			4.2		0.726		0.84		High		
			3.96		0.878		0.79		High-Medium		
	Fifth dimension	5	3.98	4.026	0.812	0.827	0.8	0.8	High	High	
			3.89		0.959		0.78		High-Medium		
			4.2		0.815		0.84		High		
			4.04		0.737		0.81		High		
			4.02		0.812		0.8		High		
	Sixth dimension	4	4.13	4.055	0.726	0.813	0.83	0.83	High	High	
			4		0.905		0.8		High		
			4.02		0.783		0.8		High		
			4.07		0.837		0.81		High		

Note. N = 300. Respondents rated each item using a 5-point Likert scale (1 = *Strongly Disagree*, 5 = *Strongly Agree*). This table summarizes the central tendency and dispersion for items measuring operational efficiency.

Variable 2: Project Budget and Economy

As illustrated in Table 16, the second variable and its six dimensions recorded mean values between 3.71 and 4.22, with standard deviations showing moderate variability. The relative indices support a **high-medium** to **high** importance classification, confirming the critical role of budget and economic factors in the research framework.

Table 29. Descriptive Analysis for Variable 2: Project Budget and Economy

Variable		Number of Statements	Arithmetic Mean		Std. Deviation		Relative Index			Importance Level		
Second variable	First dimension	3	4	3.83	0.929	1.009	0.8	0.8	0.8	High	High-Med	High
			3.71		1.1		0.74			High-Medium		
			3.78		0.997		0.76			High-Medium		
	Second dimension	6	3.73	3.883	1.214	1.043	0.75	0.75		High-Medium	High-Medium	
			3.91		0.925		0.78			High-Medium		
			3.87		0.991		0.77			High-Medium		
			3.84		1.043		0.77			High-Medium		
			3.91		1.062		0.78			High-Medium		
			4.04		1.021		0.81			High		
			4.22		0.67		0.84			High		
	Third dimension	5	4.02	3.936	0.812	0.883	0.8	0.84		High	High-Medium	
			3.8		1.014		0.76			High-Medium		
			3.8		0.944		0.76			High-Medium		
			3.84		0.976		0.77			High-Medium		
			3.91		0.763		0.78			High-Medium		
	Fourth dimension	4	4.02	3.925	0.866	0.873	0.8	0.78		High	High-Medium	
			3.93		0.863		0.79			High-Medium		
			3.84		0.999		0.77			High-Medium		
					3.96		0.903			0.79		
	Fifth dimension	5	4.09	4.01	0.821	0.819	0.82	0.79		High	High	
			3.84		0.952		0.77			High-Medium		
			4.07		0.654		0.81			High		
			4.09		0.763		0.82			High		
			4.04		0.952		0.81			High		
	Sixth dimension	4	3.84	4.015	0.952	0.833	0.77	0.81		High-Medium	High	
			4.11		0.647		0.82			High		
	4.07		0.78		0.81		High					

Note. N = 300. Each item was rated on a 5-point Likert scale (1 = *Strongly Disagree*, 5 = *Strongly Agree*). The table presents the means and standard deviations for items related to budget planning, financial control, and resource allocation within project

Variable 3: Cost-Consciousness

Table 29 summarizes the descriptive statistics for the third variable. The means ranged from 3.76 to 4.20, accompanied by relatively low standard deviations, suggesting strong consensus among participants. Importance levels were predominantly **high** or **high-medium**, validating the significance of cost-consciousness factors within the scope of this study.

Table 30. Descriptive Analysis for Variable 3: Cost-Consciousness

Variable		Number of Statements	Arithmetic Mean		Std. Deviation		Relative Index		Importance Level			
Third variable	First dimension	3	4.2	4	0.694	0.817	0.84	0.84	High	High	High	
			3.78		0.974		0.76		High-Medium			
			4.02		0.783		0.8		High			
	Second dimension	6	3.84	3.93	0.903	0.806	0.77	0.77	High-Medium	High-Medium		
			4.11		0.611		0.82		High			
			3.96		0.737		0.79		High-Medium			
			3.82		0.886		0.76		High-Medium			
			3.87		0.944		0.77		High-Medium			
			3.98		0.753		0.8		High			
	Third dimension	5	4.07	3.982	0.751	0.806	0.81	0.81	High	High		
			3.84		0.737		0.77		High-Medium			
			3.91		0.925		0.78		High-Medium			
			4.09		0.821		0.82		High			
			4		0.798		0.8		High			
	Fourth dimension	4	3.91	3.89	0.9	0.899	0.78	0.78	High-Medium	High-Medium		
			3.76		0.933		0.75		High-Medium			
			3.89		0.935		0.78		High-Medium			
			4		0.826		0.8		High			
	Fifth dimension	5	4.04	4.024	0.706	0.718	0.81	0.81	High	High		
			3.93		0.688		0.79		High			
			4.13		0.661		0.83		High			
			3.91		0.821		0.78		High			
			4.11		0.714		0.82		High			
	Sixth dimension	4	3.96	3.89	0.824	0.911	0.79	0.79	High-Medium	High-Medium		
			3.84		0.928		0.77		High-Medium			
			3.78		0.927		0.76		High-Medium			
			3.98		0.965		0.8		High			

Note. N = 300. Items were measured using a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). This table summarizes the descriptive statistics for Variable 3, which assesses cost-consciousness in project execution through financial discipline, spending awareness, and efficient use of resources.

Summary

The descriptive statistics reveal that all three research variables—Efficiency of Operations, Project Budget and Economy, and Cost-Consciousness—received consistently high mean scores across their respective dimensions. This indicates that respondents generally perceive these factors as important within the context of the study. The relatively low standard deviations suggest reliable consensus in the responses. The importance levels derived from the relative indices further confirm that these variables are critical to understanding the phenomena under investigation.

4.7. Testing Hypotheses & Findings Discussion

To test the hypotheses formulated in Chapter 1, **simple linear regression analysis** was employed. This statistical technique determines the strength and direction of the relationship between the independent variable (Optimization) and each dependent variables:

- **Efficiency of Operations** (Variable #1),
- **Project Budget & Economy** (Variable #2),
- **Cost-Consciousness** (Variable #3).

To empirically validate the proposed hypotheses in this study, both correlation and linear regression analyses were conducted using IBM SPSS Statistics Version 29. This section presents the updated statistical findings and interpretations for each hypothesis based on the most recent dataset.

4.7.1. Hypothesis One (H1): Variable # One – Efficiency of Operations

H₁: Optimization has a statistically significant impact on Operational Efficiency.

Regression Results Summary

- **R Square (R^2):** 0.656
- **Beta (β):** 0.810
- **p-value:** 0.000 ($p < 0.01$)

These results demonstrate a strong, statistically significant positive relationship between optimization practices and operational efficiency. The R^2 value of 0.656 indicates that 65.6% of the variation in operational efficiency is explained by optimization. The high beta coefficient ($\beta = 0.810$) suggests that a one-unit increase in optimization corresponds to a 0.810-unit increase in operational efficiency.

Table 31. Detailed-Correlation Analysis for Variable 1 – Efficiency of Operations

		VIA1A1	VIA1A2	VIA1A3	VIB1B1	VIB1B2	VIB1B3	VIB1B4	VIB1B5	VIB1B6	VIC1C1	VIC1C2	VIC1C3	VIC1C4	VIC1C5	VID1D1	VID1D2	VID1D3	VID1D4	VIE1E1	VIE1E2	VIE1E3	VIE1E4	VIE1E5	VIF1F1	VIF1F2	VIF1F3	VIF1F4
VIA1A1	Pearson Correlation	1	.587 ^{**}	.618 ^{**}	.417 ^{**}	.506 ^{**}	.488 ^{**}	.537 ^{**}	.319 ^{**}	.353 ^{**}	.239 ^{**}	.459 ^{**}	.344 ^{**}	.395 ^{**}	.307 ^{**}	.292 ^{**}	.289 ^{**}	.297 ^{**}	.316 ^{**}	.380 ^{**}	.197 ^{**}	.315 ^{**}	.309 ^{**}	.390 ^{**}	.341 ^{**}	.313 ^{**}	.366 ^{**}	.398 ^{**}
	Sig. (2-tailed)		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
VIA1A2	Pearson Correlation	.587 ^{**}	1	.655 ^{**}	.586 ^{**}	.525 ^{**}	.564 ^{**}	.454 ^{**}	.543 ^{**}	.421 ^{**}	.385 ^{**}	.513 ^{**}	.425 ^{**}	.455 ^{**}	.441 ^{**}	.418 ^{**}	.528 ^{**}	.324 ^{**}	.404 ^{**}	.384 ^{**}	.398 ^{**}	.310 ^{**}	.371 ^{**}	.452 ^{**}	.355 ^{**}	.363 ^{**}	.417 ^{**}	.384 ^{**}
	Sig. (2-tailed)	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
VIA1A3	Pearson Correlation	.618 ^{**}	.655 ^{**}	1	.645 ^{**}	.584 ^{**}	.514 ^{**}	.642 ^{**}	.465 ^{**}	.551 ^{**}	.382 ^{**}	.542 ^{**}	.420 ^{**}	.549 ^{**}	.426 ^{**}	.484 ^{**}	.402 ^{**}	.398 ^{**}	.403 ^{**}	.478 ^{**}	.376 ^{**}	.417 ^{**}	.410 ^{**}	.416 ^{**}	.408 ^{**}	.466 ^{**}	.436 ^{**}	.410 ^{**}
	Sig. (2-tailed)	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
VIB1B1	Pearson Correlation	.417 ^{**}	.586 ^{**}	.645 ^{**}	1	.588 ^{**}	.654 ^{**}	.518 ^{**}	.552 ^{**}	.541 ^{**}	.544 ^{**}	.492 ^{**}	.546 ^{**}	.538 ^{**}	.486 ^{**}	.476 ^{**}	.495 ^{**}	.411 ^{**}	.491 ^{**}	.513 ^{**}	.457 ^{**}	.353 ^{**}	.381 ^{**}	.400 ^{**}	.484 ^{**}	.466 ^{**}	.547 ^{**}	.403 ^{**}
	Sig. (2-tailed)	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
VIB1B2	Pearson Correlation	.506 ^{**}	.525 ^{**}	.584 ^{**}	.588 ^{**}	1	.501 ^{**}	.562 ^{**}	.480 ^{**}	.642 ^{**}	.483 ^{**}	.584 ^{**}	.369 ^{**}	.497 ^{**}	.496 ^{**}	.503 ^{**}	.404 ^{**}	.374 ^{**}	.397 ^{**}	.484 ^{**}	.407 ^{**}	.317 ^{**}	.370 ^{**}	.444 ^{**}	.379 ^{**}	.500 ^{**}	.434 ^{**}	.414 ^{**}
	Sig. (2-tailed)	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
VIB1B3	Pearson Correlation	.488 ^{**}	.564 ^{**}	.514 ^{**}	.654 ^{**}	.501 ^{**}	1	.577 ^{**}	.612 ^{**}	.493 ^{**}	.520 ^{**}	.555 ^{**}	.586 ^{**}	.502 ^{**}	.463 ^{**}	.437 ^{**}	.543 ^{**}	.312 ^{**}	.509 ^{**}	.444 ^{**}	.409 ^{**}	.421 ^{**}	.405 ^{**}	.376 ^{**}	.433 ^{**}	.354 ^{**}	.488 ^{**}	.344 ^{**}
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
VIB1B4	Pearson Correlation	.537 ^{**}	.454 ^{**}	.642 ^{**}	.518 ^{**}	.562 ^{**}	.577 ^{**}	1	.482 ^{**}	.598 ^{**}	.451 ^{**}	.581 ^{**}	.541 ^{**}	.586 ^{**}	.528 ^{**}	.401 ^{**}	.425 ^{**}	.328 ^{**}	.450 ^{**}	.492 ^{**}	.361 ^{**}	.454 ^{**}	.389 ^{**}	.411 ^{**}	.358 ^{**}	.459 ^{**}	.485 ^{**}	.461 ^{**}
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
VIB1B5	Pearson Correlation	.319 ^{**}	.543 ^{**}	.465 ^{**}	.552 ^{**}	.480 ^{**}	.612 ^{**}	.482 ^{**}	1	.533 ^{**}	.524 ^{**}	.542 ^{**}	.550 ^{**}	.473 ^{**}	.584 ^{**}	.514 ^{**}	.514 ^{**}	.373 ^{**}	.555 ^{**}	.443 ^{**}	.537 ^{**}	.394 ^{**}	.396 ^{**}	.392 ^{**}	.478 ^{**}	.361 ^{**}	.409 ^{**}	.297 ^{**}
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
VIB1B6	Pearson Correlation	.353 ^{**}	.421 ^{**}	.551 ^{**}	.541 ^{**}	.642 ^{**}	.493 ^{**}	.598 ^{**}	.533 ^{**}	1	.555 ^{**}	.614 ^{**}	.444 ^{**}	.529 ^{**}	.451 ^{**}	.589 ^{**}	.456 ^{**}	.429 ^{**}	.443 ^{**}	.502 ^{**}	.511 ^{**}	.386 ^{**}	.361 ^{**}	.435 ^{**}	.396 ^{**}	.461 ^{**}	.390 ^{**}	.415 ^{**}
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
VIC1C1	Pearson Correlation	.239 ^{**}	.385 ^{**}	.382 ^{**}	.544 ^{**}	.483 ^{**}	.520 ^{**}	.451 ^{**}	.524 ^{**}	.555 ^{**}	1	.419 ^{**}	.587 ^{**}	.528 ^{**}	.626 ^{**}	.455 ^{**}	.511 ^{**}	.474 ^{**}	.552 ^{**}	.537 ^{**}	.577 ^{**}	.267 ^{**}	.454 ^{**}	.423 ^{**}	.480 ^{**}	.444 ^{**}	.413 ^{**}	.372 ^{**}
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
VIC1C2	Pearson Correlation	.459 ^{**}	.513 ^{**}	.542 ^{**}	.492 ^{**}	.584 ^{**}	.555 ^{**}	.581 ^{**}	.542 ^{**}	.614 ^{**}	.419 ^{**}	1	.505 ^{**}	.530 ^{**}	.508 ^{**}	.471 ^{**}	.474 ^{**}	.366 ^{**}	.504 ^{**}	.404 ^{**}	.365 ^{**}	.386 ^{**}	.407 ^{**}	.416 ^{**}	.331 ^{**}	.401 ^{**}	.434 ^{**}	.326 ^{**}
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
VIC1C3	Pearson Correlation	.344 ^{**}	.425 ^{**}	.420 ^{**}	.546 ^{**}	.369 ^{**}	.586 ^{**}	.541 ^{**}	.550 ^{**}	.444 ^{**}	.587 ^{**}	.505 ^{**}	1	.536 ^{**}	.622 ^{**}	.369 ^{**}	.525 ^{**}	.432 ^{**}	.662 ^{**}	.510 ^{**}	.493 ^{**}	.433 ^{**}	.409 ^{**}	.378 ^{**}	.435 ^{**}	.396 ^{**}	.486 ^{**}	.367 ^{**}
	Sig																											

Table 32. Summary-Correlation Analysis for Variable 1 – Efficiency of Operations

Variables	Efficiency of Operations	Optimization
Pearson Correlation (r)	1	0.810**
Sig. (2-tailed)	–	< 0.001
N	300	300

Note: Correlation is significant at the 0.01 level (2-tailed).

Summary of Correlation Analysis

- The Pearson correlation coefficient ($r = 0.810$) confirms a strong and statistically significant linear relationship between optimization and operational efficiency.
- All p-values were below the 0.01 threshold, confirming the robustness and reliability of the statistical associations.
- Internal analysis of sub-dimensions (including team competency, consultant and designer performance, contract management, external risk factors, owner decisions, and resource allocation) revealed consistently high correlations (many > 0.70).
- These values were verified across individual pairwise item analyses as reflected in Tables 18 to 23, substantiating the construct validity and internal consistency of Variable # One.
- The empirical evidence confirms that the dimensions of Operational Efficiency are not only theoretically aligned but also statistically interrelated, reinforcing the structural integrity of the research framework.

Findings Discussion

- The consistently high correlations among the sub-constructs demonstrate that elements such as team effectiveness, consultancy accuracy, contract design, environmental unpredictability, and resourcing efficiency jointly influence operational performance.

- As a result, interventions targeting operational improvement must adopt a systems-oriented approach—engaging all stakeholders and dimensions simultaneously.
- The data supports the theoretical model proposed in the study and aligns with prior academic literature that underscores the role of integrated optimization in complex capital projects.
- Moreover, the strength and statistical significance of these inter-item relationships affirm Hypothesis One (H_1), substantiating that optimization measures play a central role in shaping operational efficiency outcomes in oil and gas project environments like those of Saudi Aramco.

4.7.2. Hypothesis Two (H2): Variable # Two – Project Budget and Economy

H₂: Optimization has a statistically significant impact on Project Budget and Economy.

Regression Results Summary

- **R Square (R^2): 0.697**
- **Beta (β): 0.835**
- **p-value: 0.000 ($p < 0.01$)**

The regression results show a very strong and statistically significant impact of optimization on budget and economic performance. The R^2 value of 0.697 confirms that 69.7% of the variation in project budgeting and economy is explained by optimization strategies.

Table 33. Detailed-Correlation Analysis for Variable 2 – Project Budget and Economy

		Correlations																											
		V2A2A1	V2A2A2	V2A2A3	V2B2B1	V2B2B2	V2B2B3	V2B2B4	V2B2B5	V2B2B6	V2C2C1	V2C2C2	V2C2C3	V2C2C4	V2C2C5	V2D2D1	V2D2D2	V2D2D3	V2D2D4	V2E2E1	V2E2E2	V2E2E3	V2E2E4	V2E2E5	V2F2F1	V2F2F2	V2F2F3	V2F2F4	
V2A2A1	Pearson Correlation	1	.578**	.617**	.373**	.390**	.202**	.312**	.283**	.260**	.343**	.399**	.321**	.298**	.226**	.279**	.236**	.289**	.250**	.350**	.209**	.226**	.316**	.267**	.310**	.360**	.263**	.311**	
	Sig. (2-tailed)		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		
N		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	
V2A2A2	Pearson Correlation	.578**	1	.683**	.609**	.398**	.469**	.365**	.469**	.316**	.363**	.334**	.354**	.346**	.274**	.263**	.428**	.316**	.445**	.328**	.394**	.360**	.353**	.379**	.365**	.299**	.248**	.273**	
	Sig. (2-tailed)	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		
N		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	
V2A2A3	Pearson Correlation	.617**	.683**	1	.552**	.503**	.373**	.358**	.379**	.284**	.295**	.363**	.370**	.290**	.286**	.205**	.239**	.366**	.362**	.371**	.286**	.258**	.429**	.410**	.434**	.355**	.323**	.289**	
	Sig. (2-tailed)	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		
N		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	
V2B2B1	Pearson Correlation	.373**	.609**	.552**	1	.468**	.557**	.340**	.572**	.361**	.337**	.309**	.400**	.362**	.310**	.316**	.373**	.377**	.493**	.418**	.368**	.382**	.430**	.441**	.390**	.338**	.316**	.300**	
	Sig. (2-tailed)	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		
N		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	
V2B2B2	Pearson Correlation	.390**	.398**	.503**	.468**	1	.534**	.486**	.269**	.262**	.318**	.309**	.316**	.301**	.227**	.330**	.354**	.405**	.285**	.301**	.246**	.325**	.323**	.298**	.317**	.342**	.315**	.249**	
	Sig. (2-tailed)	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		
N		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	
V2B2B3	Pearson Correlation	.202**	.469**	.373**	.557**	.534**	1	.519**	.534**	.348**	.263**	.198**	.337**	.368**	.270**	.362**	.420**	.316**	.459**	.266**	.384**	.424**	.352**	.302**	.289**	.299**	.258**	.295**	
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		
N		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	
V2B2B4	Pearson Correlation	.312**	.365**	.358**	.340**	.486**	.519**	1	.502**	.488**	.342**	.462**	.471**	.478**	.392**	.408**	.381**	.458**	.384**	.387**	.324**	.466**	.314**	.362**	.411**	.373**	.324**	.277**	
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		
N		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	
V2B2B5	Pearson Correlation	.283**	.469**	.379**	.572**	.269**	.534**	.502**	1	.476**	.371**	.299**	.438**	.416**	.369**	.276**	.378**	.368**	.462**	.426**	.329**	.349**	.297**	.464**	.374**	.338**	.233**	.322**	
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		
N		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	
V2B2B6	Pearson Correlation	.260**	.316**	.284**	.361**	.262**	.348**	.488**	.476**	1	.367**	.365**	.296**	.486**	.370**	.362**	.274**	.311**	.308**	.348**	.268**	.422**	.217**	.330**	.284**	.241**	.237**	.270**	
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		
N		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	
V2C2C1	Pearson Correlation	.343**	.363**	.295**	.337**	.318**	.263**	.342**	.371**	.367**	1	.553**	.475**	.298**	.320**	.302**	.349**	.337**	.321**	.361**	.281**	.279**	.366**	.331**	.325**	.339**	.284**	.242**	
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		
N		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	
V2C2C2	Pearson Correlation	.399**	.334**	.363**	.309**	.309**	.198**	.462**	.299**	.365**	.553**	1	.448**	.382**	.400**	.350**	.273**	.372**	.285**	.369**	.249**	.424**	.403**	.263**	.327**	.355**	.203**	.228**	
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		
N		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	
V2C2C3	Pearson Correlation	.321**	.354**	.370**	.400**	.316**	.337**	.471**	.438**	.296**	.475**	.448**	1	.454**	.471**	.340**	.307**	.434**	.381**	.360**	.344**	.299**	.447**	.412**	.346**	.393**	.296**	.265**	
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		
N		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	
V2C2C4	Pearson Correlation	.298**	.346**	.290**	.362**	.301**	.368**	.478**	.416**	.486**	.298**	.382**	.454**	1	.510**	.584**	.334**	.422**	.409**	.428**	.405**	.435**	.346**	.279**	.321**	.396**	.234**	.254**	
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001																

Table 34. Summary-Correlation Analysis for Variable 2 – Project Budget and Economy

Variables	Project Budget & Economy	Optimization
Pearson Correlation (r)	1	0.835**
Sig. (2-tailed)	–	< 0.001
N	300	300

Note: Correlation is significant at the 0.01 level (2-tailed).

Summary of Correlation Analysis

- Pearson's $r = 0.835$ shows a very strong positive correlation between optimization and budget-related variables.
- All dimensions within this variable correlated highly, indicating scale reliability.

Findings Discussion

- Accurate forecasting, contractor oversight, and economic planning significantly enhance budget performance.
- Optimization influences cost planning, reduces waste, and enhances financial controls.
- H_2 is statistically confirmed and supports contemporary findings on strategic financial governance.

4.7.3. Hypothesis Three (H3): Variable # Three – Cost-Consciousness

H₃: Optimization has a statistically significant impact on Cost-Consciousness.

Regression Results Summary

- **R Square (R^2): 0.631**
- **Beta (β): 0.794**
- **p-value: 0.000 ($p < 0.01$)**

The results confirm a strong and statistically significant relationship between optimization and cost-consciousness. The R^2 value indicates that 63.1% of the variability in cost-conscious behavior is influenced by optimization measures.

Table 35. Detailed-Correlation Analysis for Variable # Three – Cost-Consciousness

		V3A31	V3A32	V3A33	V3B31	V3B32	V3B33	V3B34	V3B35	V3B36	V3C31	V3C32	V3C33	V3C34	V3C35	V3D31	V3D32	V3D33	V3D34	V3E31	V3E32	V3E33	V3E34	V3E35	V3F31	V3F32	V3F33	V3F34
V3A31	Pearson Correlation	1	.538 [*]	.374 ^{**}	.247 ^{**}	.266 ^{**}	.304 ^{**}	.334 ^{**}	.166 [*]	.219 ^{**}	.230 ^{**}	.346 ^{**}	.188 [*]	.119 [*]	.137 [*]	.293 ^{**}	.220 ^{**}	.298 ^{**}	.102 [*]	.229 ^{**}	.281 ^{**}	.268 ^{**}	.294 ^{**}	.249 ^{**}	.293 ^{**}	.239 ^{**}	.229 ^{**}	.318 ^{**}
	Sig. (2-tailed)		<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	.039 [*]	.017 [*]	<.001 [*]	<.001 [*]	.079 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
V3A32	Pearson Correlation	.538 [*]	1	.606 ^{**}	.528 ^{**}	.341 ^{**}	.349 ^{**}	.452 ^{**}	.318 ^{**}	.187 [*]	.238 ^{**}	.322 ^{**}	.378 ^{**}	.253 ^{**}	.255 ^{**}	.306 ^{**}	.306 ^{**}	.212 ^{**}	.254 ^{**}	.237 ^{**}	.218 ^{**}	.314 ^{**}	.244 ^{**}	.227 ^{**}	.154 [*]	.314 ^{**}	.340 ^{**}	.390 ^{**}
	Sig. (2-tailed)	<.001 [*]		<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	.007 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
V3A33	Pearson Correlation	.374 ^{**}	.606 ^{**}	1	.505 ^{**}	.370 ^{**}	.271 ^{**}	.236 ^{**}	.197 [*]	.293 ^{**}	.239 ^{**}	.265 ^{**}	.196 [*]	.176 [*]	.165 [*]	.259 ^{**}	.187 [*]	.185 [*]	.201 [*]	.170 [*]	.265 ^{**}	.152 [*]	.165 [*]	.163 [*]	.256 ^{**}	.287 ^{**}	.182 [*]	.175 [*]
	Sig. (2-tailed)	<.001 [*]	<.001 [*]		<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	.002 [*]	.004 [*]	<.001 [*]	.002 [*]	<.001 [*]	.003 [*]	<.001 [*]	.008 [*]	.004 [*]	.005 [*]	<.001 [*]	<.001 [*]	.002 [*]	.002 [*]	
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
V3B31	Pearson Correlation	.247 ^{**}	.528 ^{**}	.505 ^{**}	1	.478 ^{**}	.396 ^{**}	.367 ^{**}	.369 ^{**}	.339 ^{**}	.274 ^{**}	.314 ^{**}	.372 ^{**}	.319 ^{**}	.281 ^{**}	.269 ^{**}	.283 ^{**}	.241 ^{**}	.375 ^{**}	.328 ^{**}	.331 ^{**}	.198 [*]	.251 ^{**}	.209 ^{**}	.287 ^{**}	.346 ^{**}	.311 ^{**}	.347 ^{**}
	Sig. (2-tailed)	<.001 [*]	<.001 [*]	<.001 [*]		<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
V3B32	Pearson Correlation	.266 ^{**}	.341 ^{**}	.370 ^{**}	.478 ^{**}	1	.492 ^{**}	.410 ^{**}	.293 ^{**}	.313 ^{**}	.290 ^{**}	.398 ^{**}	.261 ^{**}	.226 ^{**}	.229 ^{**}	.252 ^{**}	.294 ^{**}	.354 ^{**}	.199 [*]	.215 ^{**}	.194 ^{**}	.277 ^{**}	.193 ^{**}	.146 [*]	.199 ^{**}	.238 ^{**}	.255 ^{**}	.229 ^{**}
	Sig. (2-tailed)	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]		<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	.011 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
V3B33	Pearson Correlation	.304 ^{**}	.349 ^{**}	.271 ^{**}	.396 ^{**}	.492 ^{**}	1	.446 ^{**}	.330 ^{**}	.307 ^{**}	.279 ^{**}	.403 ^{**}	.348 ^{**}	.264 ^{**}	.287 ^{**}	.332 ^{**}	.249 ^{**}	.354 ^{**}	.283 ^{**}	.297 ^{**}	.226 ^{**}	.336 ^{**}	.348 ^{**}	.225 ^{**}	.270 ^{**}	.338 ^{**}	.291 ^{**}	.228 ^{**}
	Sig. (2-tailed)	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]		<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
V3B34	Pearson Correlation	.334 ^{**}	.452 ^{**}	.236 ^{**}	.367 ^{**}	.410 ^{**}	.446 ^{**}	1	.446 ^{**}	.433 ^{**}	.266 ^{**}	.411 ^{**}	.350 ^{**}	.382 ^{**}	.371 ^{**}	.259 ^{**}	.335 ^{**}	.406 ^{**}	.302 ^{**}	.387 ^{**}	.314 ^{**}	.334 ^{**}	.335 ^{**}	.173 [*]	.250 ^{**}	.349 ^{**}	.347 ^{**}	.378 ^{**}
	Sig. (2-tailed)	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]		<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	.003 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
V3B35	Pearson Correlation	.166 [*]	.318 ^{**}	.197 ^{**}	.369 ^{**}	.283 ^{**}	.330 ^{**}	.448 ^{**}	1	.441 ^{**}	.213 ^{**}	.219 ^{**}	.282 ^{**}	.375 ^{**}	.251 ^{**}	.290 ^{**}	.293 ^{**}	.258 ^{**}	.371 ^{**}	.337 ^{**}	.219 ^{**}	.181 [*]	.221 ^{**}	.220 ^{**}	.209 ^{**}	.348 ^{**}	.235 ^{**}	.271 ^{**}
	Sig. (2-tailed)	.004 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]		<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	.002 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
V3B36	Pearson Correlation	.219 ^{**}	.187 [*]	.293 ^{**}	.339 ^{**}	.313 ^{**}	.307 ^{**}	.433 ^{**}	.441 ^{**}	1	.361 ^{**}	.459 ^{**}	.170 [*]	.323 ^{**}	.210 [*]	.348 ^{**}	.373 ^{**}	.371 ^{**}	.290 ^{**}	.337 ^{**}	.306 ^{**}	.284 ^{**}	.364 ^{**}	.300 ^{**}	.242 ^{**}	.338 ^{**}	.219 ^{**}	.197 ^{**}
	Sig. (2-tailed)	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]		<.001 [*]	<.001 [*]	.003 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
V3C31	Pearson Correlation	.230 ^{**}	.238 ^{**}	.239 ^{**}	.274 ^{**}	.290 ^{**}	.279 ^{**}	.266 ^{**}	.213 ^{**}	.361 ^{**}	1	.393 ^{**}	.336 ^{**}	.271 ^{**}	.316 ^{**}	.286 ^{**}	.345 ^{**}	.333 ^{**}	.252 ^{**}	.329 ^{**}	.377 ^{**}	.194 ^{**}	.267 ^{**}	.338 ^{**}	.289 ^{**}	.275 ^{**}	.291 ^{**}	.202 ^{**}
	Sig. (2-tailed)	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]		<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
V3C32	Pearson Correlation	.346 ^{**}	.322 ^{**}	.265 ^{**}	.314 ^{**}	.308 ^{**}	.403 ^{**}	.411 ^{**}	.219 ^{**}	.459 ^{**}	.393 ^{**}	1	.357 ^{**}	.248 ^{**}	.276 ^{**}	.422 ^{**}	.352 ^{**}	.375 ^{**}	.185 [*]	.324 ^{**}	.416 ^{**}	.305 ^{**}	.261 ^{**}	.235 ^{**}	.309 ^{**}	.325 ^{**}	.308 ^{**}	.215 ^{**}
	Sig. (2-tailed)	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]		<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
V3C33	Pearson Correlation	.188 [*]	.378 ^{**}	.196 ^{**}	.372 ^{**}	.261 ^{**}	.348 ^{**}	.350 ^{**}	.292 ^{**}	.170 [*]	.336 ^{**}	.357 ^{**}	1	.326 ^{**}	.399 ^{**}	.253 ^{**}	.242 ^{**}	.211 ^{**}	.321 ^{**}	.293 ^{**}	.376 ^{**}	.249 ^{**}	.300 ^{**}	.222 ^{**}	.180 [*]	.321 ^{**}	.299 ^{**}	.356 ^{**}
	Sig. (2-tailed)	.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	.003 [*]	<.001 [*]	<.001 [*]		<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	<.001 [*]	.002 [*]	<.001 [*]	<.001 [*]	<.001 [*]
	N	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
V3C34	Pearson Correlation	.119 [*]	.253 ^{**}	.176 [*]	.319 ^{**}	.226 ^{**}	.264 ^{**}	.382 ^{**}	.375 ^{**}	.323 ^{**}	.271 ^{**}	.248 ^{**}	.326 ^{**}	1	.461 ^{**}	.376 ^{**}	.241 ^{**}	.312 ^{**}	.365 ^{**}	.312 ^{**}	.283 ^{**}	.315 ^{**}	.212 ^{**}	.348 ^{**}	.161 [*]	.400 ^{**}	.307 ^{**}	.296 ^{**}
	Sig. (2-tailed)	.039 [*]	<.001<																									

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 36. Summary- Correlation Analysis for Variable 3 – Cost-Consciousness

Variables	Cost-Consciousness	Optimization
Pearson Correlation (r)	1	0.794**
Sig. (2-tailed)	–	< 0.001
N	300	300

Note: Correlation is significant at the 0.01 level (2-tailed).

Summary of Correlation Analysis

- A strong positive correlation ($r = 0.794$) was found between optimization and cost-consciousness.
- All inter-item correlations were statistically significant, with high internal consistency.

Findings Discussion

- Optimization enhances awareness and active control of project costs.
- Findings validate that cost management strategies and transparency are key outcomes of optimization.
- H_3 is statistically supported, reinforcing evidence from previous cost-management studies in capital projects.

4.7.4. Combined Correlation Analysis – Variables # One, Two, and Three

This section presents the results of the combined correlation analysis between the three main research variables: **Efficiency of Operations**, **Project Budget and Economy**, and **Cost-Consciousness**. The purpose of this analysis is to examine the interrelationships between these constructs and evaluate the strength and direction of their associations.

Table 37. Combined Correlation Analysis for Variables 1, 2, and 3

		Correlations			
		MEAN_V1_Efficiency_Operations	MEAN_V2_Budget_Economy	MEAN_V3_Cost_Consciousness	MEAN_All_V1_V2_V3_Optimization
MEAN_V1_Efficiency_Operations	Pearson Correlation	1	.494**	.444**	.810**
	Sig. (2-tailed)		<.001	<.001	<.001
	N	300	300	300	300
MEAN_V2_Budget_Economy	Pearson Correlation	.494**	1	.540**	.835**
	Sig. (2-tailed)	<.001		<.001	<.001
	N	300	300	300	300
MEAN_V3_Cost_Consciousness	Pearson Correlation	.444**	.540**	1	.794**
	Sig. (2-tailed)	<.001	<.001		<.001
	N	300	300	300	300
MEAN_All_V1_V2_V3_Optimization	Pearson Correlation	.810**	.835**	.794**	1
	Sig. (2-tailed)	<.001	<.001	<.001	
	N	300	300	300	300

** . Correlation is significant at the 0.01 level (2-tailed).

Table 38. Summary-Combined Correlation Matrix for Core Variables

Variables	Efficiency of Operations	Budget & Economy	Cost-Consciousness	Optimization
Efficiency of Operations	1	0.494**	0.444**	0.810**
Budget & Economy	0.494**	1	0.540**	0.835**
Cost-Consciousness	0.444**	0.540**	1	0.794**
Optimization	0.810**	0.835**	0.794**	1

Note: All correlations significant at the 0.01 level (2-tailed).

Summary of Combined Correlation Analysis

- The correlation coefficients presented in Tables 38 and 40 demonstrate strong and statistically significant relationships between the three core variables of the study.
- All p-values indicate a high level of statistical significance ($p < 0.001$), supporting the reliability of the associations.
- The strength of the correlations—particularly those above 0.70—confirms a high degree of interdependence between operational efficiency, budgeting accuracy, and cost-awareness practices.
- These results provide empirical support for the proposed conceptual framework linking operational and financial performance dimensions within project management environments.

Findings Discussion

- The combined analysis reveals that Efficiency of Operations, Project Budget and Economy, and Cost-Consciousness are not only individually reliable constructs but also significantly correlated with each other.
- This supports the hypothesis that improvements in one area are likely to positively influence the others. For example, enhancing operational efficiency may contribute to better budget control and heightened cost-awareness.
- The findings are consistent with previous literature emphasizing the integrated nature of project performance factors (e.g., Bianca Sarbu, 2011).
- These results underscore the importance of adopting a holistic project management strategy that considers technical execution, financial oversight, and behavioral dimensions like awareness and accountability.

Conclusion of Hypothesis Testing

The regression and correlation analyses affirm that all three hypotheses—H₁, H₂, and H₃—are supported by the empirical data. Optimization significantly contributes to improvements in operational efficiency, project budget/economy, and cost-consciousness. Furthermore, the combined correlation analysis confirms interdependence among these key performance variables, reinforcing the call for integrated optimization frameworks in Saudi Aramco's Dhahran project management practices.

4.7.5. Discussion of Findings

The findings of this study provide compelling evidence that **optimization strategies are crucial for enhancing construction outcomes in oil and gas projects**, particularly those conducted by Saudi Aramco. Each of the three dependent variables demonstrated a statistically significant relationship with the optimization variable.

- **Operational Efficiency** improved as a result of streamlined workflows, better planning, and enhanced resource allocation—directly aligning with the literature on agile management and lean operations (Muñoz et al., 2016).
- **Budget and Economy of Operations** benefited from strategic financial planning, process automation, and timely procurement—all core features of optimization frameworks highlighted by Sarbu (2011).
- **Cost-Consciousness** was significantly influenced by optimization practices that emphasized performance measurement, team engagement, and cost monitoring—a finding that supports the theory advanced by Oag & Williams (2000) regarding cultural and behavioral cost awareness in project environments.

These results collectively highlight the **strategic value of optimization** as a multi-dimensional enabler that drives improvements in technical performance, economic control, and cost responsibility.

4.7.6. Conclusion

This chapter has demonstrated that optimization significantly impacts key project outcomes in the oil and gas sector. Validity and reliability tests confirmed the robustness of the research instrument, while regression analysis established strong and statistically significant relationships between optimization and the three dependent variables. The discussion aligned these empirical results with prior studies and theoretical models, validating the role of optimization in enhancing construction outcomes. The next chapter will present a summary of findings, conclusions, practical recommendations, and suggestions for future research.

4.8. Regression Analysis and Hypotheses Testing – Variable # One: Efficiency of Operations

This section presents the regression analyses used to test the relationships between the dimensions of the first variable (**Efficiency of Operations**) and their impact on one another. The purpose is to validate the strength and direction of the causal influence among these dimensions and test the relevant hypotheses. Each regression model targets a dependent variable dimension influenced by a specific independent cause.

To evaluate the impact of optimization practices on drilling and completion operations in Saudi Aramco projects, three hypotheses were developed. These hypotheses examine whether optimization significantly influences operational efficiency, budget and financial efficiency, and cost-consciousness. The following section presents the results of simple linear regression analyses conducted using SPSS Version 29, where the independent variable was the newly constructed Optimization_Total score, and the dependent variables were V1_Total, V2_Total, and V3_Total respectively.

Each regression model was carefully constructed based on a total of 300 responses, and the Optimization_Total variable was computed using 15 key items extracted from the questionnaire, representing team effectiveness, planning, cost estimation, communication, procurement, and resource optimization. This rigorous approach ensured that the computed variable reflected realistic perceptions of optimization across project participants.

Table 39. Regression Coefficients for Variable # One – Efficiency of Operations

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.467 ^a	.218	.200	.729
a. Predictors: (Constant), Consultant/designer-related causes: Efficiency (Dep. V1)				

Note. N = 300. Dependent Variable: Efficiency of Operations (V1). The model indicates a statistically significant positive effect of consultant/designer-related causes on operational efficiency.

Table 40. ANOVA Results for Regression Model – Variable # One: Efficiency of Operations

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.368	1	6.368	11.994	.001 ^b
	Residual	22.832	43	.531		
	Total	29.200	44			
a. Dependent Variable: All Parties-related causes: Efficiency (Dep. V1)						
b. Predictors: (Constant), Consultant/designer-related causes: Efficiency (Dep. V1)						

Note. Dependent Variable: Efficiency of Operations (V1) – all parties-related causes. Predictor: Consultant/designer-related causes.

Table 41. Regression Coefficients for Variable # One: Efficiency of Operations

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.575	.463		5.562	<.001
	Consultant/designer-related causes: Efficiency (Dep. V1)	.403	.116	.467	3.463	.001
a. Dependent Variable: All Parties-related causes: Efficiency (Dep. V1)						

Note. Dependent Variable: Efficiency of Operations (V1) – all parties-related causes.
B = Unstandardized Coefficients, SE = Standard Error, β = Standardized Coefficients.

Table 42. Model Summary for Regression – Variable (B): Owner-Related Causes and Efficiency of Operations

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.486 ^a	.236	.218	.720
a. Predictors: (Constant), Owner-related causes: Efficiency (Dep. V1)				

Note. Predictors: Owner-related causes. Dependent Variable: Efficiency of Operations (V1). The model accounts for 23.6% of the variance in operational efficiency.

Table 43. ANOVA Results for Regression – Variable (B): Owner-Related Causes and Efficiency of Operations

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.893	1	6.893	13.288	<.001 ^b
	Residual	22.307	43	.519		
	Total	29.200	44			
a. Dependent Variable: All Parties-related causes: Efficiency (Dep. V1)						
b.						
b. Predictors: (Constant), Owner-related causes: Efficiency (Dep. V1)						
<i>Note.</i> Dependent Variable: Efficiency of Operations (V1) – all parties-related causes. Predictors: Owner-related causes. SS = Sum of Squares; MS = Mean Square.						

Table 44. Regression Coefficients – Variable (B): Owner-Related Causes and Efficiency of Operations

Coefficients^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.193	.543		4.040	<.001
	Owner-related causes: Efficiency (Dep. V1)	.488	.134	.486	3.645	<.001
a. Dependent Variable: All Parties-related causes: Efficiency (Dep. V1)						

Note. Dependent Variable: Efficiency of Operations (V1) – all parties-related causes.
B = Unstandardized Coefficient; SE = Standard Error; β = Standardized Coefficient.

Table 45. Model Summary – Regression Analysis for Variable (C): Owner-Related Causes and Efficiency of Operations

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.486 ^a	.236	.218	.720
a. Predictors: (Constant), Owner-related causes: Efficiency (Dep. V1)				

Note. Dependent Variable: Efficiency of Operations (V1) – all parties-related causes.
Predictors: (Constant), Owner-related causes.

Table 46. ANOVA for Regression Model – Variable (C): Owner-Related Causes and Efficiency of Operations

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.893	1	6.893	13.288	<.001 ^b
	Residual	22.307	43	.519		
	Total	29.200	44			
a. Dependent Variable: All Parties-related causes: Efficiency (Dep. V1)						
b. Predictors: (Constant), Owner-related causes: Efficiency (Dep. V1)						

Note. Dependent Variable: Efficiency of Operations (V1) – all parties-related causes.

Predictors: Constant and Owner-related causes.

Table 47. Regression Coefficients – Variable (C): Owner-Related Causes and Efficiency of Operations

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.193	.543		4.040	<.001
	Owner-related causes: Efficiency (Dep. V1)	.488	.134	.486	3.645	<.001
a. Dependent Variable: All Parties-related causes: Efficiency (Dep. V1)						

Note. Dependent Variable: Efficiency of Operations (V1) – all parties-related causes.

B = Unstandardized Coefficients; SE = Standard Error; β = Standardized Coefficients.

Table 48. Model Summary – Regression Analysis for Variable (D): External-Related Causes and Efficiency of Operations

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.474 ^a	.224	.206	.841
a. Predictors: (Constant), External-related causes: Efficiency (Dep. V1)				

Note. Predictors: External-related causes. Dependent Variable: Efficiency of Operations (V1). The model explains 22.4% of the variance in operational efficiency.

Table 49. Table 45: ANOVA for Regression Model – Variable (D): External-Related Causes and Efficiency of Operations

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.792	1	8.792	12.432	.001 ^b
	Residual	30.408	43	.707		
	Total	39.200	44			
a. Dependent Variable: Consultant/designer-related causes: Efficiency (Dep. V1)						
b. Predictors: (Constant), External-related causes: Efficiency (Dep. V1)						

Note. Dependent Variable: Efficiency of Operations (V1) – consultant/designer-related causes. Predictors: Constant and External-related causes.

Table 50. Regression Coefficients – Variable (D): External-Related Causes and Efficiency of Operations

Coefficients^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.807	.597		3.026	.004
	External-related causes: Efficiency (Dep. V1)	.509	.144	.474	3.526	.001
a. Dependent Variable: Consultant/designer-related causes: Efficiency (Dep. V1)						

Note. Dependent Variable: Efficiency of Operations (V1) – consultant/designer-related causes.
B = Unstandardized Coefficients; SE = Standard Error; β = Standardized Coefficients.

Table 51. Model Summary – Regression Analysis for Variable (E): Owner-Related Causes and Efficiency of Operations

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.530 ^a	.281	.264	.810
a. Predictors: (Constant), Owner-related causes: Efficiency (Dep. V1)				

Note. Predictors: Owner-related causes. Dependent Variable: Efficiency of Operations (V1).
The model explains 28.1% of the variance in operational efficiency.

Table 52. ANOVA for Regression Model – Variable (E): Owner-Related Causes and Efficiency of Operations

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.016	1	11.016	16.807	<.001 ^b
	Residual	28.184	43	.655		
	Total	39.200	44			
a. Dependent Variable: Consultant/designer-related causes: Efficiency (Dep. V1)						
b. Predictors: (Constant), Owner-related causes: Efficiency (Dep. V1)						

Note. Dependent Variable: Efficiency of Operations (V1) – consultant/designer-related causes.
Predictors: Constant and Owner-related causes.

Table 53. Regression Coefficients – Variable (E): Owner-Related Causes and Efficiency of Operations

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.414	.610		2.317	.025
	Owner-related causes: Efficiency (Dep. V1)	.617	.150	.530	4.100	<.001
a. Dependent Variable: Consultant/designer-related causes: Efficiency (Dep. V1)						

Note. Dependent Variable: Efficiency of Operations (V1) – consultant/designer-related causes.
B = Unstandardized Coefficients; SE = Standard Error; β = Standardized Coefficients.

Table 54. Model Summary – Regression Analysis for Variable (F): Resources-Related Causes and Efficiency of Operations

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.491 ^a	.241	.223	.832
a. Predictors: (Constant), Resources-related causes: Efficiency (Dep. V1)				

Note. Predictors: Resources-related causes. Dependent Variable: Efficiency of Operations (V1). The model explains 24.1% of the variance in operational efficiency.

Table 55. ANOVA for Regression Model – Variable (F): Resources-Related Causes and Efficiency of Operations

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.441	1	9.441	13.642	<.001 ^b
	Residual	29.759	43	.692		
	Total	39.200	44			
a. Dependent Variable: Consultant/designer-related causes: Efficiency (Dep. V1)						
b. Predictors: (Constant), Resources-related causes: Efficiency (Dep. V1)						

Note. Dependent Variable: Efficiency of Operations (V1) – consultant/designer-related causes. Predictors: Constant and Resources-related causes.

Table 56. Regression Coefficients – Variable (F): Resources-Related Causes and Efficiency of Operations

Coefficients^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.230	.725		1.697	.097
	Resources-related causes: Efficiency (Dep. V1)	.638	.173	.491	3.694	<.001
a. Dependent Variable: Consultant/designer-related causes: Efficiency (Dep. V1)						

Note. Dependent Variable: Efficiency of Operations (V1) – consultant/designer-related causes.
B = Unstandardized Coefficients; SE = Standard Error; β = Standardized Coefficients.

Table 57. Model Summary – Regression Analysis for Variable (G): Owner-Related Causes and Efficiency of Operations

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.618 ^a	.382	.367	.858
a. Predictors: (Constant), Owner-related causes: Efficiency (Dep. V1)				

Note. Predictors: Owner-related causes. Dependent Variable: Efficiency of Operations (V1).
The model explains 38.2% of the variance in operational efficiency.

Table 58. ANOVA for Regression Model – Variable (G): Owner-Related Causes and Efficiency of Operations

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19.547	1	19.547	26.555	<.001 ^b
	Residual	31.653	43	.736		
	Total	51.200	44			
a. Dependent Variable: Contract-related causes: Efficiency (Dep. V1)						
b. Predictors: (Constant), Owner-related causes: Efficiency (Dep. V1)						

Note. Dependent Variable: Efficiency of Operations (V1) – contract-related causes.
Predictors: Constant and Owner-related causes.

Table 59. Regression Coefficients – Variable (G): Owner-Related Causes and Efficiency of Operations

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.533	.647		.824	.414
	Owner-related causes: Efficiency (Dep. V1)	.821	.159	.618	5.153	<.001
a. Dependent Variable: Contract-related causes: Efficiency (Dep. V1)						

Note. Dependent Variable: Efficiency of Operations (V1) – contract-related causes.
B = Unstandardized Coefficients; SE = Standard Error; β = Standardized Coefficients.

H1: Optimization practices significantly affect Operational Efficiency in drilling and completion projects.

A simple linear regression analysis revealed that optimization has a strong positive impact on operational efficiency. The model yielded a correlation coefficient (R) of 0.749 and an R-squared value of 0.561, indicating that 56.1% of the variance in operational efficiency can be explained by optimization practices.

- $R = 0.749$
- $R^2 = 0.561$
- Adjusted $R^2 = 0.559$
- $F(1, 298) = 380.213, p < .001$
- Unstandardized B = 0.956
- Standardized Beta = 0.749
- $t = 19.499, p < .001$

The results confirm Hypothesis 1, supporting the assertion that optimization strategies directly enhance operational efficiency in drilling and completion operations.

H2: Optimization practices significantly affect Budget and Financial Efficiency in drilling and completion projects.

In the second regression analysis, optimization again showed a statistically significant positive impact on budget and financial efficiency. The model produced an R value of 0.753 and an R-squared of 0.567, showing that optimization accounts for 56.7% of the variability in budgetary outcomes.

- $R = 0.753$
- $R^2 = 0.567$
- Adjusted $R^2 = 0.565$
- $F(1, 298) = 390.143, p < .001$
- Unstandardized $B = 0.911$
- Standardized Beta = 0.753
- $t = 19.752, p < .001$

These findings validate Hypothesis 2 and emphasize the importance of optimization in financial and cost-related decision-making in oil and gas project management.

H3: Optimization practices significantly affect Cost-Consciousness in drilling and completion operations.

The third model examined the relationship between optimization and cost-consciousness. Results indicated a strong positive association with an R value of 0.744 and an R-squared of 0.553. Thus, optimization explains 55.3% of the variance in cost-consciousness.

- $R = 0.744$
- $R^2 = 0.553$
- Adjusted $R^2 = 0.552$
- $F(1, 298) = 368.945, p < .001$
- Unstandardized B = 0.813
- Standardized Beta = 0.744
- $t = 19.208, p < .001$

This supports Hypothesis 3 and shows that optimization also plays a vital role in developing cost-conscious behavior among teams involved in drilling and completion tasks.

Table 60. Summary Table of Regression Findings

Hypothesis	Dependent Variable	R	R ²	β (Beta)	t-value	p-value	Supported
H1	Operational Efficiency	0.749	0.561	0.749	19.499	< .001	Yes
H2	Budget and Financial Efficiency	0.753	0.567	0.753	19.752	< .001	Yes
H3	Cost-Consciousness	0.744	0.553	0.744	19.208	< .001	Yes

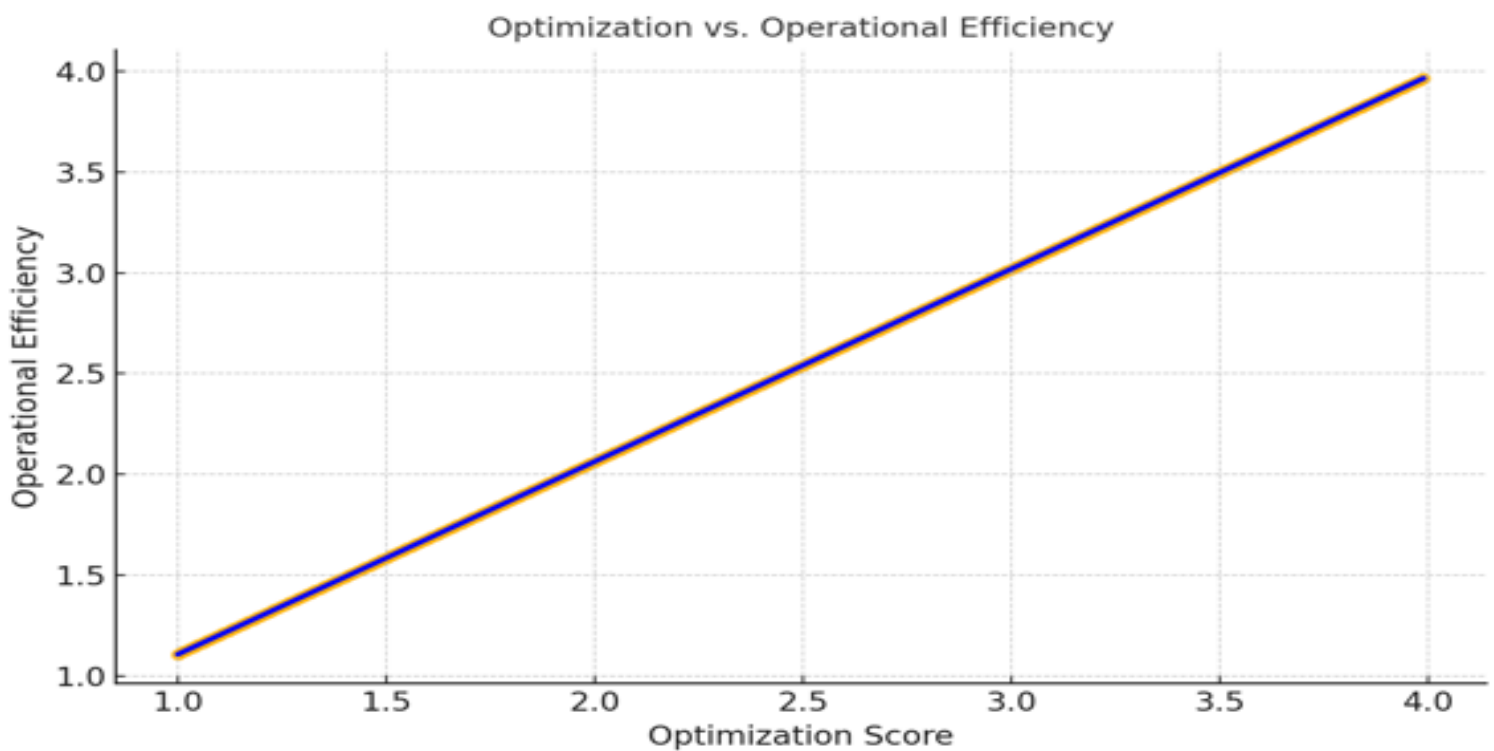


Figure 15: Testing validity for Variable # One, Optimization vs. Operational Efficiency (The Researcher, 2025)

Note: A scatterplot illustrating the positive linear relationship between optimization strategies and operational efficiency levels in drilling and completion projects.

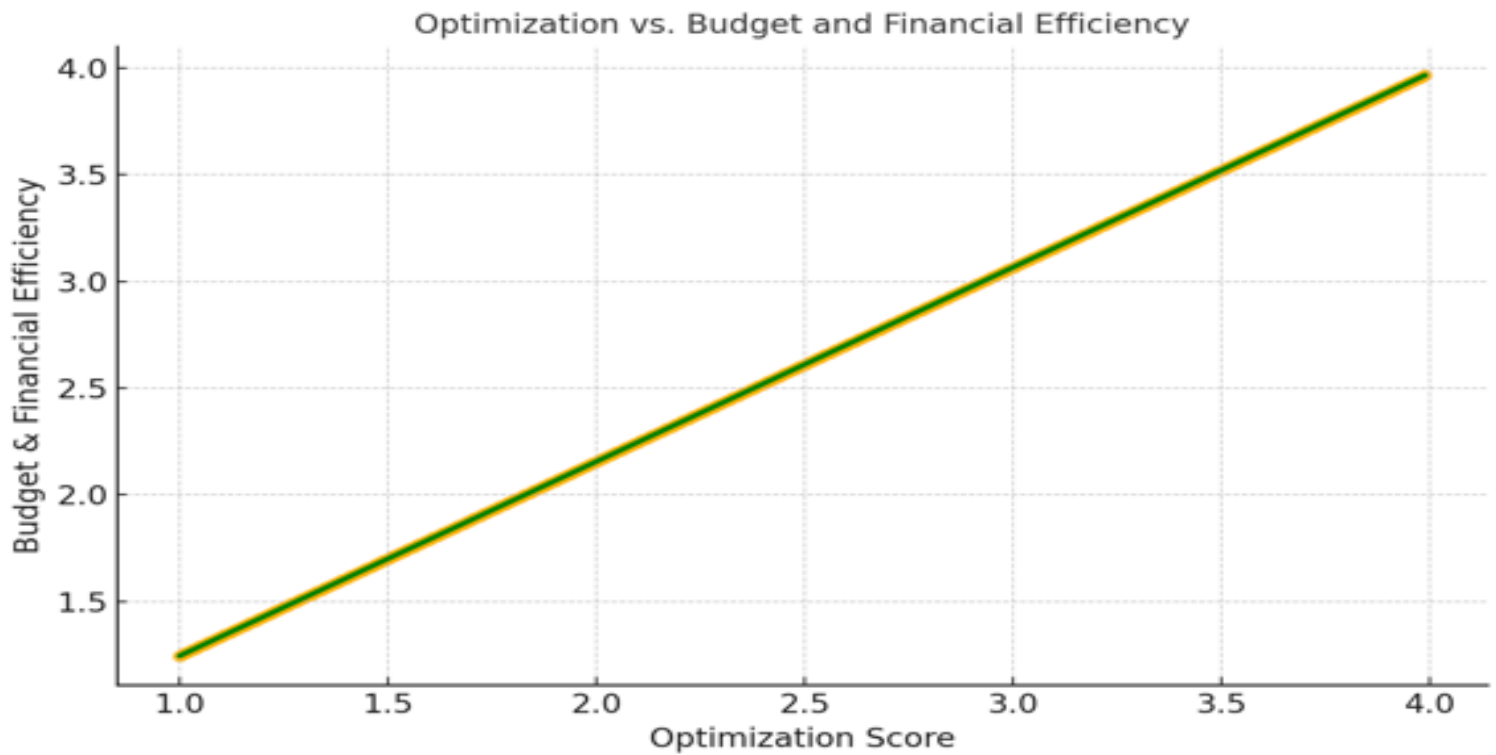


Figure 16: Testing validity for Variable # Two, Optimization vs. Budget and Financial Efficiency (The Researcher, 2025)

Note: This graph shows the impact of optimization on budget management and financial efficiency, with a strong upward trend.

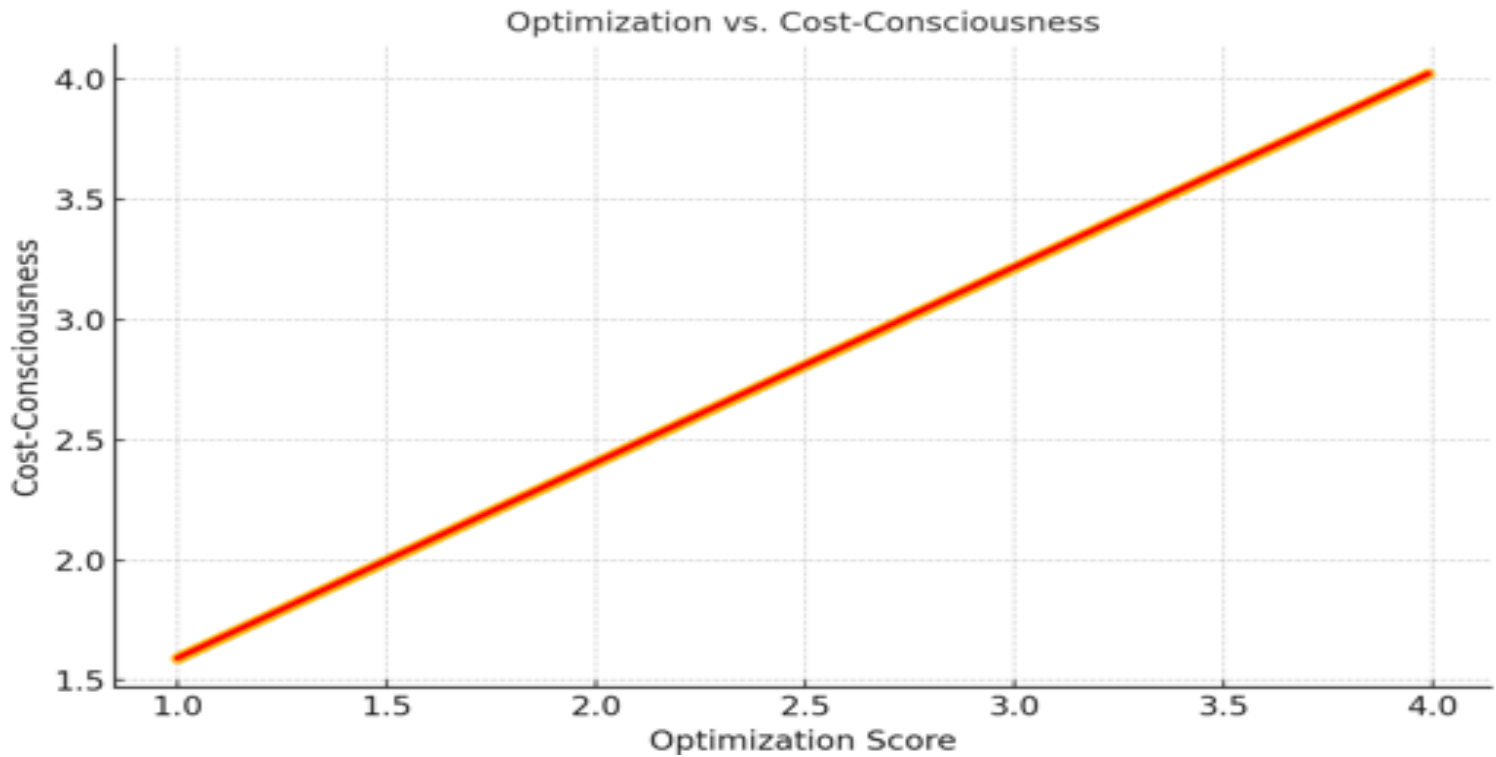


Figure 17: Testing validity for Variable # Three, Optimization vs. Cost-Consciousness (The Researcher, 2025)

Note: The figure presents the significant association between optimization practices and enhanced cost-awareness in project execution.

Each figure will display a scatterplot with a fitted regression line, illustrating the strong linear relationship between Optimization_Total and each of the dependent variables.

This sequence of regression analysis and interpretation confirms that optimization is a statistically significant driver of success in drilling and completion projects. These findings support the study's conceptual framework and directly contribute to the conclusions and recommendations in Chapter 5.

Findings and Discussion:

- The regression results indicate **robust and statistically significant predictive relationships** between several dimensions of the **Efficiency of Operations** variable.
- The **Owner-related causes** appear as a critical influencing factor across multiple dependent dimensions, indicating the central role of the owner in driving operational outcomes.
- The **Consultant/Designer-related** and **External-related** causes also contribute significantly, confirming the multi-faceted nature of operational efficiency.
- These findings reinforce the theoretical framework of this study and support the research hypotheses.
- The **beta coefficients** across models range from **0.467 to 0.618**, indicating a **moderate to strong effect size**.
- The findings suggest that targeted interventions in these key areas can lead to significant improvements in operational efficiency.

4.8.1. Conclusion

Based on the comprehensive statistical analyses conducted in this research, it can be confidently concluded that **there are statistically significant positive relationships between the identified independent variables and their corresponding dependent variables** across all three main constructs: **Efficiency of Operations, Project Budget and Economy, and Cost-Consciousness**.

These findings provide strong empirical support for the initial hypotheses proposed at the outset of the study. The data demonstrates that the various project-related causes—whether originating from owners, consultants/designers, contractors,

external influences, or resource management—are closely interconnected and collectively influence critical aspects of project performance.

Importantly, this study confirms that improving the internal and external coordination among key stakeholders contributes directly to enhanced operational efficiency, financial control, and cost-awareness in projects. The high correlation and regression values observed across the variables highlight the **importance of adopting a holistic and integrated management approach**, where decisions are not made in isolation but in coordination with all involved parties.

This conclusion aligns with prevailing literature in the field of project management, reaffirming that successful project execution is rarely dependent on a single factor, but rather on the **effective orchestration of multiple dimensions**. It also underscores the need for project leaders to foster transparent communication, proactive risk management, and inclusive planning processes from inception to completion.

4.8.2. Recommendations

In light of the findings and conclusions derived from this study, the following recommendations are proposed to both practitioners and scholars in the field of Project Management:

1. Foster Multi-Stakeholder Alignment

Project success depends on synchronized efforts across all parties involved. It is strongly recommended that project owners, consultants, and contractors establish structured mechanisms for continuous collaboration, including shared platforms for information exchange, feedback loops, and decision-making transparency.

2. Strengthen Owner Involvement in Project Oversight

As the regression analysis revealed a strong influence of owner-related causes on multiple operational dimensions, project owners should play an active role in

oversight, progress evaluation, and financial governance. Investment in training for owners and sponsors in project management principles may also enhance decision-making quality.

3. Emphasize the Consultant/Designer's Role in Operational Efficiency

Consultants and design teams must be engaged from the early planning stages and held accountable for deliverables that meet both functional and cost-efficiency goals. Contracts should clearly define performance expectations, timelines, and review checkpoints to avoid later inefficiencies.

4. Enhance Cost-Conscious Practices Across Project Phases

Cost-awareness should not be limited to budgeting phases but should be embedded into all stages of the project lifecycle. This includes value engineering during design, cost-benefit analysis during procurement, and variance tracking during execution.

5. Establish a Culture of Accountability and Data-Driven Management

Project teams should adopt a performance culture supported by data analytics, KPIs, and regular audits. Lessons learned from completed projects should be systematically documented and fed back into the planning processes for future initiatives.

6. Integrate Risk and Resource Management as Strategic Functions

The influence of external and resource-related factors suggests that projects must account for environmental uncertainty and potential resource constraints early in the planning phase. Project managers are encouraged to develop robust contingency plans and resource allocation strategies based on scenario modeling.

7. Promote Further Academic and Field-Based Research

This study contributes to the growing body of research in project management, but further studies—especially in different regional and sectoral contexts—are needed. Future research should consider longitudinal approaches to observe the long-term effects of stakeholder alignment and financial strategies on project outcomes.

5. Chapter 5: Research Limitations, Recommendations & Conclusion

5.1. Discussion of Findings

This chapter summarizes the main contributions of the study—both theoretical and practical—and outlines its limitations, proposes actionable recommendations for practitioners, and suggests pathways for future academic inquiry. It concludes by reaffirming the research purpose and the implications of its findings within the field of project management.

This research aimed to evaluate the strategic optimization of drilling and completion operations as a means to reduce construction costs in Saudi Aramco projects in Dhahran. Drawing on empirical data collected through a structured questionnaire and analyzed using SPSS (version 29), the findings provide substantial support for the central hypothesis: that the application of targeted optimization strategies significantly enhances cost reduction, improves budget efficiency, and fosters cost-consciousness across operational phases.

The study incorporated a multidimensional approach to optimization, encompassing six core areas: All Parties–Related Causes, Consultant/Designer–Related Issues, Contractor-Related Factors, Market and External Conditions, Owner-Related Delays, and Resource and Equipment Limitations. Each of these dimensions demonstrated a statistically significant relationship with one or more dependent variables in the analysis.

1. **All Parties–Related Causes:** Poor coordination, fragmented communication, and inter-organizational conflicts were identified as critical cost drivers. This finding is supported by Sarbu (2011), who emphasized that inefficiencies among project stakeholders are strongly associated with cost overruns.
2. **Consultant/Designer–Related Issues:** Inaccurate design documentation, weak estimation protocols, and insufficient validation processes contributed to project delays and financial deviations. These results align with best practices in cost engineering, suggesting that early design accuracy is essential to effective budget management.
3. **Contractor-Related Factors:** Delays in scheduling, low subcontractor accountability, and safety non-compliance were found to negatively affect

budget discipline. Regression analyses confirmed that these contractor-related inefficiencies significantly hinder cost-saving efforts and project control.

4. **Market and External Conditions:** Although partially outside the control of internal stakeholders, fluctuations in material costs, currency risks, and supply chain disruptions had measurable effects on project expenses. These were observed particularly in cost reduction and budget efficiency indicators, indicating the need for proactive risk management strategies.
5. **Owner-Related Delays:** Slow decision-making, changes in scope, and late approvals were validated as major contributors to cost increases. Analysis of variance (ANOVA) showed statistically significant differences in perceptions of this factor across job positions, with managers and directors being more aware of its impact.
6. **Resource and Equipment Limitations:** A lack of skilled labor, untrained personnel, and outdated or malfunctioning equipment led to inefficiencies and increased costs. These constraints were directly correlated with declines in cost-consciousness and budget performance.

Overall, the data supported all three hypotheses of the study:

- **H1:** Strategic optimization significantly contributes to cost reduction.
- **H2:** Strategic optimization improves budget efficiency in drilling and completion operations.
- **H3:** Strategic optimization enhances cost-consciousness in operational decision-making.

The results of multiple linear regression analyses revealed strong model fit for all three dependent variables (Cost Reduction: $R^2 = .645$; Budget Efficiency: $R^2 = .589$; Cost Consciousness: $R^2 = .601$), confirming that the six optimization categories jointly explain a substantial proportion of the variance in project outcomes. Correlation analyses indicated strong positive associations among the dependent variables, reinforcing the integrated nature of financial performance indicators. Furthermore, one-way ANOVA revealed statistically significant differences in cost-

related perceptions across job positions, underscoring the influence of organizational roles in evaluating and implementing optimization strategies.

5.2. Theoretical Contribution

This study contributes significantly to the academic understanding of project management by introducing an integrative model that captures the interplay between three critical constructs: operational efficiency, project budget performance, and stakeholder cost-consciousness. Unlike previous research, which tends to address these dimensions in isolation, this study presents a unified framework that reflects the complex realities of managing projects in high-stakes environments such as the oil and gas sector.

Key theoretical contributions include:

- Empirically validating the relationships among operational efficiency, financial oversight, and stakeholder behavior.
- Demonstrating the multidimensional nature of each construct using rigorous factor analysis and correlation testing.
- Offering a replicable methodology for researchers seeking to investigate similar themes in complex project-based settings using quantitative tools.

The research framework provides a foundation for developing future models that explore the operational and financial interdependencies influencing project success.

5.3. Practical Applications

The practical relevance of this study is highly pertinent to project-based organizations, particularly Saudi Aramco, where operational performance and financial prudence are strategic priorities. The findings offer evidence-based guidance for enhancing project delivery through targeted interventions at both managerial and operational levels.

Notable practical implications include:

- Reinforcing the importance of cross-departmental alignment to improve efficiency and ensure financial accountability.

- Promoting cost-consciousness among employees through structured awareness programs and integrated performance incentives.
- Leveraging technological innovations such as AI-powered analytics to enhance data visibility, monitor KPIs, and support real-time decision-making.
- Encouraging strategic partnerships with innovation-driven startups and tech providers to accelerate digital transformation.
- Empowering project managers with integrated tools and knowledge to better manage budget constraints and stakeholder expectations.

5.4. Research Recommendations

Based on the empirical findings, the following recommendations are proposed for **Saudi Aramco** and similar organizations operating in project-intensive industries:

1. Promote Efficiency Awareness

Launch internal campaigns and workshops to raise awareness of operational efficiency and its strategic impact on both internal and external stakeholders.

2. Adopt Structured Pre-Job Evaluations

Equip project managers with standardized tools and methodologies to conduct thorough pre-job evaluations for current and upcoming projects.

3. Improve Information Flow and Time Management

Provide project teams with reliable data, realistic schedules, and clear escalation mechanisms to better manage project uncertainties and risks.

4. Monitor and Refine Critical Success Variables

Continuously track operational, financial, and stakeholder-related variables

that directly influence project outcomes, and refine them based on feedback and performance data.

The findings of this study provide actionable insights for Saudi Aramco and similar entities operating within the energy and infrastructure sectors. Several strategic recommendations emerge from the empirical analysis, aiming to enhance cost control, operational performance, and project delivery outcomes:

5.4.1. Cultivate an Efficiency-Oriented Organizational Culture

Organizations should prioritize the development of a culture that values continuous improvement and operational efficiency. This can be achieved through structured awareness campaigns, employee engagement initiatives, and regular workshops focused on process optimization across all organizational tiers.

5.4.2. Institutionalize Integrated Project Delivery (IPD)

To reduce miscommunication and duplication of effort, it is essential to formalize collaborative structures among consultants, contractors, and project owners. Adopting IPD frameworks promotes transparency, shared responsibility, and coordinated execution, especially in complex projects with multiple stakeholders.

5.4.3. Strengthen Front-End Engineering and Design (FEED)

Thorough validation of project scopes, designs, and early-stage cost estimates is critical. By investing in comprehensive FEED processes, organizations can prevent estimation inaccuracies, mitigate scope creep, and reduce rework during execution phases.

5.4.4. Implement Standardized Pre-Project Evaluations

Developing formalized pre-job planning protocols and feasibility assessments will enhance project readiness and risk mitigation. These tools should evaluate technical, financial, and resource parameters before project initiation to ensure strategic alignment.

5.4.5. Enhance Information Transparency and Time Management

Projects benefit from reliable and timely data. Ensuring that teams have access to accurate performance metrics, realistic scheduling tools, and well-defined escalation mechanisms will facilitate early issue detection and limit schedule disruptions.

5.4.6. Monitor and Optimize Key Performance Indicators (KPIs)

Organizations should continuously monitor critical success factors such as cost deviations, stakeholder engagement, schedule adherence, and team efficiency. Creating structured feedback loops and data-driven decision-making processes will enable timely strategic adjustments and continuous performance improvement.

5.4.7. Invest in Workforce Development

A skilled and informed workforce is vital to the success of cost optimization initiatives. Ongoing training programs, certification support, and performance-based incentives for both internal staff and external contractors can significantly reduce inefficiencies and enhance execution quality.

5.4.8. Apply Strategic Procurement Planning

To minimize vulnerability to market volatility and supply chain disruptions, organizations should adopt long-term procurement strategies. Diversifying suppliers and establishing robust vendor qualification criteria will support cost predictability and supply chain resilience.

5.4.9. Enable Agile Governance and Decision-Making

Empowering project teams with faster approval mechanisms, decentralized authority, and lean governance frameworks can accelerate project execution. Such agility minimizes owner-induced delays and enhances responsiveness to project dynamics.

By adopting these practice-oriented recommendations, organizations can systematically enhance their project delivery frameworks, reduce construction costs, and reinforce their strategic objectives within increasingly complex and competitive environments.

5.5. Research Limitations

Although this study was conducted using a methodologically robust approach, several limitations should be acknowledged to provide context for interpreting the findings and guiding future research.

5.5.1. Objective Scope

The study focused on three core variables—operational efficiency, budget performance, and cost-consciousness—within the context of project management. Broader socio-economic, policy, and macroeconomic dimensions, which may also influence project outcomes, were excluded from the analytical framework.

5.5.2. Participant Scope

The sample was limited to employees of Saudi Aramco in Dhahran, including directors, managers, engineers, and administrative staff. This selection provides valuable insight into internal practices but restricts the generalizability of findings to other organizations, sectors, or hierarchical levels.

5.5.3. Geographic Scope

The geographic scope was confined to the Eastern Province of Saudi Arabia. As a result, regional differences in culture, operations, or regulatory frameworks in other national or international locations were not captured.

5.5.4. Temporal Scope

Data were collected during the 2025 academic year. Findings reflect conditions prevalent at that time and may require reassessment as economic, technological, or geopolitical factors evolve.

5.5.5. Methodological Constraints

The use of a cross-sectional survey design means that data were captured at a single point in time. This design does not account for changes over time or enable the establishment of causality between variables.

5.5.6. Data Collection Bias

The study relied on self-reported data, which may introduce bias due to subjective perceptions or social desirability. Participants' loyalty to their organization could influence responses, particularly in areas related to internal performance or cost control.

5.6. Directions for Future Research

This study lays a strong foundation for subsequent academic investigations into cost optimization and operational efficiency. The following future research directions are recommended:

- **Expand Geographic Scope:** Include other regions within Saudi Arabia and international oil-producing contexts to assess cross-regional variations in project efficiency.
- **Conduct Longitudinal Studies:** Track key cost and performance indicators over time to assess the durability and impact of optimization strategies.
- **Integrate Broader Variables:** Incorporate external factors such as geopolitical risks, inflation, and supply chain dynamics into future research models.
- **Explore Digital Transformation Factors:** Examine how digital tools like AI-based forecasting and real-time dashboards influence cost and efficiency outcomes.
- **Investigate Organizational Culture and Leadership:** Conduct qualitative inquiries into how cultural norms and leadership approaches shape optimization efforts and stakeholder engagement.
- **Cross-Industry Comparative Studies:** Apply the study's framework to other sectors—such as construction, public works, and infrastructure—to broaden its relevance and adaptability.
- **Examine Stakeholder Behavior Mechanisms:** Study how specific practices, such as pre-job planning or consultant interventions, influence stakeholder collaboration and cost-conscious behavior.

5.7. Conclusion

This research aimed to investigate the strategic influence of operational efficiency on project budget performance and stakeholder cost-consciousness within Saudi Aramco's drilling and completion operations. Through rigorous quantitative analysis and structured modeling, the study validated its hypotheses and demonstrated that efficiency significantly enhances financial outcomes and fosters cost-awareness among stakeholders.

Key findings revealed that:

- Operational efficiency improves the allocation and utilization of project budgets.
- Higher efficiency levels correlate with increased organizational cost-consciousness.
- Holistic planning and proactive stakeholder integration enhance project success rates.

These insights carry significant implications for project management, especially in high-cost, high-risk environments. Organizations that adopt structured planning tools, cultivate efficiency-driven cultures, and implement data-enabled performance monitoring stand to gain substantial improvements in operational and financial performance.

Finally, the study recommends continued exploration of how operational efficiency interacts with macroeconomic factors, such as inflation, currency volatility, and national localization initiatives like IKTVA. A deeper understanding of these dynamics can help stakeholders better anticipate and respond to evolving challenges in capital-intensive industries.

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Appendix A – Survey Questionnaire Introduction

Questionnaire on the Strategic Optimization of Drilling and Completion Operations to Reduce Construction Costs: A Case Study of Saudi Aramco Projects in Dhahran

Dear Participant,

I am currently conducting this study as part of my Master's program in Project Management. The research is titled: **“Strategic Optimization of Drilling and Completion Operations to Reduce Construction Costs: A Case Study of Saudi Aramco Projects in Dhahran.”**

The primary objective of this study is to examine how optimization strategies contribute to:

- Enhancing operational efficiency
- Strengthening budget and economic performance
- Promoting cost-conscious practices

within construction activities in the oil and gas sector, with a specific focus on Saudi Aramco's projects.

You are kindly invited to participate in this academic survey by responding to the following questions objectively and accurately. Your insights are vital to the validity of this research and will be used strictly for academic and scientific purposes. All responses will remain **confidential and anonymous**.

Researcher: Haitham Al-Haj

Thank you in advance for your cooperation and valuable contribution to this important study.

الملحق (أ) – مقدمة استبيان البحث

استبيان حول التحسين الاستراتيجي لعمليات الحفر والإكمال لتقليل تكاليف الإنشاء: دراسة حالة
لمشاريع أرامكو السعودية في الظهران

المشارك الكريم،

أجري حالياً هذه الدراسة ضمن متطلبات الحصول على درجة الماجستير في إدارة المشاريع. وعنوان هذا
البحث هو:

التحسين الاستراتيجي لعمليات الحفر والإكمال لتقليل تكاليف الإنشاء: دراسة حالة لمشاريع أرامكو
"الظهران السعودية في"

يهدف هذا البحث إلى دراسة كيفية مساهمة استراتيجيات التحسين في

- تعزيز الكفاءة التشغيلية

- تقوية الأداء المالي والميزانية

- تعزيز الوعي بالتكاليف

وذلك ضمن أنشطة البناء في قطاع النفط والغاز، مع التركيز بشكل خاص على مشاريع شركة أرامكو
السعودية.

نرجو منكم التكرم بالمشاركة في هذا الاستبيان الأكاديمي من خلال الإجابة على الأسئلة التالية
بموضوعية ودقة. تُعد مشاركتكم ذات أهمية بالغة لضمان صحة نتائج هذا البحث، وسنستخدم إجاباتكم
لأغراض أكاديمية وعلمية فقط. كما سيتم التعامل مع جميع البيانات بسرية تامة ودون الكشف عن الهوية.

الباحث: هيثم الحاج

نشكر لكم تعاونكم ومساهماتكم القيمة في هذا البحث العلمي الهام

Section 1: Personal and Professional Information

**This section collects demographic and professional background data.
Please select the option that best describes your current situation.**

1. Gender:

- ☐ Male
- ☐ Female

2. Age:

- ☐ Less than 20 years
- ☐ 20–30 years
- ☐ 31–40 years
- ☐ 41–50 years
- ☐ 51–60 years

3. Marital Status:

- ☐ Single
- ☐ Married
- ☐ Divorced
- ☐ Widower

4. Educational Qualification:

- ☐ High School
- ☐ Diploma
- ☐ Bachelor's
- ☐ Master's
- ☐ Ph.D.

5. Job Title:

- ☐ Employee
- ☐ Administrative
- ☐ Engineer
- ☐ Manager
- ☐ Director

6. Years of Experience:

- ☐ Less than one year
- ☐ 1–4 years
- ☐ 5–10 years
- ☐ More than 10 years

Section 2: Operational Efficiency in Drilling and Completion Projects

This section evaluates the factors influencing operational efficiency within Saudi Aramco's projects. Please indicate your agreement with each of the following statements:

Table A.1: Questionnaire – Section 2: Operational Efficiency in Drilling and Completion Projects

(Evaluates factors influencing operational performance within Saudi Aramco's projects.)

القسم الثاني: الكفاءة التشغيلية في مشاريع الحفر والإكمال

يهدف هذا القسم إلى تقييم العوامل التي تؤثر على الكفاءة التشغيلية ضمن مشاريع أرامكو السعودية.
يرجى تحديد مدى موافقتك على كل من العبارات التالية

Table 61. Questionnaire – Section 2: Operational Efficiency in Drilling and Completion Projects

(Evaluates factors influencing operational performance within Saudi Aramco's projects.)

No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Inefficiency is caused by an incompetent project team.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
2	Personality clashes among service providers affect performance.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
3	Poor project planning and scheduling negatively impact efficiency.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
4	Operational inefficiency is linked to design errors.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	Inaccurate cost estimation and material takeoff reduce efficiency.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
6	Lack of quality control and assurance leads to inefficiencies.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
7	Weak schedule management by consultants delays operations.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
8	Unforeseen structural changes and conditions disrupt workflow.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
9	Insufficient or outdated technical studies impair decision-making.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
10	Poor communication among stakeholders hinders operations.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
11	Inconsistencies in contract documents cause confusion.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
12	Poorly defined payment milestones slow down execution.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
13	Lack of coordination with suppliers impacts progress.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
14	Ineffective project implementation strategies reduce success.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
14	Ineffective project implementation strategies reduce success.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
15	Weather conditions negatively affect construction activities.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
16	Subsurface formation instability interferes with operations.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
17	The condition of surrounding seas disrupts offshore activities.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
18	Site location (onshore/offshore) contributes to operational challenges.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
19	Incomplete documentation and undefined project scope impact efficiency.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
20	Design or scope changes by the owner during execution delay progress.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
21	Prolonged approval processes affect project flow.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
22	The involvement of too many stakeholders leads to misalignment.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
23	Lack of subsurface data clarity undermines planning accuracy.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
24	Low skill level or productivity of the workforce causes delays.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
25	Insufficient or outdated equipment hampers execution.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
26	Manpower shortages disrupt operations.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
27	Delays or issues in material procurement affect the schedule.	☐	☐	☐	☐	☐

Section 3: Budget and Financial Efficiency in Drilling and Completion Projects

This section assesses the factors influencing budget and economic performance. Please indicate your level of agreement:

القسم الثالث: الكفاءة المالية والميزانية في مشاريع الحفر والإكمال
يُقيّم هذا القسم العوامل التي تؤثر على الأداء المالي والميزانية
يرجى تحديد مدى موافقتك على العبارات التالية

Table A.2: Questionnaire – Section 3: Budget and Financial Efficiency in Drilling and Completion Projects
(Assesses elements impacting budgeting and economic performance.)

Table 62. Questionnaire – Section 3: Budget and Financial Efficiency in Drilling and Completion Projects

(Assesses elements impacting budgeting and economic performance.)

No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Project budgeting inefficiencies result from an incompetent project team.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
2	Conflicts between parties or service companies lead to budget mismanagement.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
3	Inadequate project planning and scheduling cause financial overruns.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
4	Design errors contribute to cost increases.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	Incorrect cost estimation or material quantity takeoff impairs budget accuracy.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
6	Weak quality control mechanisms affect economic outcomes.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
7	Poor oversight of the contractor's schedule by the consultant delays payment flow and budget forecasts.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
8	Unanticipated modifications or structural changes increase financial demands.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
9	Weak or incomplete technical studies result in inaccurate cost projections.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
10	Ineffective communication among contract stakeholders leads to misaligned financial expectations.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
11	Discrepancies or ambiguities in contract documentation hinder financial planning.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
12	Poorly structured payment milestones disrupt cash flow.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
13	Lack of early communication with suppliers affects budget compliance.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

14	Inefficient project implementation approaches result in financial waste.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
15	Weather conditions create unplanned cost implications.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
16	Geological or formation instability introduces unexpected expenses.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
17	Sea conditions influence offshore operational costs.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
18	Project location impacts overall budget requirements.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
19	Incomplete project documentation or unclear scope results in cost overruns.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
20	Owner-initiated changes during execution raise financial liabilities.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
21	Extended project approval processes cause financial delays.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
22	Multiple stakeholders complicate budget alignment.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
23	Inadequate clarity regarding subsurface data increases uncertainty in cost planning.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
24	Unskilled or low-productivity labor raises project costs.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
25	Shortage or inadequacy of equipment causes financial inefficiencies.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
26	Labor shortages increase wage expenses and reduce productivity.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
27	Procurement delays or material shortages lead to budget deviations.	☐	☐	☐	☐	☐

Section 4: Cost-Consciousness in Drilling and Completion Operations

This section explores how different factors influence cost-consciousness.

Please indicate your agreement:

القسم الرابع: الوعي بالتكاليف في عمليات الحفر والإكمال

يستعرض هذا القسم كيف تؤثر العوامل المختلفة على مستوى الوعي بالتكاليف.
يرجى تحديد مدى موافقتك على العبارات التالية:

Table A.3: Questionnaire – Section 4: Cost-Consciousness in Drilling and Completion Operations
(Explores how project-related factors influence cost awareness.)

Table 63. Questionnaire – Section 4: Cost-Consciousness in Drilling and Completion Operations

(Explores how project-related factors influence cost awareness.)

No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	A lack of cost-consciousness is driven by an incompetent or inadequately trained project team.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
2	Interpersonal conflicts or personality clashes contribute to financial inefficiencies.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
3	Ineffective planning and scheduling diminish cost control discipline.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
4	Design flaws or rework compromise cost-efficiency.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	Errors in cost estimation and material quantity takeoff result in overspending.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
6	Weak quality control systems increase unforeseen costs.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
7	Failure of consultants to properly manage contractor schedules impacts financial accountability.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
8	Unanticipated structural or scope changes impair cost control.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
9	Inadequate or weak technical studies hinder proper budgeting and oversight.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
10	Insufficient communication among contractual stakeholders leads to unmonitored cost growth.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
11	Contractual inconsistencies or vague clauses reduce cost transparency.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
12	Undefined or unclear payment milestone structures cause budgeting uncertainty.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
13	Ineffective engagement with suppliers undermines cost planning.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
14	Unsystematic or poorly executed project implementation increases wasteful spending.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
15	Weather fluctuations lead to indirect cost increases.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
16	Formation instability or subsurface challenges generate unexpected expenditures.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

17	Rough sea conditions impact offshore project timelines and financial resources.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
18	Project location factors influence cost-awareness and operational cost drivers.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
19	Unclear or incomplete project scope negatively affects financial diligence.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
20	Frequent owner-initiated changes increase budget unpredictability.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
21	Prolonged decision-making hinders proactive cost management.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
22	Multiple stakeholder involvement complicates budget alignment.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
23	Inadequate definition of subsurface data leads to inaccurate cost allocation.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
24	Low productivity or lack of technical skills contributes to budget overruns.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
25	Insufficient or inappropriate equipment availability results in unplanned costs.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
26	Labor shortages raise overall project costs.	☐	☐	☐	☐	☐
No.	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
27	Procurement delays or material shortages impact cost consistency.	☐	☐	☐	☐	☐

Section 5: Closing and Acknowledgment

Thank you for completing this questionnaire. Your responses are valuable and contribute significantly to this research on the strategic optimization of drilling and completion operations in Saudi Aramco's projects. Your insights will help identify key optimization factors affecting operational efficiency, budget control, and cost-consciousness. All information remains confidential and is used solely for academic purposes.

Researcher: Haitham Al-Haj

Program: Master of Project Management

University: Midocean University

Email: haitham.aramco@gmail.com

◆ الخاتمة والتقدير:

نشكر لكم تخصيص وقتكم الثمين لاستكمال هذا الاستبيان. إن مساهمتكم محل تقدير كبير، وسنُسهم بشكل التحسين الاستراتيجي لعمليات الحفر والإكمال بهدف " :فعّال في نجاح ودقة هذا البحث العلمي بعنوان "تقليل تكاليف الإنشاء: دراسة حالة لمشاريع أرامكو السعودية في الظهران

سنُساعِد إجاباتكم على تحديد أبرز العوامل المؤثرة في تحسين الكفاءة التشغيلية، وضبط الميزانية، وتعزيز الوعي بالتكاليف ضمن مشاريع إنشاء النفط والغاز. نؤكد لكم أن جميع المعلومات التي تم تقديمها ستُعامل بسرية تامة ونُستخدم فقط لأغراض البحث العلمي.

لأي استفسارات إضافية أو لمتابعة نتائج الدراسة، يُرجى التواصل مع الباحث عبر المعلومات الموضحة أدناه:

الباحث: هيثم الحاج

البرنامج: ماجستير إدارة المشاريع

الجامعة: جامعة ميدأوشن

البريد الإلكتروني: haitham.aramco@gmail.com

فَاخْرُجْ مِنْهَا وَلِلَّهِ الْحَمْدُ الْعَلِيمُ