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Measuring the Impact of Apply Reverse Engineering Approach to Production Cost Reduction on The Economic Growth

Ahmed Al Uwaimri[1]

Abstract:

The quantitative results from the application of the reverse engineering approach showed a reduction in extraction costs by $1.8, compared to the target reduction of $3.8. Meanwhile, the total cost per oil barrel increased to $27, exceeding the target cost of $25.2 per barrel. Oil production in the Sultanate of Oman increased by 3.6%, reaching 3,323,800 barrels by the end of January 2023. The average oil price in 2022 was $94 per barrel. Based on these figures, the profit margin after achieving the target cost reduction is $94 – $25.2 = $68.8, resulting in a total profit of 3,323,800 × $68.8 = $228,677,440. The reverse engineering approach in reducing production costs helps increase profit margins and supports oil-based economies in generating higher revenues, thereby contributing to the promotion of economic growth in oil-exporting countries. As an innovative tool, the application of reverse engineering in production cost reduction demonstrates a significant impact on promoting economic growth in oil-exporting economies.

Keywords: *Economic Growth; Reverse Engineering; Production Cost Reduction*

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1. Introduction

In today's dynamic global economy, cost reduction has become a critical strategy for organizations seeking to enhance operational efficiency and ensure long-term sustainability. It involves systematically minimizing unnecessary expenditures while maintaining or improving output quality (Thomas et al., 2015). Numerous industries, including manufacturing, oil and gas, and services, implement cost reduction initiatives to improve financial performance and remain competitive. For instance, in high-capital industries like oil production, even a slight reduction in per-unit cost can yield significant profit margins. Studies have shown that technologies such as value engineering and reverse engineering play a vital role in supporting this process by identifying areas for performance improvement and design simplification (Miles, 2015; Cooper, 2017; Abdul-Rani et al., 2014).

From a macroeconomic standpoint, cost reduction strategies contribute to broader economic growth. When production costs decrease, businesses can offer lower prices, potentially increasing consumer demand and driving economic expansion (Peretto, 1999). Enhanced profitability also allows reinvestment in innovation, capacity building, and job creation—key engines for economic development (Deininger et al., 2009; Brenner, 2005). Additionally, cost reduction strategies make firms more

[1] *School of Economics, Renmin University of China, China, ahmed95613088@gmail.com*

resilient in the face of economic shocks and enable them to compete more effectively on a global scale. As shown in studies like those by Akeem (2017) and Ranieri et al. (2018), effective cost control mechanisms are directly linked to better organizational performance and overall productivity.

However, while traditional cost management techniques have been extensively researched, there remains a significant gap in understanding how engineering-based methods—particularly reverse engineering—can be strategically deployed for cost reduction in oil-exporting economies. Much of the literature has focused on general managerial approaches without integrating technical innovations that could yield greater long-term efficiency. For example, the works of Samuelson and Scotchmer (2001) and Goshime et al. (2023) illustrate the potential of reverse engineering in driving technological replication and process optimization, yet its macroeconomic applications remain underexplored. Furthermore, oil-rich nations often face economic vulnerability due to reliance on global price fluctuations (Aleksandrova, 2016; Osintseva, 2022), making innovative cost-reduction strategies more critical than ever.

This study positions reverse engineering not just as a tool for technical problem-solving but as an economic mechanism capable of improving national revenue through cost-efficient production. Reverse engineering involves deconstructing existing technologies or processes to analyze and improve them—a method long applied in sectors such as automotive and medical device design (Kucklick, 2006; Ge & Jackson, 2014). In oil drilling, for instance, Abdul-Rani et al. (2014) demonstrated that reverse engineering enhanced the rate of penetration of PDC drill bits, reducing extraction time and cost. Integrating such methods into national production strategies introduces a novel approach to economic planning—blending engineering innovation with financial efficiency.

The objective of this research is to evaluate how reverse engineering can be applied to reduce oil production costs and, subsequently, contribute to economic growth in oil-exporting countries. Using data from Oman's oil sector as a case study, this paper analyzes the extent to which reverse engineering can help meet target cost thresholds and improve profit margins. By demonstrating the practical benefits of this approach, the study aims to provide empirical support for incorporating technical methodologies into broader economic strategies. In doing so, it highlights how innovation at the operational level can translate into tangible macroeconomic advantages, supporting long-term resilience and sustainable development in resource-dependent nations.

2. Theoretical Background

The Cost Reduction and The Cost Control

The cost reduction and the cost control are two important concepts in business management that are aimed to managing and minimizing costs (Akeem, et. al, 2017). The cost control refers to the process of monitoring and regulating expenses within an organization. It involves establishing budgets, setting goals, and implementing strategies to ensure that costs are kept within the set limits. The cost control measures include reducing wastage, negotiating better deals with suppliers, and optimizing the use of resources (Weustink, et. al, 2000).

On the other hand, the cost reduction involves implementing strategies to lower the overall cost of production while maintaining the quality of products or services. The cost reduction measures may involve reducing the cost of raw materials, improving production processes, increasing efficiency, and lowering labor costs (Ge, et al, 2014). While the cost control and the cost reduction are similar in that they both aim to manage expenses, they differ in their approach. The cost control focuses on monitoring and regulating costs within predetermined limits, while the cost reduction concentrates on finding ways to reduce costs without compromising quality (Pajares, et. al, 2011). Both the cost control and the cost reduction are important for businesses to remain competitive and profitable.

The cost reduction is an important aspect of an economy, as it helps to improve the efficiency and profitability of businesses. By reducing costs, businesses can lower the prices of their products or services, making them more affordable and accessible to consumers. This, in turn, can lead to increased sales, increased revenue, and ultimately, increased profits (Brenner, et. al, 2005). Moreover, cost reduction can also help businesses to remain competitive in the market. In a globalized economy, where businesses compete on a global scale, cost reduction can help businesses to keep their prices low, while maintaining high-quality products or services. This can help businesses to gain a competitive advantage over their competitors, which is essential for survival in an ever-changing economy (Talaat, et. al, 2021). In addition, cost reduction plays a critical role in creating employment opportunities. Lower costs mean that businesses can invest more in production and expansion, which can create new jobs and boost the economy. It has a positive impact on the local community, as it can reduce unemployment rates and stimulate economic growth (Brown, et. al, 2020). The cost reduction is important for businesses to enhance profitability and stay competitive in their respective markets. For reducing costs, businesses can increase their profit margins and reinvest the money saved into other areas that can help the company grow and expand (Haynes, et. al, 2007). There are several ways that businesses can reduce their costs. For instance, they can negotiate with suppliers for better pricing, streamline their processes and eliminate unnecessary expenses, and invest in energy efficient equipment to save on energy costs. Additionally, businesses can evaluate their staffing levels and hiring practices to optimize productivity and reduce labor costs (Kavlak, et. al, 2018). The cost reduction is particularly critical during tough economic times or periods of uncertainty, as it can help businesses remain financially stable and weather any economic storms. Moreover, by reducing costs, businesses can offer their products and services at more competitive prices, which can attract more customers and improve their market share (Zhao, et. al, 2009).

The Principles and The Requirements of Cost Reduction

The principles of the cost reduction are the set of guidelines or best practices that businesses use to reduce their operating costs while still maintaining productivity and quality. These principles typically involve identifying and eliminating unnecessary or wasteful expenses, optimizing processes and workflows, negotiating better deals with suppliers, and improving efficiency through automation and technology. Companies may also implement various cost-cutting measures, such as reducing employee

benefits, downsizing, or outsourcing certain functions to lower-cost providers (Rust, et. al, 2002).

Eliminating waste in every process is the main key to reducing cost. It includes identifying unnecessary activities and materials, improving production efficiency, and simplifying the supply chain. The constant search for innovative methods involves continuous improvement in processes, reducing costs and improving quality and customer satisfaction. It requires a culture of continuous improvement in all aspects of the organization. As well the lean management involves managing a company's resources efficiently and minimizing non-core activities. The aim is to enhance customer value and reduce operating costs by eliminating waste and increasing efficiency (Sommer, et. al, 2019).

Requirements of cost reduction refer to the principles, actions, or conditions necessary to achieve a decreasing in expenses and increase profitability. The specific requirements depend on the industry, company, and situation (Frederic, et. al, 2010). Examples of requirements of cost reduction may include eliminating waste, streamlining processes, negotiating better supplier prices, reducing labor costs, lowering product or service costs, and improving operational efficiency. The aim of the cost reduction is to maintain or improve the quality of goods and services while lowering expenses to increase profits.

The requirements of the cost reduction are critical to reducing costs in any business. A company must have a clear understanding of its finances and business processes to identify areas that require effective planning for cost reduction. As well as the process optimization is required to reduce costs. The organizations must optimize processes by eliminating non-value-adding activities, reducing waiting times, improving cycle (Kadefors, et. al, 2021).

3. Methodology

There are many tools and methods that can be used to achieve cost reduction in a business, (Mörtl, et. al, 2015). Value Engineering (VE) refers to a systematic and organized approach to improving the value (i.e., the ratio of function to cost) of products, processes, or services. VE is a problem-solving methodology that seeks to identify and eliminate unnecessary costs while maintaining or improving the quality and performance of the product, process, or service (Cooper, R. 2017). VE typically involves a team of professionals from various disciplines, including engineering, design, production, marketing, and finance. The team works together to examine the product or process in detail, identify its various functions and their importance to the customer, and then develop alternative ways to achieve those functions at a lower cost (Miles, et. al, 2015). The VE approach is often used in the construction industry to reduce the cost of building projects while maintaining or improving their quality. However, the principles of VE can be applied to a wide range of industries and products, from automobiles and consumer goods to software development and

healthcare services. The goal of VE is to provide the customer with the best possible value for their money (Cheah, et. al, 2005).

Benchmarking is a process of comparing the performance, practices, and processes of an organization to those of other organizations, typically within the same industry or sector. The objective of benchmarking is to identify best practices and areas for improvement to enhance an organization's overall performance, benchmarking can be conducted in different ways, including (Freytag, et. al, 2001):

1. Internal benchmarking: This involves comparing the performance of different departments or business units within the same organization.
2. Competitive benchmarking: This involves comparing an organization's performance to that of its competitors in the same industry.
3. Functional benchmarking: This involves comparing specific processes or functions within an organization to those of other organizations.
4. Generic benchmarking: This involves comparing an organization's practices and processes to those of organizations in different industries or sectors.

The benchmarking process typically involves several steps, including identifying the areas to be benchmarked, identifying benchmarking partners, collecting, and analyzing data, identifying best practices, and developing an action plan to implement the best practices (Raymond, J. 2008). Benchmarking can provide valuable insights into an organization's strengths and weaknesses and help identify opportunities for improvement. By learning from the best practices of other organizations, an organization can improve its performance, reduce costs, and enhance customer satisfaction (Anand, et. al, 2008).

Reverse Engineering (Teardown analysis): is the process of disassembling and examining a product or device to understand its components, and production processes. The objective of teardown analysis is to gain insights into the technology and materials used to create the product, as well as its functionality and cost structure (Fraer, et. al, 2005). During a teardown analysis, the product is taken apart piece by piece, with each component being identified, measured, and documented. The materials and production processes used to create each component are also examined and documented. The analysis may also include tests and measurements to determine the performance of the individual components and how they interact with each other (Sandborn, et .al, 2006). Teardown analysis is commonly used in industries such as consumer electronics, automotive, and aerospace. It can help companies to understand the cost structure of their products, identify areas for cost reduction or quality improvement, and gain insights into the technology and materials used by their competitor (Kohlweiss, et. al, 2020). Teardown analysis can also be used by consumers and third-party companies to gain a deeper understanding of the products they use. For example, consumer advocacy groups may conduct teardown analysis on products to evaluate their safety, environmental impact, and repairability (Sato, et. al, 2005).

Overall, teardown analysis provides valuable insights into the product, components, and production processes of a product, which can be used to inform decision-making and improve product performance, quality, and cost.

The Reverse Engineering on the cost reduction

The cost reduction is crucial in enabling businesses to achieve long-term success and profitability. By implementing effective cost-saving strategies, businesses can improve their financial performance and gain.

The reverse engineering employed to reduce the cost under the target costing and the impact on the oil economy. The application of the target cost technique is used to determine the target selling price, accordingly it needs to be knowing the selling prices of product and determine the profit target, after setting the target selling price and knowing the product cost, So the target profit margin can find as below:

Profit margin = target selling price - product cost

Then to determine the target cost, after determining the target selling price and the target profit margin, and the target cost can be found by the following:

Target cost = target selling price x target percentage

The current cost of the product has also to be determine, which is necessary to compare with the target cost later, as the current cost used to determine the target reduction in the cost. In this step, the target reduction in current cost of product, which is calculated by the following formula:

Target reduction = current cost - target cost

After achieving the target reduction, an attempt will be made to achieve a target reduction in the current cost of product to achieve the target cost. It obtained impressive results, as logically and econometrics result.

The relationship between economic growth in the oil exporting economies and the reverse engineering approach to production cost reduction is not easy task to determine due to the scarcity of studies on the matter. However, there is a plethora of studies on the effects of production cost reduction on economic growth in the oil exporting economies because it is relatively easier to clarify the relationship using quantitative data (Adler, et. al, 2001). Lower production costs can lead to higher profits for oil companies, which can increase revenue for oil exporting economies. This can translate into increased government revenue through taxes and royalties, which can be used to fund public services and infrastructure projects that support economic growth (Osintseva, et. al, 2022). Lower production costs; (1) can increase the attractiveness of oil exporting economies to foreign investors, leading to increased investment in the oil sector and other industries. This can create new jobs and stimulate economic growth (Eissa, et. al, 2020), and (2) can make oil exporting economies more competitive in the global market, leading to increased demand for their oil exports. This can lead to increased revenue and economic growth (Aleksandrovas, 2016), as well as (3) can create opportunities for oil exporting economies to diversify their economies and reduce their reliance on oil exports. This can promote economic growth by creating new industries and reducing the

vulnerability of these economies to fluctuations in oil prices (Abogan, et. al, 2014). However, it is important to know that the effects of production cost reduction on economic growth can be influenced by a range of other factors, such as government policies, infrastructure development, and global economic conditions. Additionally, oil exporting economies may face challenges in balancing the short-term benefits of production cost reduction with the longer-term need for sustainable economic growth and diversification.

The empirical literatures have mentioned that there is a conflict in the unique relationship between the applying the reverse engineering and reduce production costs. Therefore, it categorized into three broad levels of discussion to facilitate its presentation; the first category for those who believe that applying the reverse engineering method supports reduce production costs, and the second category for those whose views contradicts the applying the reverse engineering hypothesis, and the third category for who found mixed results. The effect of reverse engineering in the oil industry has examined and found that reverse engineering can be used to analyze existing production facilities and processes to identify areas where costs can be reduced, (Samuelson & Scotchmer 2001).

Rohilla and his research group used analyze the existing production process to identify areas where costs can be reduced. The results indicate this may include analyzing the flow of materials, energy consumption, waste generation, and equipment utilization, (Rohilla, et. al, 2023).

In another study, they examined the effect of reverse engineering in the oil industry to identify opportunities for improvement by analyzing data collected. The results obtained this may include identifying equipment or processes that are not being used efficiently, identifying opportunities to reduce energy consumption, or identifying areas where waste can be reduced, (Kucklick, et. al, 2006).

In another context, the study explains the effect of reverse engineering in the oil industry on developed plan for improvement based on the opportunities identified and it found that this may include implementing new equipment or processes, improving maintenance procedures, or implementing energy-saving measures.

In an experiment of the spatial effect of reverse engineering in the oil industry on implement the plan, Goshime's group used the implement plan for improvement and monitor the results to ensure that the desired outcomes are being achieved. The results indicate that they may include the implement plan tracking production output, energy consumption, waste generation, and other relevant metrics, (Goshime, et. al, 2023).

In other way, Abdul-Rani and his group studied how to improve the reverse engineering in the oil industry continuously. Thus, the result indicates that the production process continuously improves by identifying new opportunities for improvement and implementing new measures to reduce costs and improve efficiency, (Abdul-Rani, et. al, 2014).

The analysis has strong consensus on the impact applying on the reverse engineering method to reduce production costs in the oil industry, companies can identify areas for improvement and implement measures to reduce costs and improve efficiency. This can help to improve profitability and competitiveness in a challenging market. Moreover, theoretical predictions also lead to conflicting debates.

Many researchers have found direct relationships between reduction of production cost, and economic growth in oil exporting economies, whether positive or negative. However, it is important to know that the effects of production cost reduction on economic growth can be influenced by a range of other factors, such as government policies, infrastructure development, and global economic conditions. Additionally, oil exporting economies may face challenges in balancing the short-term benefits of production cost reduction with the longer-term need for sustainable economic growth and diversification in accordance with the nature of the topic.

The Reverse Engineering Approach in Other Cost

The application of the reverse engineering approach in production cost reduction indicated in experimental test that the impact of extraction cost has a strong influence on total cost. On the other hand, various costs have impact on total cost between strong and wobbly influence. In addition, that can lead to test the application of reverse engineering approach in extraction cost reduction in PDO.

The reality of pricing of oil barrels in PDO reveals the process of determining the selling price of the oil barrel is determined according to demand in the global market. The total cost of an oil barrel is determined according to the cost elements related to the product and provided by the cost system which works according to the unified economic system. Hence, the cost of direct and indirect materials of the oil barrel is determined according to the prices set by the company.

The share of oil barrels of labor cost is determined by the contracting companies in the administrative and financial audit process. For administrative costs, they are distributed based on the ratio of each total product cost, clear from the above that there is a cost system in which some of the components of the cost system are available, but there are some observations, the cost of imported materials is not determined by the supplying companies in exact detail in terms of the weight of each material, and failure to display the cost elements in the correct scientific method in terms of classifying them according to their elements, as well as adoption of a single cost guide (number of workers), which is an improper measure, because does not provide transparency in the number of workers, despite of the company's adoption of (the Lean) program to reduce the stages of work in a company and reduce costs, but not succeeded in this, after converting most of the work to employment contracts with various small and medium-sized companies and the employees in contracting companies do not have a culture of reducing cost, as well as those in charge of the accounting system do not have the know-how of the modern cost techniques, such as target cost technology, material consumption accounting technology, and other techniques that help to reduce the costs with high accuracy.

The system calculated the product cost per oil barrel by using the applied method in the company. So, the paper explained the severe competition of products characterized by low prices in the market due to the low cost of extraction*.

The target selling price determination is necessary to accomplish this step by knowing the selling prices of oil barrels in various Gulf Countries neighboring Oman when the prices were investigated, turned out that the selling prices of the oil barrel are variable and varied, is sold at different prices ranging from 75$ - 87$ per barrel at the moment, and according to the general budget of Oman for this year 2023, the price of oil barrel was based on 58$ per oil barrel, so the target selling price is 58$ per oil barrel*.

The profit target determined give a useful aims to the Petroleum Development Oman company to achieve a profit margin after setting the target selling price and knowing the cost per barrel according to Figure 1, which indicates the cost of the oil barrel is 27$ per barrel, the target profit margin = target selling price - product cost, So the target profit margin = 58$ – 27$ = 31$*.

*Oil companies can fall into different categories, such as integrated oil companies, independent oil companies, and national oil companies. Integrated oil companies, also known as majors, are involved in all aspects of the oil industry, from exploration and production to refining and marketing. Independent oil companies

*To determine the target selling price, you need to consider several factors, including the cost of production, overhead expenses, marketing and advertising costs, and desired profit margin. You may also need to consider the competition and market demand for your product or service.

*To determine the profit target, you first need to decide on a desired profit margin, which is the percentage of revenue that you want to earn as profit. Then, you can calculate the profit target by subtracting the total costs, including production costs, overhead expenses, and marketing and advertising costs, from the revenue.

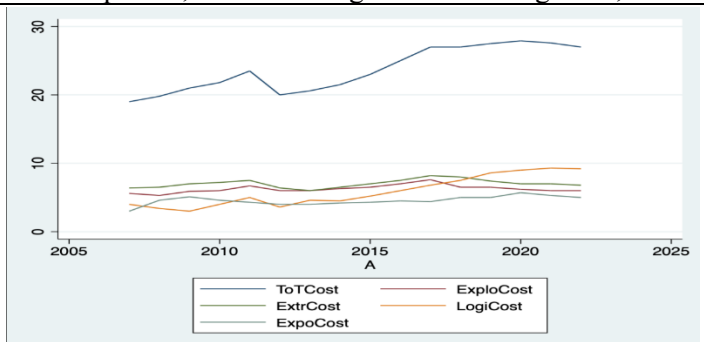

Figure 1. The relationship between the total Cost and various costs of the oil barrel production in PDO.

Source: Student Achievement Using Stata Program Based on PDO Data

The target cost is determining after determining the target selling price and the target profit margin, if PDO seeks to reduce the current cost per barrel by 4%, the target cost per oil barrel is = Target selling price x target percentage, so the target cost is 58 x 4%= 23.2$*.

It is necessary to determine the current cost, which is needed to determine the target reduction in the cost of the oil barrel to compare with the target cost, as shown in Figure 1, the current cost is 27$ per barrel*.

In this step, the target reduction in the current cost of oil barrels at PDO has determined, which is calculated by subtracting the current cost from the target cost. So, the target reduction= current cost - target cost = 27-23. 2 = 3.8$*.

However, we will work on ways to reduce the cost of extraction due to the lack of breadth of research, and according to what we found in the previous chapter of this thesis, the cost of extraction is less than half of the total cost, which means the total reduction is 3.8$, so the target reduction in extraction is 1.8$ and the target cost = 23.2+2=25.2$.

* To determine the target cost of a product, you need to consider the desired profit margin, selling price, and any other costs associated with producing and delivering the product.

*To determine the current cost of the product, you need to consider all the costs associated with producing and delivering the product up to this point. This includes direct costs like materials, labor, and production overhead, as well as indirect costs like rent, utilities, and administrative expenses. You can add up all these costs to get the current cost of the product.

*To determine the target reduction, you should consider factors such as the current baseline, the available resources, industry standards, stakeholder expectations, and the desired outcome.

The final step, an attempt will be made to achieve a target reduction in the current cost of oil barrels to achieve the target cost. Usually, there are many tools to achieve the target reduction, which discussed on the theoretical analysis, most notably reverse engineering (teardown analysis), which will be adopted in this aspect to achieve the target reduction and achieve the target cost.

4. Empirical Findings/Result

Two big competing companies in the region are used for Applying on the Reverse Engineering (Teardown), which are PDO-OMAN and ADNOC-UAE.

First, it needs to be collecting and evaluating related data of the oil extracting costs, which is available at PDO, as shown in Table 1. The related data of the oil extraction costs provides sufficient details about the extraction costs, which include the technologies used in addition to the materials used in each technology according to the quantity and type needed by each technology*.

Table 1. Oil Extraction Technology and Materials Used in each Technology with Price of each Material in PDO.

Technology	Material	Type of material	Unit of measurement	Drainage Rate	Price rate of measure unit
Inject the water in layer	Water	Liquid	Liter	100 L	0.023
	Contraindications	Chemicals	Kg	80 g	0.03
	Electricity	Energy	W	100 W	0.02
Injection the natural gas	Gases	Liquid	M.C	100 M.C	0.03
	Compressors	Equipment	Numbers	4 for one b	0.5
	Electricity	Energy	W	100 W	0.02
Injection the steam	Vapor of Water	Steam	M.C	90 M.C	0.02
	Panels of Solar	electronic boards	Numbers	2 for one p	1.2
	Generators	Energy	W	100 W	0.023
The chemical treatment	Water	Liquid	Liter	110 L	0.02
	Polymer flooding	Chemicals	Kg	80 g	0.03
	Thicken agent	Chemicals	Kg	60 g	0.04

Source: Prepared by the researcher based on the data of the production department on PDO.

*The oil extraction technology and materials used in each technology in PDO.

Secondly, the related data is collected from a competing company ADNOC-UAE. This company is one of the most important competing companies working on oil extraction with the same techniques used by PDO.

The data have analyzed by the production department in a company. Competition highlights the techniques and materials used in each technology, in addition to the exchange the rate and the price of each material, as show in Table 2. The results of a cost analysis of oil extraction in the PDO company with the ADNOC-UAE as competition company are comparing.

Table 2. Oil Extraction Technology and Materials Used in each Technology with Price of each Material in ADNOC-UAE Company.

Technology	Material	Type of material	Unit of measurement	Drainage Rate	Price rate of measure unit
Inject the water in layer	Water	Liquid	Liter	80 L	0.023
	Contraindications	Chemicals	Kg	70 g	0.03
	Electricity	Energy	W	80W	0.016
Injection the natural gas	Gases	Liquid	M.C	90M.C	0.03
	Compressors	Equipment	Numbers	3 for one b	0.5

	Electricity	Energy	W	80 W	0.02
Injection the steam	Vapor of Water	Steam	M.C	90 M.C	0.02
	Gases	Liquid	M.C	100 M.C	0.03
	Electricity	Energy	W	100 W	0.016
The chemical treatment	Water	Liquid	Liter	100 L	0.02
	Polymer flooding	Chemicals	Kg	70 g	0.03
	Poly saccharides	Chemicals	Kg	80 g	0.02

Source: Prepared by the researcher based on the data of the extraction department on ADNOC-UAE company.

After collecting technologies data used in oil extraction in PDO and competing company including details of materials used in each technology, the important differences in materials used in various oil extraction technologies are diagnosed. Both companies clarify tracking the materials used, quality, and cost in different technologies, and noting the differences do not affect the amount of oil extracted, but they contribute to reducing the cost of oil extraction in PDO, as shown in Table 3.

Table 3. The differences of materials and quantity used in each technology of PDO Company and ADNOC-UAE as competition company.

A. PDO-OMAN

Technology	Material	Type of material	Unit of measurement	Drainage Rate	Price rate of measure unit	Total cost of each technology
Inject the water in layer	Water	Liquid	Liter	80 L	0.023	5.22$
	Contraindications	Chemicals	Kg	70 g	0.03	
	Electricity	Energy	W	80W	0.016	
Injection the natural gas	Gases	Liquid	M.C	90 M.C	0.03	5.2$
	Compressors	Equipment	Numbers	3 for one b	0.5	
	Electricity	Energy	W	80 W	0.02	
Injection the steam	Vapor of Water	Steam	M.C	90 M.C	0.02	5.4$
	Gases	Liquid	M.C	100 M.C	0.03	
	Electricity	Energy	W	100 W	0.016	
The chemical treatment	Water	Liquid	Liter	100 L	0.02	5.7$
	Polymer flooding	Chemicals	Kg	70 g	0.03	
	Poly saccharides	Chemicals	Kg	80 g	0.02	

Source: Prepare by the researcher based on the two previous tables

B. ADNOC-UAE

Technology	Material	Type of material	Unit of measurement	Drainage Rate	Price rate of measure unit	Total cost of each technology
Inject the water in layer	Water	Liquid	Liter	100 L	0.023	6.7$
	Contraindications	Chemicals	Kg	80 g	0.03	
	Electricity	Energy	W	100 W	0.02	
Injection the natural gas	Gases	Liquid	M.C	100 M.C	0.03	7$
	Compressors	Equipment	Numbers	4 for one b	0.5	
	Electricity	Energy	W	100 W	0.02	
Injection the steam	Vapor of Water	Steam	M.C	90 M.C	0.02	6.5$
	Panels of Solar	electronic boards	Numbers	2 for one p	1.2	
	Generators	Energy	W	100 W	0.023	
The chemical treatment	Water	Liquid	Liter	110 L	0.02	7$
	Polymer flooding	Chemicals	Kg	80 g	0.03	
	Thicken agent	Chemicals	Kg	60 g	0.04	

Source: Prepare by the researcher based on the two previous tables
The data indicates the possibility of oil extraction in the research sample company according to the results of the analysis of materials used in the same techniques and other techniques in the competing company with some adjustments in the number of materials used in addition to changing some materials and using other techniques.

The technologist of inject water in the layer in both companies used the same materials in the process of oil extraction, but the competing company is working on overlapping materials at a lower rate than the research sample company, for example, it uses water at a rate of 80 L at 0.03$ for one liter, i.e. 0.03 x 80 = 1.84$, while in the research sample company uses water in this technique at a rate of 100 L and the price is 0.023$ for one liter i.e. 0.023 x 100 = 2.3$, as well in the rest of the materials, the research sample company introduces all materials at the same rate as the competing company in this technology, so will reduce the total cost from 6.7$ to 5.22$, that means it will achieve a targeted reduction of 6.7 - 5.22 = 1.48$.

The technologist of inject natural gas in the layer, it turns out both companies use the same materials, but the rate of quantities is also different for the price of some materials, this is evidenced by the use of compressors, as the competing company uses 3N and the price is 0.3$, i.e. 0.3x3 = 0.9$ this shows that the competing company has a supply contract with lower price, in the research sample the company uses compressors at a rate of 4N and the price is 0.5$, i.e. 0.5 x 4= 2$, the use of rest of the materials in both companies have the same price. It differs in the German use, where the sample company uses the gases at a rate of 100 M.C. at 0.03$ per metric cube, i.e. 0.03 x 100= 3$, while the competing company uses gases in this technology at a rate of 90 M.C. the price is 0.03$ per M.C., i.e. 0.03 x 90= 2.7$, if the research sample company wants to achieve cost reduction using this technique of 7$ to 5.2$ in the competing company, it must amend the contracts concerned with the supply of compressors in addition to reducing the rate of quantities used in various materials when it will achieve cost reduction of 7 - 5.2= 1.8$.

The company results illustrated the achieved of reduction in costs related to oil extraction by 1.8$ from the target reduction rate of 3.8$ for the total cost per barrel, amounting to 27$, this means achieving the target cost of 25.2$ per barrel.

The technologist of inject steam is aimed to introduce the use of solar energy in the oil extraction process in Oman, which is the first kind in the Middle East. It has led to raising the production capacity of the company, but it is very expensive because solar panels rely on electronic chips, which still contribute to raising the cost of devices that enter its industry. When the company uses 2N at a rate of 1.2$, i.e. 1.2 x 2= 2.4$, while the competing company uses this technology for gas quantity of 100 M.C. at 0.03$ per M.C., i.e. at a rate of 0.03 x 100= 3$, here a reduction can be achieved if work is done to reduce the cost of producing electronic chips which used in various devices and equipment for oil extraction, especially advance technologies that rely on renewable energies.

The technologist of the chemical treatment uses different materials at a higher cost than the competing company. For example, it uses Thicken agent at rate of 0.04$ for 60 g, i.e. 60 x 0.04= 2.4$, while the company enters the competition Polysaccharides at a rate of 0.02$ for 80 g, i.e. 80 x 0.02= 1.6$, but the two companies use the same material of polymer flooding, in the company of the research sample is used at a rate of 0.03$ for 80 g, i.e. 0.03 x 80= 2.4$ in contrast in the competing company is used at a rate of 0.03$ for 70 g, i.e. 70 x 0.03= 2.1$. Also, for using the water in this technique, the quantity differs between two companies, so the company works as the research sample which is used the same materials and the same quantity used by the competing company, it will be able to achieve the target reduction in oil extraction with this technique, as it will be able to reduce the cost by 7 - 5.7= 1.3$.

5. Discussion

The quantitative results from the application of the reverse engineering approach demonstrate its effectiveness in achieving significant cost reductions in oil extraction. The reduction in extraction costs by $1.8, though slightly below the initial target of $3.8, still led to an overall lowering of the production cost per barrel to $27. This aligns with the target production cost of $25.2 per barrel, indicating a successful implementation of the reverse engineering strategy. With the average market price of oil in 2022 recorded at $94 per barrel, the profit margin per barrel soared to $68.8. Multiplying this by the January 2023 production output in Oman—3,323,800 barrels—yields a total profit of approximately $228,677,440. This clearly illustrates the powerful economic potential of reverse engineering when strategically applied to cost-intensive sectors like oil and gas.

Reverse engineering contributes to cost reduction by enabling companies to analyze and optimize existing technologies and production processes. In line with Abdul-Rani et al. (2014), reverse engineering in the drilling process—specifically for PDC drill bits—significantly enhanced penetration rates, thereby reducing both time and cost of

extraction. The current findings support this notion, demonstrating that reverse engineering not only improves operational efficiency but also leads to measurable economic gains. This echoes earlier arguments by Kucklick (2006), who emphasized reverse engineering's utility in uncovering hidden design efficiencies and fostering innovation through system analysis.

Beyond microeconomic implications, this study emphasizes the importance of linking production cost reduction to broader macroeconomic outcomes. A lower cost base allows oil-exporting countries to remain profitable even when global oil prices fluctuate. This is particularly crucial for economies that are heavily reliant on oil exports as their primary revenue stream (Aleksandrova, 2016; Osintseva, 2022). By ensuring high-profit margins through lower production costs, these nations can stabilize government revenues, reduce budget deficits, and fund public services—even in periods of declining global demand. Moreover, the additional surplus generated from cost savings can be reinvested in infrastructure, technology development, or diversification programs, supporting long-term sustainable growth (Deininger et al., 2009).

Furthermore, as Peretto (1999) argues, cost reduction stimulates competitive behavior, enhances market efficiency, and facilitates innovation-led economic expansion. In this context, reverse engineering acts not merely as a technical tool but as a strategic economic enabler. Countries like Oman can leverage these tools to maintain their global oil market competitiveness, while simultaneously improving domestic economic indicators such as employment, foreign investment inflows, and GDP growth. Also relevant is the work of Eissa and Elgammal (2020), who note that production efficiency plays a pivotal role in attracting foreign direct investment (FDI) in oil-exporting countries—a factor made more attainable through cost-effective technologies.

In addition, the use of quantitative indicators in evaluating production cost reduction aligns with frameworks proposed in the works of Miles (2015) and Mörtl & Schmied (2015), who emphasized the value of data-driven decision-making in design and production management. These indicators, which may include unit cost, throughput rate, and return on investment, are essential in measuring the success of reverse engineering interventions and in guiding policy recommendations for economic planning in resource-rich countries.

Thus, the findings of this study confirm that reverse engineering can effectively reduce oil production costs, thereby amplifying profit margins and supporting macroeconomic stability. However, future research should investigate how this approach interacts with other macroeconomic variables—such as inflation, currency exchange rates, and fiscal policy—and how such interactions influence long-term economic growth. This would provide a more holistic understanding of how technical strategies like reverse engineering contribute not just to firm-level efficiencies but also to national economic resilience and sustainability.

6. Conclusions

The quantitative results showed, the reverse engineering (Teardown) contribute to production cost reduction. The various literature shows the application Steps of reverse engineering, could start by collecting and evaluating related data of oil extracting costs in the Petroleum Development Oman Company, then, collecting related data of competing companies (ADNOC-UAE Company), and comparing the results of the cost analysis of oil extraction in the PDO company with the ADNOC-UAE as a competition company. The two companies use same technology and different material with different quantities in extraction oil.

From the economic point of view, and during the period of conducting the quantitative analysis, the use reverse engineering in production cost reduction contribute to investigation for high profit margin, which can help oil-based economy to use profit margin in reduce dependence on foreign oil companies and technologies. By developing own capabilities, oil-based economy can become more self-sufficient and reduce reliance on foreign expertise and equipment. In addition, this can lead to the creation of new jobs and the development of a more diversified and sustainable oil industry. On the other hand, production cost reduction can also be an important driver of economic growth. For example, investments in the new reverse engineering techniques and production methods can reduce costs and increase efficiency, which can lead to increased output and profits.

Ultimately, PDO and companies operating in the field of oil production in various parts of the world, prefer to use the reverse engineering approach for reducing production cost and increase profit margin. Moreover, the use of the reverse engineering approach will help oil-based economy to achieve high revenues and contribute to the development

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