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Profitability Analysis of Oilfield Projects using Non-Time Dependent Economic Tools

ADAOBI STEPHENIE NWOSI-ANELE[1]; KAINE BENE CHINWAH[2]
[1]*Department of Petroleum Engineering*
[2]*Department of Chemical/Petrochemical, Rivers State University, Port Harcourt, Rivers State, Nigeria*

Abstract—Oilfields projects demand reliable profitability evaluation tools, especially under volatile market conditions and limited data availability. This study applied non-time dependent economic indicators—Internal Rate of Return (IRR), Average Rate of Return (ARR), Return on Assets (ROA), Return on Equity (ROE), Return on Sale (ROS), and Unit Technical Cost (UTC)—to assess project viability. Using standardized inputs on costs, reserves, oil price, income, asset, and equity, spreadsheet simulations revealed competitive unit technical cost costs and strong returns on assets and equity, confirming operational efficiency and financial attractiveness. This optimization of resources not only secures immediate financial gains but aligns with circular economy principles by minimizing waste and maximizing asset utility. Although return on sale was modest, the overall analysis validates non-time dependent tools as practical alternatives to time-dependent models, offering quick, transparent, and effective measures for petroleum project appraisal.

Index Terms—Oilfield projects, Profitability indicators, non-time dependent tools, Petroleum economics, Unit technical cost.

I. INTRODUCTION

Project success remains the central objective of organizations and stakeholders, yet achieving it continues to be a challenge despite decades of research and methodological development. Cooke-Davies [3] and Joslin and Muller [16] emphasize that organizations convert opportunities into projects to achieve strategic goals, but many fail to meet expectations. The Standish Group [28] reported that only 32% of projects were successful, while 44% were challenged and 24% failed. The Project Management Institute [21] defines project management as the application of knowledge, tools, and techniques to meet objectives, noting that adherence to Project Management Methodologies (PMMs) reduces risks, cuts costs, and improves success rates [20]. However, Wells [29] observed that nearly half of project managers did not achieve anticipated outcomes from PMMs, while Joslin and Muller [16] demonstrated that PMMs contribute 22.3% to project success, supporting Berssaneti and Carvalho [2] who argued that established methodologies improve performance. In oil and gas projects, cost overruns and schedule delays remain persistent challenges [12].

The volatility of global oil prices has intensified the need for projects to be delivered on time, within budget, and in alignment with stakeholder expectations. Oil companies face significant risks and uncertainties, making execution increasingly complex. Success requires optimized reservoir performance, efficient production, and effective risk management. Importantly, project success differs from project management success: while sound management contributes to success, it cannot guarantee it. Success is measured by the extent to which objectives are achieved, typically in terms of cost, time, and quality [24]. Thus, project evaluation must consider both efficiency in resource use and effectiveness in meeting stakeholder needs. In the modern energy landscape, these stakeholder needs increasingly demand adherence to sustainable development goals, requiring projects to balance economic viability with environmental stewardship. Specifically, within this study, sustainable development is operationally defined as the ability of an oilfield project to maintain long-term economic viability and operational efficiency [8]. This aligns with Circular Economy principles which prioritize the optimized use of capital and assets to prevent resource wastage, ensuring that extraction generates maximum value with minimum input costs and maximum asset longevity [10].

Investment decision-making in oil exploration is particularly complex due to the capital-intensive nature of projects and the long-term consequences of losses or profits. Traditional tools such as Net Present Value (NPV), Internal Rate of Return (IRR), Return on Investment (ROI), and payback period are widely used, requiring accurate projections of crude oil prices, production rates, and reservoir characteristics. The second industrial revolution accelerated hydrocarbon utilization, and today hydrocarbons remain a major global energy source, with consumption reaching 100.87 million barrels of oil equivalent per day in 2019 [7]. Natural gas also plays a critical role in power generation [4], [9]. Exploration and production (E&P) investments are highly capital intensive, often borne by firms or shared with National Oil Companies [15], [22]. Profitability depends largely on the cost of producing a barrel of oil, with Unit Technical Cost (UTC) serving as a benchmark for operational efficiency [1].

This study focuses on non-time dependent profitability indicators as criteria for oilfield project success. These include IRR, UTC, Return on Sales (ROS), Return on Assets (ROA), Return on Equity (ROE), and Average Rate of Return (ARR). An oilfield project is considered successful when exploration, development, production, and marketing are completed profitably without casualties or equipment loss, achieved through sound risk management and stakeholder cooperation. By emphasizing non-time dependent tools, this research seeks to provide investors and managers with alternative measures of success beyond conventional time-based metrics.

Capital projects in the oil industry demand predictability and reliability in management tools. Poor frameworks can lead to value loss and strained relationships, while effective use of economic tools enhances success and shareholder satisfaction. This research therefore aims to evaluate oilfield project success using non-time dependent economic tools, with objectives including: examining available economic tools, distinguishing time-dependent from non-time dependent techniques, applying indicators to crude oil fields, maximizing profit, analyzing investment decision procedures, and establishing relationships between tools and project success.

The significance of this study lies in its contribution to scholars, investors, and companies by broadening knowledge of profitability indicators and their role in decision-making. It emphasizes the importance of these tools in improving organizational performance and guiding investment strategies. Given the capital-intensive nature of oilfield projects, empirical analysis is essential to complement theoretical assumptions and quantify success. The findings will also highlight how organizations can improve decision-making frameworks to enhance efficiency and profitability.

Ultimately, petroleum operations aim not only to supply crude oil and gas but also to generate profit. Profitability is influenced by factors such as finding costs, oil prices, production volumes, and investment levels. While some factors are controllable, others—such as fiscal and geological risks—are not. Risk in petroleum projects is defined as uncertainty of outcomes [30], [13], encompassing reserves, capital expenditures, operating costs, production rates, and pricing [25]. Risk management involves systematic identification, assessment, and prioritization of risks, followed by coordinated resource application to minimize negative impacts and maximize opportunities [14]. Effective risk management increases the likelihood of achieving project objectives and ensuring sustainable long-term operations, thereby enhancing oilfield project success. In addition to traditional risk management, the industry is increasingly adopting frameworks that align economic performance with resource efficiency. Stahel [27] emphasizes that the circular economy shifts the focus from flow to stock, making the longevity of assets—measured here by ROA—a primary driver of value. This perspective is supported by Silvius [26], who argues that incorporating sustainability into project management criteria is no longer optional but essential for long-term viability. Furthermore, Ghisellini et al. [11] highlight that in capital-intensive sectors, economic efficiency indicators often serve as effective proxies for environmental performance by signaling reduced resource intensity.

A. Literature Review

The exploration of crude oil in Nigeria began in 1908 when the Nigerian Bitumen Corporation commenced operations in Ondo State after observing oil seepages in the Araromi area [5]. Their activities were interrupted by the First World War in 1914, and later resumed by Shell D'Arcy Company, which also faced disruption during the Second World War [3]. After ten years of intensive search and heavy investment, commercial quantities of crude oil were discovered in 1956 at Oloibiri in present-day Bayelsa State [16]. Expansion of exploration into other regions led to discoveries in Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo, and Rivers States, transforming Nigeria's petroleum industry and contributing to urbanization and infrastructure development [23].

Oil and gas reserves are defined as estimated quantities of hydrocarbons recoverable under existing economic and operating conditions [5]. These reserves cannot be measured directly but are inferred through geological and engineering analyses, which carry intrinsic uncertainty. Proven reserves, often referred to as 1P, are those with at least 90% certainty of recovery and are subdivided into proven developed and proven undeveloped categories [13]. Unproven reserves include probable and possible reserves, which are subject to greater uncertainty. Nigeria is estimated to hold about 159 trillion cubic feet of natural gas reserves, ranking among the top ten globally [25]. In 2003, recoverable oil reserves were estimated at several billion barrels, with projections of growth through continued appraisal drilling and exploration. More than 900 million barrels of recoverable crude oil reserves have already been identified, and the Nigerian government set a target to achieve 40 billion barrels of oil reserves by 2010 [14].

An oilfield is generally defined as a geographic area containing hydrocarbon reserves, typically developed through multiple wells. With global energy demand continuing to rise, exploration and production activities have expanded worldwide, often through joint ventures and partnerships [19]. Success in petroleum projects requires evolving technologies, human resource expertise, and strong project management methodologies to mitigate risks and adapt to unforeseen changes [24]. Oilfield project success is achieved when exploration, development, production, and marketing are completed profitably, without casualties or equipment loss, and with effective risk management and stakeholder cooperation [23]. Success is multidimensional, encompassing both short-term project management efficiency and long-term project benefits. This long-term perspective naturally aligns with sustainable development principles, which seek to balance industrial growth with ecological preservation. Project success depends on the perspective of stakeholders and should address the diversity of their interests [17].

Traditional measures of success have often relied on the "iron triangle" of cost, time, and scope [19]. However, these measures are increasingly criticized as insufficient. Serrador and Turner [24] argue that the iron triangle accounts for only about 60% of project success. Berssaneti and Carvalho [2] further divide quality into two dimensions: meeting technical specifications and satisfying customer demand. Khan et al. [17] identified 34 success criteria variables from a review of literature spanning 40 years, later consolidated into five dimensions through factor analysis. These findings highlight that success is not limited to budget and schedule compliance but also includes stakeholder satisfaction and long-term development outcomes. A project may fail in meeting immediate cost and schedule goals yet succeed in delivering broader benefits, or conversely, meet short-term targets but fail to achieve long-term objectives [3]. Defining success criteria at the project's initiation is therefore critical [16].

Profitability indicators, or economic tools, play a central role in evaluating oilfield project success. These include Internal Rate of Return (IRR), Unit Technical Cost (UTC), Return on Sales (ROS), Return on Assets (ROA), Return on Equity (ROE), and Average Rate of Return (ARR) [1]. Such tools provide decision-makers with quantitative measures of efficiency and profitability, guiding investment strategies and risk management [15]. Economic tools are essential for evaluating capital-intensive oilfield projects. They help investors assess feasibility, profitability, and risk exposure [22]. Tools such as preference theory, decision trees, cash flow diagrams, sensitivity analysis, and value-at-risk models provide structured approaches to decision-making [6]. Financial ratios, annuities, and price-earnings ratios further enhance understanding of project performance [18]. These tools enable firms to balance technical feasibility with economic viability, ensuring that investments align with strategic objectives [4], [9].

The volatility of oil markets directly impacts project profitability, making market price changes a critical factor in investment decisions [12]. Quantitative risk analysis is therefore indispensable, incorporating variables such as reserves, capital expenditures, operating costs, production rates, and oil pricing [25]. Risk is broadly defined as uncertainty of outcomes [13], while risk management involves systematic identification, assessment, and prioritization of risks to minimize negative impacts and maximize opportunities [14]. Profitability depends largely on the cost of producing a barrel of oil, with Unit Technical Cost (UTC) serving as a benchmark for operational efficiency [1]. Furthermore, adopting circular economy frameworks such as reusing produced water or repurposing equipment can directly lower this UTC, thereby enhancing overall project profitability. In petroleum projects, effective risk management enhances the likelihood of achieving objectives despite market and geological uncertainties [3].

II. RESEARCH ELABORATIONS

A. Research Design

This study was designed to evaluate the profitability of oilfield projects using non-time dependent economic tools. The methodology was structured to reflect the petroleum project life cycle, beginning with exploration and continuing through appraisal, development, and production. Each stage was examined to capture the costs, revenues, and operational realities that influence profitability.

B. Economic Framework

The petroleum project life cycle was used as the guiding framework. Exploration involved seismic surveys, geological studies, and exploratory drilling. Appraisal included delineation wells and reservoir characterization. Development covered capital investments in drilling, completion, surface facilities, and infrastructure. Production involved operating expenditures, maintenance costs, and revenue streams from hydrocarbon sales. This framework ensured that profitability indicators were computed in line with operational realities.

C. Model Building

The economic model was developed using spreadsheet-based simulations. Deterministic inputs such as reserve volumes, production rates, oil prices, capital expenditures (CAPEX), and operating expenditures (OPEX) were incorporated. Financial data including net income, shareholder equity, and total assets were also integrated. By excluding time-dependent discounting, the model emphasized static profitability measures that are often used by investors and regulators in early project evaluation.

D. Data Collection

Data inputs were obtained from secondary sources including petroleum economics literature, industry reports, and empirical studies on Nigerian oilfield projects. Oil price assumptions were based on average benchmark prices. Production data were derived from estimated recoverable reserves and daily production rates. Cost data covered CAPEX, OPEX, and UTC values. Financial data included net income, shareholder equity, and total assets. All data were standardized to ensure comparability across indicators.

E. Research Data

Table 2.1: Data for IRR

NPV ($m)	DISCOUNT RATE
399.25	0
215.60	5
90.01	10
0.06	15
(66.81)	20
(118.00)	25

The numbers in bracket means negative; -66.81 and -118.00

Table 2.2: Additional given and/or Assumed Data.

OTHER DATA ARE	
Total cost (USD)	63000
Total Reserve produced (BLLS)	3000
Oil Price (USD)	74.17
Operating Profit (USD)	53.17
Net sales (USD)	2000
Net income (USD)	50000
Total asset (USD)	135000
Shareholder’s equity (USD)	300000
Average income (USD)	72500

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Average investment (USD)	350000

F. Analytical Procedures

The analytical procedures focused on six non-time dependent tools. Internal Rate of Return (IRR) was used to assess profitability relative to capital cost. Average Rate of Return (ARR) was computed as average annual profit divided by average investment. Return on Assets (ROA) was calculated as net income divided by total assets, reflecting asset utilization efficiency. Return on Equity (ROE) was derived from net income divided by shareholder equity, indicating value creation for investors. Return on Sales (ROS) was measured as net income divided by total sales revenue, providing insight into profitability relative to turnover. Finally, Unit Technical Cost (UTC) was determined by dividing total cost by total reserves produced, serving as a benchmark for operational efficiency.

Table 2.3 Profitability Indicators and Their Formulas

Indicator	Formula	Interpretation
IRR	Rate at which NPV = 0	Profitability relative to cost of capital
ARR	Avg. annual profit ÷ Avg. investment	Simple measure of return
ROA	Net income ÷ Total assets	Efficiency of asset utilization
ROE	Net income ÷ Shareholder equity	Value creation for investors
ROS	Net income ÷ Total sales	Profitability relative to turnover
UTC	Total cost ÷ Total reserves produced	Benchmark for operational efficiency

Each indicator was analyzed to determine sensitivity to variations in oil price, production volume, and cost structure. Comparative analysis was conducted to establish how each tool contributes to understanding project profitability and efficiency.

G. Ethical Considerations

The study relied exclusively on secondary data and did not involve human participants or confidential corporate information. All sources were properly acknowledged to maintain academic integrity.

III. RESULTS OR FINDING

A. Data Presentation

The standardized data collected formed the basis for the profitability analysis. Variables included total cost, total reserves produced, oil price, operating profit, net income, total assets, shareholder equity, average income, and average investment.

Table 3.1: Summary of Oilfield Project Data

PARAMETER	AMOUNT ($)
Total cost	63,000
Total reserve produced	300,000 bbl
Oil price	74.17
Operating profit	53.17
Net income	50,000
Total asset	135,000
Shareholder equity	300,000
Average income	72,500
Average investment	350,000

This table provides the baseline data used in the profitability analysis.

B. Profitability Indicators

The profitability indicators were computed using the collected data to assess the efficiency and viability of the oilfield project.

Table 3.2: Computed Profitability Indicators

Unit technical cost	Return on equity	Return on sale	Return on assets	Average rate of return
21	0.167	0.026	0.37	0.21

The results show that the project achieved a unit technical cost of 21, which indicates competitive production efficiency. Return on equity was 0.167, reflecting moderate value creation for shareholders. Return on sales was 0.026, suggesting relatively low profitability compared to revenue. Return on assets was 0.37, showing strong efficiency in asset utilization. The average rate of return was 0.21, confirming that the project generated consistent returns relative to investment.

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C. Discussion of Results

The findings demonstrate that non-time dependent tools provide valuable insights into project success. The Unit Technical Cost (UTC) of 21 highlights operational efficiency, showing that production costs remain manageable. Return on Equity (ROE), though moderate, indicates that shareholders benefit from the project's profitability. Return on Sales (ROS) is relatively low, suggesting that while the project is profitable, revenue margins could be improved. Return on Assets (ROA) is strong at 0.37, reflecting effective use of resources. The Average Rate of Return (ARR) of 0.21 confirms that the project consistently generates returns relative to investment.

Comparative analysis reveals that Return on Assets is particularly strong, underscoring the project's ability to maximize resource utilization. From a sustainable development perspective, this high utilization implies a reduction in the need for new capital extraction, thereby lowering the project's environmental footprint while maintaining economic output. The relatively low Return on Sales, however, points to potential challenges in revenue generation or pricing strategies. Overall, the results confirm that oilfield projects can be successfully evaluated using non-time dependent profitability indicators. These tools offer practical measures for decision-making, especially in contexts where time-dependent models may be less applicable or data availability is limited.

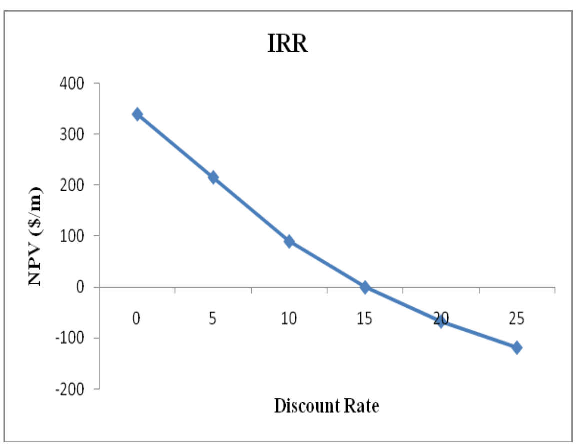

Fig. 3.1 IRR Curve

IV. CONCLUSION

This study assessed oilfield project profitability using non-time dependent tools. Data on costs, reserves, oil price, income, assets, and equity were analyzed through spreadsheet simulations. Indicators applied included IRR, ARR, ROA, ROE, ROS, and UTC. Results showed a Unit Technical Cost of 21, Return on Equity of 0.167, Return on Sales of 0.026, Return on Assets of 0.37, and an Average Rate of Return of 0.21. These values confirm the project's profitability, efficiency, and competitiveness.

The analysis demonstrates that non-time dependent indicators reliably measure project success. IRR and ARR confirmed profitability, ROA and ROE highlighted efficiency and shareholder value, ROS reflected turnover margins, and UTC benchmarked operational costs. Furthermore, the emphasis on cost control and asset optimization implicitly supports sustainable development by discouraging resource wastage. Together, they validate these tools as practical alternatives to time-dependent models, especially where quick decisions or limited data are involved.

V. RECOMMENDATIONS

1. Use of Indicators: Project managers should apply UTC, ROA, ROE, and ARR in early evaluations for quick profitability checks.
2. Sales Efficiency: The low ROS suggests improving pricing and market strategies to raise revenue margins.
3. Asset Utilization: Strong ROA highlights the need to sustain efficient resource management and technology use. Strategies that reduce waste generation should be prioritized, as they simultaneously support sustainable development objectives and improve the cost-based indicators (UTC and ROS) analyzed in this study.
4. Balanced Approach: Non-time dependent tools should be complemented with time-dependent models for long-term projects.
5. Policy Application: Regulators should adopt these indicators for benchmarking oilfield performance and guiding investment decisions.
6. Circular Economy Integration: Operators should actively integrate circular economy principles,

such as material reuse and component life extension into project planning to structurally lower Unit Technical Cost (UTC) and mitigate supply chain volatility.

7. Sustainability Benchmarking: Stakeholders should leverage these efficiency-focused indicators (UTC and ROA) as proxies for environmental performance, recognizing that minimizing input costs often correlates with reduced resource consumption and lower environmental impact.

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