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# THE TECHNOLOGICAL INNOVATION AND ITS EFFECT ON OPERATION EFFICIENCY OF THE OIL AND GAS SECTOR OF THE UNITED ARAB EMIRATES

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WALEED MOHAMED SALEM MOHAMED AL HOSANI

SULTAN IDRIS EDUCATION UNIVERSITY

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DISSERTATION PRESENTED TO QUALIFY FOR A
MASTER OF MANAGEMENT
(RESEARCH MODE)

FACULTY OF MANAGEMENT AND ECONOMICS
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22/02/2024

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## ABSTRACT

This study aimed to examine the technological innovation and its effect on operation efficiency of the Oil and Gas Sector of the United Arab Emirates. The causal research design was employed through quantitative research methodology, using self-administered online surveys for data collection. The purposive sampling technique selected 253 respondents of 5 ADNOC group and its subsidiaries from ADNOC Onshore, ADNOC Offshore, ADNOC Drilling, ADNOC Sour Gas and ADNOC LNG.. The study used regression, correlational, and descriptive statistics to analyse the proposed conceptual framework where after regression, Advanced Robotics significantly predicted OPE, $F(1, 251) = 590.627$, $p < 0.001$, which indicates that AR can plays a significant role in shaping OPE ($b = 0.821$, $p < 0.001$) hence HI supported. Autonomous under Water Vehicles significantly predicted OPE, $F(1, 251) = 761.505$, $p < 0.001$, which indicates that AU can play a significant role in shaping OPE ($b = 0.867$, $p < 0.001$). Artificial intelligence in the same way significantly predicted OPE, $F(1, 251) = 1564.411$, $p < 0.001$, which indicates that AI can play a significant role in shaping OPE ($b = 0.955$, $p < 0.001$) yet 3-D Scanning Technology significantly predicted OPE, $F(1, 251) = 761.505$, $p < 0.001$, which indicates that 3D-Scanning can play a significant role in shaping OPE ($b = 1.005$, $p < 0.001$). Adopting advanced robotics, autonomous under water vehicles, artificial intelligence and 3-D scanning technology higly influence the operation efficiency of an organization. This study thus checks policy implementation on technological adoption, introduces cost-efficient ways for production and prepares the oil and gas companies to be more flexible and adaptable to changes in the environment. Future scholars have also found this study as baseline for their research.

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# INOVASI TEKNOLOGI DAN KESANNYA TERHADAP KECEKAPAN OPERASI SEKTOR MINYAK DAN GAS DI EMIRIAT ARAB BERSATU

## ABSTRAK

Kajian ini bertujuan untuk mengkaji inovasi teknologi dan kesannya terhadap kecekapan operasi Sektor Minyak dan Gas di Emiriah Arab Bersatu. Reka bentuk penyelidikan kausal diaplikasikan melalui metodologi penyelidikan kuantitatif dengan menggunakan tinjauan atas talian yang ditadbir sendiri untuk pengumpulan data. Teknik persampelan bertujuan memilih 253 responden daripada 5 kumpulan ADNOC dan anak syarikatnya iaitu ADNOC Onshore, ADNOC Offshore, ADNOC Drilling, ADNOC Sour Gas dan ADNOC LNG. Kajian ini menggunakan statistik regresi, korelasi, dan deskriptif untuk menganalisis rangka konseptual yang dicadangkan di mana selepas regresi, Robotik Lanjutan secara signifikan meramalkan OPE, $F (1, 251) = 590.627$, $p < 0.001$, menunjukkan bahawa AR dapat memainkan peranan penting dalam membentuk OPE ($b = 0.821$, $p < 0.001$), oleh itu HI disokong. Kenderaan Autonomi Bawah Air secara signifikan meramalkan OPE, $F (1, 251) = 761.505$, $p < 0.001$, yang mengindikasikan bahawa AU boleh berperanan penting dalam membentuk OPE ($b = 0.867$, $p < 0.001$). Kecerdasan Buatan (AI) dengan cara yang sama secara signifikan meramalkan OPE, $F (1, 251) = 1564.411$, $p < 0.001$, yang mengindikasikan bahwa AI dapat memainkan peranan penting dalam membentuk OPE ($b = 0.955$, $p < 0.001$). Sementara itu, Teknologi Pemindaian 3-D secara signifikan meramalkan OPE, $F (1, 251) = 761.505$, $p < 0.001$, yang mengindikasikan bahwa Pemindaian 3D dapat memainkan peranan penting dalam membentuk OPE ($b = 1.005$, $p < 0.001$). Penggunaan robotik lanjutan, kenderaan autonomi bawah air, kecerdasan buatan, dan teknologi pemindaian 3D secara signifikan mempengaruhi kecekapan operasi sebuah organisasi. Kajian ini bertujuan untuk memeriksa pelaksanaan dasar ke atas penerimagunaan teknologi, memperkenalkan kaedah pengeluaran yang kos-eficien, dan menyediakan syarikat-syarikat minyak dan gas untuk menjadi lebih fleksibel dan mudah menyesuaikan diri dengan perubahan dalam persekitaran. Penyelidik-penyelidik masa depan juga menganggap kajian ini sebagai asas rujukan penyelidikan mereka.

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| AD | After Christ |
| ADCOP | Abu Dhabi oil is called Abu Dhabi Crude Oil Pipe Line |
| ADNOC | Abu Dhabi National Oil Company |
| AI | Artificial Intelligence |
| AUVs | Autonomous underwater vehicles |
| BC | Before Christ |
| GASCO | Gas Industries Limited |
| GDP | Gross Domestic Product |
| IoT | Information Technology |
| KNOC | Korea National Oil Corporation |
| LPG | Liquefied Petroleum Gas |
| OPEC | Organization of Petroleum Exporting Countries |
| UAE | United Arab Emirates |
| VLGCs | Very Large Gas Carriers |

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# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

Technonolgical innovation is a bedrock of the oil and gas sector, whereby any amount of work less than 10% of the operators' time devotes the remaining 90% to creating next level workflow (Aviles, 2020). Responding to technological shifts has been thus a global trend (Wong, 2021), to the extent that various innovative technologies are available today in the oil and gas industry to improve exploration, production, safety and monitoring of the systems in the gas and oil production process (Medal, 2020). That way, ADNOC is very interested in adopting and implementing the latest innovative technologies that can help in achieving operation efficiency through making ADNOC one of the lowest cost producers of oil and lowest carbon emitters (ADNOC, 2019).

Through the UAE government strategy, there has been campaign for the widespread in the adoption of innovative technologies in the gas and oil sector of the UAE (Hana, 2022). The oil and gas sector has provided a climate that supports

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innovation aimed at achieving production excellency and efficiency in the sector (Al Mazouqi, 2019). Different innovative technologies like robotics, autonomous underwater vehicles, Artificial intelligence (AI), 3-D scanning technology, Internet of Things (IoT) and advanced robotics have been adopted in the various parts of the oil and gas sector for various operational reasons (Medal, 2018). Consequently, technology has drastically improved and accelerated the efficiency of business operations with the ultimate potential to boost business, hence companies looking forward to stay ahead of the curve should embrace technological innovation (Fiddle, 2023). Business leaders should identify their organization's specific challenges and goals so that they can ensure choice of proper tools to offer real value and contribute to organization's success.This research focused at examining the technological innovation and its effect on Operation Efficiency of the Oil and Gas Sector of the United Arab Emirates. Chapter one thus gave the introduction, research background, problem statement, research objectives and hypothesis. It also presented the conceptual framework, definition of terms and significance of the research.

## 1.2 Background of the Research

The Abu Dhabi National Oil Company (ADNOC) Drilling was created by virtue of an Emiri Decree in 1972 and started out known as the National Drilling Company (NDC) established in 1973 as the first UAE government-owned company specialized in the national and international marketing and distribution of petroleum products, ADNOC Distribution is now one of the region's largest and most innovative petroleum companies. It was the first subsidiary of the Abu Dhabi National Oil Company

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(ADNOC) with a mission to drill wells helping ADNOC unlock the UAE's vast reserves of oil and gas for the benefit of the nation. Being the main producer of oil and gas products in Abu Dhabi, ADNOC has gained great capacity to produce nearly 4 million barrels of oil, 11 billion cubic feet of raw gas and more than 1 billion cubic feet of sour gas every day, thus ranking the biggest oil and gas producers in the world (Ugal, 2022).

The UAE oil and gas sector contributes by 30% in the GDP of the UAE. Oil and gas is regarded to be the main source of income in the emirate of Abu Dhabi. The UAE is considered to be main exporter of crude oil. In 2016, the UAE exported over 2.5 million barrels per day. The Asian market is considered to be the main market for UAE oil and gas products. The UAE exports nearly 96% of its oil and gas products to varied countries in Asia. The UAE has well developed oil pipelines network in order to facilitate the exportation and the supply of its oil and gas into the international market. The four main UAE refineries are found in Ruwais, Jebel Ali, Umm Al Nar and Fujairah. Ruwais refinery is the biggest with a capacity of refining 817,000 barrels every day. There is also a plan developed by the UAE government for expanding the capacity of Fujairah refinery to reach 200,000 barrel every day (Nechully &Thomas, 2020).

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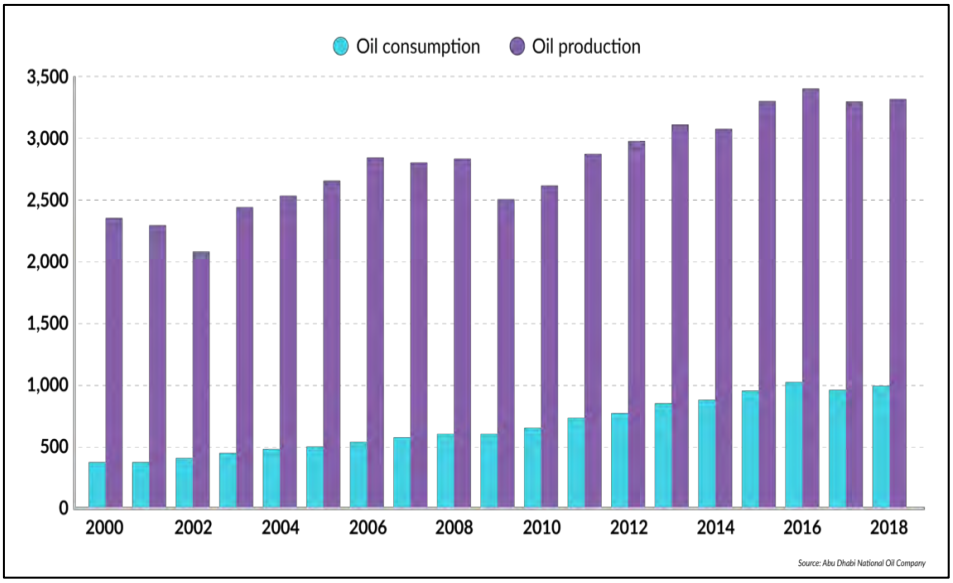


*Figure 1.1.* UAE Oil production and Consumption Nakhle (2019)

ADNOC serves a category of customers where residential takes the largest percentage, commercial and industrial spaces where demand for natural gas services and solutions are increasing for instance the company serves hotels, malls, hospitals and restaurants that use natural gas for cooking, heating and catering (ADNOC, 2022). ADNOC has got 16 subsidiary companies for instance ADNOC Onshore, ADNOC Offshore, ADNOC Refining, ADNOC Industrial Gas, Abu Dhabi Crude Oil Pipeline LLC (ADCOP), Fertiglobe, Abu Dhabi Polymers Company (Borouge), ADNOC Gas Processing, ADNOC Drilling, ADNOC Sour Gas, Al Yasat Petroleum, ADNOC LNG, Al Dhafra Petroleum, ADNOC Logistics & Services and ADNOC Distribution (ADNOC, 2021). The firm has made quite a name for itself in the identified realm, mostly due to the innovative approach toward enhancing the productivity, all operations are guided by the focus to empower lives in Abu Dhabi and overseas, its missions and teamwork (ADNOC Distribution, 2019).

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As such, ADNOC seeks to offer the best services and products to its customers (Austria, Germany, Japan) it has recently launched a global competition to find innovations that will reshape global energy land scape however it's challenged by the decarbonization technology (UAE News, 2023). Abu Dhabi National Oil Company (ADNOC) has agreed to acquire a 30% stake in the TotalEnergies-operated Absheron gas and condensate field in the Caspian Sea, for an undisclosed fee.Upon completion of the transaction, ADNOC will own a 30% stake in Absheron, with SOCAR and TotalEnergies holding 35% stakes respectively. The offshore field is located around 100 km south-east of Baku.Musabbeh Al Kaabi. ADNOC is ensuring it retains a competitive edge in this new environment. This means we are improving operational efficiency, optimising resources and adapting the mindset of our people to focus on our strategic objectives and on maintaining our competitive edge.

The growing environmental and social pressures are pushing for the adoption of innovative technologies in the operations of the oil and gas industry (Radnejad, Vredenburg &Woiceshyn, 2017). These creates a need to study the ways in which technological innovations effect on the operations of the oil and gas industry and whether efficiency on the operations can achieved through the use of innovative technologies. As the use of the natural gas is increasing in the UAE, the UAE government is strategizing to adopt the latest innovative technologies in the production of natural gas in order to decrease the associated costs and to increase the productivity as well as to ensure high efficiency in the operation of producing gas. The UAE has implemented varied projects that involve Onshore Gas Development, Integrated Gas development and Offshore Associated Gas in order to produce more

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natural gas to meet the increasing domestic needs. In 2015, Abu Dhabi government implemented Shah Gas project that was used for producing 504 million cubic feet per day of natural gas and 50,000 b/d of natural gas liquids from 1 Bcf of gross production (Nechully & Thomas, 2020).

New technologies have been introduced in order to sustain oil and gas companies in running and managing their business activities. One of the developed innovation technologies to be used in oil and gas industry is the artificial intelligence and machine learning. It is used to learn from current available data, monitoring and forecasting performance for equipment and process outcomes in the oil and gas company. The artificial intelligence and machine learning is also used for eliminating the repetition of tasks such as the repetition of ordering new materials for supply replenishment, and the repetition of scheduling maintenance (Baaklini, 2020).

Another developed innovation technology to be used in oil and gas industry is the internet of things (IoT) to connect end-to-end field processes which drive notifications in the oil and gas companyor for monitoring oil fields remotely through providing real-time data (Baaklini, 2020). A further developed innovation technology to be used in oil and gas industry is the advanced analytics. It is used for analyzing all types of oil and gas data in order to improve decision making, transparency and field productivity. It is also used for empowering users through providing them with real time feedback on equipment performance (ADNOC, 2020).

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Moreover, robotic process automation is considered to be innovation technology to be used in oil and gas industry. It can be used for carrying specific varied tasks such as processing of supply replenishment orders, sending reminders to renew certifications, producing daily reports (Baaklini, 2020). The innovative technologies that are adopted and implemented in ADNOC are advanced robotics, autonomous underwater vehicles, Artificial intelligence (AI), and 3-D scanning technology. They are adopted recently. The advanced robotics was adopted and implemented in 2015. The autonomous underwater vehicles were adopted and implemented in 2014. The artificial intelligence (AI) was adopted and implemented in 2017. The 3-D scanning technology was adopted and implemented in 2013.

The advanced robotics, autonomous underwater vehicles, Artificial intelligence (AI), and 3-D scanning technology are chosen to be the independent variables because they are the sole innovative technologies that are adopted and implemented at ADNOC. Operation efficiency is the ability of an organization to reduce waste in time, effort and materials as much as possible, while still producing a high-quality service or product or the degree to which an organization can deliver its goods and services with minimal waste (Bahvana, 2022).

## 1.3 Problem Statement

Technological innovation as a concept is becoming a common field of interest for different scholars and sectors with the aim increasing operational efficiency (Fiddle, 2023). Unfortunately very few oil & gas companies are ready to change ways they

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operate (CISCO, 2022) yet operational efficiency stands crucial in organisational management where all operations management that influence the success, survival and efficiency are based (Vinodkumar, (2019). Just like in the past decades where over 50 years passed for a technology like hydraulic fracturing to get accepted in Oil & Gas (Developed by Halliburton in 1940s). Energy companies all over the world have been hesitant to adopt innovative technologies due to the fear of jeopardizing their critical infrastructure (Barghout, 2019).

Even though UAE enjoys the fourth-lowest cost of production in the world at $12.30/bl, after Iraq ($10.50), Kuwait ($8.50) and Saudi Arabia ($9.90) (Rystad Energy) (Nakhle, 2019). About 95% of the country's potable water comes from plants built in the 1970s and 1980s, meaning that the Oil & Gas industry for instance ADNOC is still slow at adopting new technologies to the extent that contractors of oil and gas companies are failing to meet time and costs for the activities of exploration and drilling (Mesh, 2021). Worst of all, the Energy Innovation Index has fallen from 3.1 in 2006 to 2.0 in 2015 and the proceeding years. Five year compounded annual growth rate for Oil and Gas patents was 1.3 compared to 5.7% for the overall patent universe. (Slaughter and England, 2020). Consequently, Oil and Gas industry lags behind other industries in technology and data use (Gross, 2019) & (Judah, 2022).

There are more other obstacles like, complex compliance and regulatory regimes, projects that involve multiple third party suppliers, and a workforce that has widely varying education and skill levels (Wyatt, 2021). Lack of efficient equipment used in exploring and producing oil leads to varied issues of increasing the cost of

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the production, poor quality, reduced revenue from oil and gas companies, as well wasting the time and the resources of oil and gas companies. Oil and gas industry is further exposed to price fluctuations due to the challenges found in the external business environmental yet the price of oil is not only highly linked to the demand and the supply but also it is linked to other global socioeconomic factors (Bigliani, 2020). Hence collapsing oil prices has put high pressure on not only the UAE but also all oil producer countries in the past few decades. The 2008 global financial crisis and the drop in the oil prices have affected negatively on the production and the sales of oil and gas products (Gross & Abdel Ghafar, 2019). As the UAE oil and gas market is expected to register a CAGR of more than 2% during the forecast period of 2022-2027. The low oil prices during the COVID-19 pandemic resulted in a cut down of the nation's 2021 budget by 5.3%, as compared to 2020 (Nechully, 2018). The nation has also cut down the oil production 2020 due to low crude prices and low demand for petroleum products (Ahmed, 2020). However, the market is expected to recover in 2022, owing to factors like increasing investment in the upstream sector coupled with supportive government policies.

Much as UAE launched a mega project worth USD 45 billion in 2018 to increase its refining capacities in the existing refineries, and in 2021, Mubadala Investment Company, ADNOC, Abu Dhabi Holdinfg (ADQ), and the Ministry of Energy and Infrastructure (MoEI) announced the Hydrogen Alliance to pursue producing blue and green hydrogen for export. ADNOC still face difficulty in upstream crude production due to lack of unconventional oil and gas production, resulting into only 17.7% of global gas produced by Middle East countries, which illustrates underutilized gas production when 40% of gas reserves reside in the

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Middle East (Raid, 2023). Rising global demand, highly volatile prices and increasingly stringent environmental regulations. Technological innovations presents challenges like initial investment costs, integration with existing systems, workforce skills and training, data security and privacy, environmental and safety concerns, change management and culture shifts, vendor selection and collaboration but these have not been carefully addressed for successful integration (ADNOC, 2023), all the above can effectively be addressed by the adoption of technologicval innovation.

The effect of technological innovation on the firm's productivity is heterogeneous, increasing the effect on bigger firms because once investment in technological activities increases by 1%, then the labor productivity increases by 0.22% (Berru, Aldana & Huanca, 2020). Bahvana (2022) previously viewed Operations efficiency as an organization's capacity to reduce wastage in time, effort and material while in producing quality services, it's role should be credited for the current investigation. Therefore, the adoption of new technological innovations like advanced robotics, autonomous underwater vehicles (AUVs), artificial intelligence (AI), and 3-D scanning technology in the oil and gas sector, particularly in ADNOC (Abu Dhabi National Oil Company) in the UAE, can indeed bring significant improvements in operational efficiency.

It hypothesizes that the adoption of technological innovation of advanced robotics, autonomous underwater vehicles, artificial intelligence and 3-Dscanning positively affect operatuion efficiency (where AI in oil and gas market is expected to register a CAGR of 10.81%, AR a CAGR of 11.11%, AU a CAGR of 15.22% and

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3-Dscanning 10% during the forecast period of 2022 to 2027) (Nakhle, 2019). Hence making it necessary to conduct this study in order to examine the effect of adopting innovative technologies (advanced robotics, autonomous underwater vehicles, Artificial intelligence (AI), and 3-D scanning technology on the operation efficiency at UAE oil and gas companies. The implementation of innovative technologies is expected to provide most cost efficient ways for gas and oil companies to carry out the various activities of exploration, drilling, production and processing of oil and gas products. The implementation of innovative technologies would also sustain in preparing the oil and gas companies to be more flexible and adaptable to changes in the environment (Al Marzouqi, 2019).

Much as compounded literature claim that there was a 1.3 % annual growth rate for Oil and Gas copyrights compared to the global 5.7%. (Slaughter, 2017). The UAE Oil and Gas industry still lagged behind other technological industries in terms of data usage and technology (Gross, 2017), meaning that literature still presents no pill to the high cost of entry, failure and complexity in quantifying results which retard technological adoption in the industry (2017). Having lower quality data negatively affects productivity due to the fact that it increases processing time, revenues reduction, and high costly errors, reduce end-product quality, results into confusion and accelerates workloads, opportunity loss and fines (Aljumaili, 2016).

Scholars like Datta & Roy (2019), Arntzen, B., Brown, G. G., Harrison, T. P., & Trafton, L. L. (1995). Teece, (2018), Umar (2019), Zhou, Xiong, Wang & Zhang (2020), Wong, Yang, Yan, & Gu (2018) have not given attention to the currently studied context, thus not solving issues arising from competitive advantage,

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data limitation and gaps in adoptive environments. Instead, some focused on defining concepts and discussing effect of technologies on performance and how digital technologies, standards, and licensing models affect innovation and profitability in the digital economy. Therefore, this study explores how adopting technology can influence operation efficiency in ADNOC.

Wyatt (2018) noted Oil and Gas obstacles such as multiple third party suppliers, regulatory regimes, fluctuating demand, complex compliance, gaps in education skills and volatile market prices but never provided a corresponding solution to such business threatening factors. Also the outdated equipment without control logics, operational procedures/manuals and other relevant documents are up to now not fully attended to (Barghout, 2017).

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Forecast into technological innovation impacts is given by many researchers for example, Makridakis (2017), Grace et al. (2018), Behera (2022), Chui et al. (2016) and Osborne (2017) that automation will eliminate 47% of jobs in the United States economy by 2033, advanced materials will enhance tool's longevity and durability yet 60% of jobs could become 30% automated by the early 2020s. Researchers also predict that there will be outperformance of human activity by AI-Artificial intelligence although combining robotics with Artificial intelligence potentially results into great transformation production.

Bara (2019), Verbruggen (2019) processes are well-documented as a common playbook that the organization can refer back to in carrying out the varied efficient tasks and processes within the organization but fail to clarify ways of ensuring Total

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quality management (TQM) in various business aspects. Additionally, only Matthew & Marzec (2017) highlighted the relevance of techniques and policies in operations but dominant researcher forget to check policy gaps in operations and innovations. All this therefore persuade the researcher to consider examining the impact of technological innovation adoption on operation efficiency of the Oil and gas sector in UAE"

## 1.4 Purpose of the Study

The research aimed at examining the the Technological Innovation and its effect on Operation Efficiency of the Oil and Gas Sector of the United Arab Emirates. The research project explored dimensions of technologies for instance; advanced robotics, autonomous underwater vehicles, Artificial intelligence (AI), and 3-D scanning technology and their effect on operation efficiency in UAE oil and gas companies.

## 1.5 Objectives of the study

**RO1:** To examine the the Technological Innovation and its effect on Operation Efficiency of the Oil and Gas Sector of the United Arab Emirates

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**Specific Objectives**

The specific objectives of the study are:

**RO1a:** To examine the effect of advanced robotics on operation efficiency in the Oil and Gas sector, UAE.

**RO1b:** To assess the effect of autonomous under water vehicles on on operation efficiency in the Oil and Gas sector, UAE.

**RO1c:** To examine the effect of artificial intelligence operation efficiency in the Oil and Gas sector, UAE.

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**RO1d:** To examine the effect of 3-D scanning technology on operation efficiency in the Oil and Gas sector, UAE.

## 1.6 Research Questions

1. Does technological innovation affect operation efficiency in the Oil and Gas sector, UAE?

   **1a:** Does the adoption of advanced robotics affect operations efficiency in the Oil and Gas sector, UAE?

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**1b**: Does the adoption of autonomous under water vehicles significantly affect operation efficiency in the Oil and Gas sector, UAE?

**1c**: Does the adoption of artificial intelligence affect operation efficiency in the Oil and Gas sector, UAE?

**1d** : Does the adoption of 3-D scanning technology affect operations efficiency in the Oil and Gas sector, UAE?

## 1.7 Research Hypotheses

Some important hypotheses were developed basing on the results of previous studies in order to identify the forecasted relationships between the study variables. The research hypotheses were developed to highlight the forecasted relationships of the independent and dependent variables of the study as given below.

**H1:** Adopting Technological innovation affects operation efficiency in the Oil and Gas sector, UAE.

**H1a:** Adopting Advanced Robotics significantly affect operation efficiency in the oil and gas industry in the UAE.

**H1b:** Adopting Autonomous under Water Vehicles affects Operation efficiency in the oil and gas industry in the UAE.

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**H1c:** Adopting Artificial Intelligence (AI) significantly affect operation efficiency in the oil and gas industry in the UAE.

**H1d**: Adopting 3-D Scanning Technology significantly affects operation efficiency in the oil gas industry in the UAE.

## 1.8 Conceptual Framework of the Research

The conceptual framework gives an overview of how different variables (the independent (TIA) influence the dependent (OE) in this research. There is an assumed potential effect of technological innovation on operation efficiency (Fiddle, 2023), hence the conceptual framework in figure 1.1 below. Wang (2019) confirms a positive association between technological innovation and an organization's performance or efficiency and encouraged managers to focus on implementating technological innovations for the betterment of operation efficiency. Based on the proposed conceptual framework, the study focused on four independent variables (advanced robotics, autonomous underwater vehicles, Artificial intelligence (AI), and 3-D scanning technology). Although exisiting conceptual frameworks of the innovative diffusion theory embrace operation efficiency through components like quality, flexibility and task efficiency.

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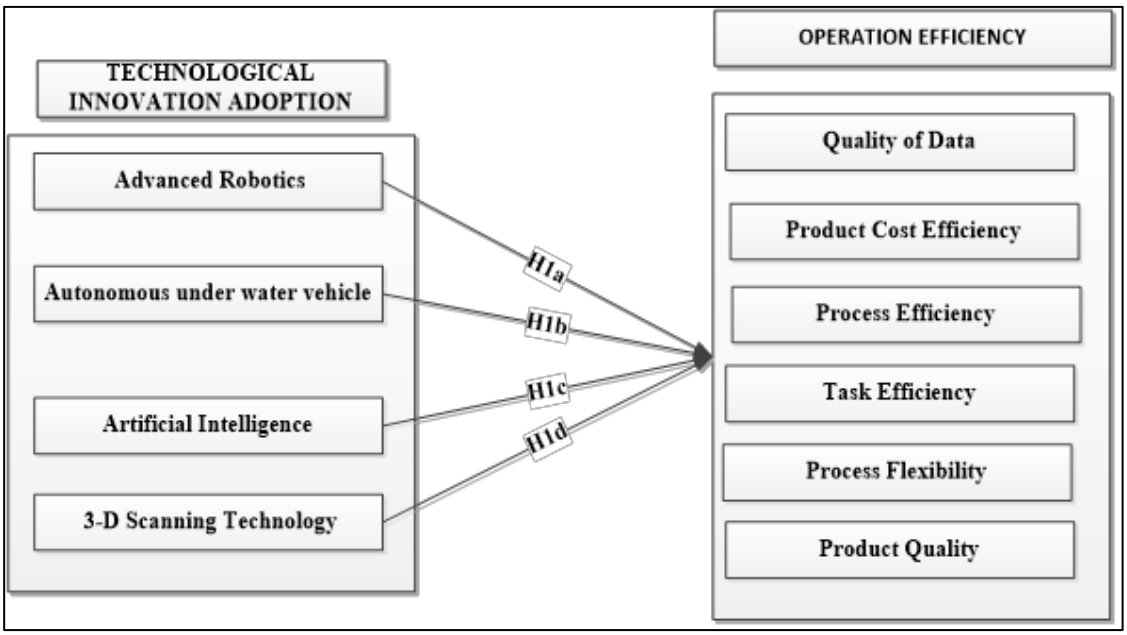


*Figure 1.2.* Proposed Conceptual framework. Modified from: Santa (2014), Fiddle (2023)& Islam (2017)

The independent and the dependent variables of the study were developed based on studying previous researches and reviewing the literature. For instance the Innovation Diffusion theory which defines the process of collective adoption over time (Straub, 2019) or the processes of developing and adopting the spread of a new idea over time (Straub, 2019). Considering the fact that interaction of diffusion factors (the process of innovation; communication channels, social system and time) helps in the adoption and the acceptance of innovation , various authors like Calzon (2023) and Fiddle (2023) have tried to reflect on resource utilization, customer service, operating profit margin/financial efficiency) as achieved operation efficiency. However the current literature looked at quality of data, product cost efficiency, process efficiency, task efficiency, process flexibility and product quality as qualities of operation efficiency. The relationships between the independent variables and the dependent variables (Operation efficiency) were examined in order to know about the extent to which the independent variables of adopting

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technological innovations effect on the operation efficiency at UAE oil and gas companies.

## 1.9 Operational Definitions

The study as from the conceptual framework will focus on a few variables in order to achieve the testing of its objectives. The main variables; the independent and the dependent variables have been operationally defined below:

**Technological Innovations:** are focused on as the independent variables in the study and are viewed as the new products, processes and changes in processes and technologies that the UAE oil sector can adopt and incorporate it in the sector's operations (Xiao & Jinxia, 2022).

**Advanced robotics:** they refer to the automated technological devices or machineries that are used in the exploration, drilling, operation and production of oil and gas. Advanced robotics are most likely to be used in the production of oil and gas from wells (Soliman, Osama & Sarah, 2021).

**Autonomous underwater vehicles (AUVs)**: are unmanned, self-propelled vehicles that are programmed to be used in oil and gas exploration. It is used for surveying the construction of oil and natural gas pipelines, scanning sea floor and collecting data before precede the construction of oil and natural gas pipelines in order to take the best decisions of where to install gas and oil pipelines (Xhang, Song, Yue & Chen, 2019).

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**Artificial intelligence (AI)**: there are two main applications of AI that are used in oil and gas industry. They are AI machine learning and AI data science. AI machine learning is automated machine that is used for collecting and interpreting data without human input. AI machine learning also refines the process through iterations to produce programs that can allow oil and gas companies to monitor complex internal operations and respond quickly to changes (Waqar, Idris, Shafiq & Mansoor, 2023). AI data science is concerned with generating information from the available data through linking related pieces of data together and form more comprehensive pictures from existing information to be used in offshore oil and gas companies for discovering new oil exploration chances and to make use of the current related pieces of data together and form more comprehensive pictures from existing information (Randolph & McBride, 2019).

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**3D scanning technology**: it is a terrestrial-based data acquisition system that is used for capturing high-density 3D geospatial data from large-scale. It can sustain oil and gas companies in improving safety, decreasing follow-up visits and maintenance on site, and providing flexibility for future brownfield modifications. It can also provide physical data such as quantity surveys, asset documentation, condition monitoring, tank calibration, maintenance support, and intelligent plant modelling for asset management activities (Wan & Sun, 2022).

**Operation efficiency:** it refers to the process of decreasing costs and cycle time, increasing productivity of the production process, and improving quality and customer service (Harper, 2023) & (Gills 2023). This study will look at operational efficiency as the ability of the company to eliminate inefficiencies and pursuing the

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best business practices. Because, management works toward achieving company objectives (maximizing output from available resources, decreasing the cost and increasing the profits) resulting into increased quality levels of operations.

**Quality of data:** this refers to the accuracy, comprehensiveness, consistency, and completeness of the data provided by the information system or the software system of the developed technological device.

**Process efficiency:** this was defined as the extent to which the use or the implementation of new technological device participates in the reduction of the operational costs and the decrease of the input/output conversion ratio.

**Product cost efficiency:** This was defined efficiency in the costs with which the firm produces its products. In other words, it refers to the ability of the firm to produce more efficient products with the lowest costs while maintaining adequate levels of quality.

**Task efficiency:** this refered to the existence of more efficient internal business processes due to the efficient tasks and activities being done. It also refers to the ability of the firm to carry out its various tasks more efficiently and effectively without wasting time, efforts and costs.

**Process flexibility:** this meant the extent to which the use or the implementation of new technological device can provide the firm with more flexibility in response to changing business environments through providing new better ways of carrying out the business processes and in becoming more agile.

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**Quality of operation:** this will mean ensuring customer delight and achieving competitiveness at the strategic level. It is necessary to build effective relationships between quality of operation and the needs of the business in order to make sure that quality operation lead to organizational success (Islam, 2020).

## 1.10 Chapter Summary

This chapter concludes in that the ways of doing business globally are changing through the adoption digital platforms and approaches in the management of resources and processes. The adoption of innovative technologies effects on the efficiency of the operations of a business. There is need to explore the available innovative technologies, their effect on the efficiency of the operations in the UAE's oil sector. The oil and gas sector of UAE is faced with challenges of meeting the economic requirements of the country through the production of oil and the need to respond to external threats of global financial crises and the fluctuations of the oil prices. The oil and gas companies have also to respond to the internal threats of increasing costs of operations and productions, maintaining worker safety, having more efficient machines and equipments for carrying out effective explorations and the monitoring of the operations of the oil and gas sector. These can be achieved through adopting innovative technologies in the oil and gas sector's operations. This research will explore the available technologies that the UAE's oil and gas sector adopt and they effect on the efficiency of the sector's operations. The relationships between adopting and implementing the technological innovations from advanced robotics, autonomous underwater vehicles, Artificial intelligence (AI), and 3-D scanning technology and their effects on the operation efficiency at UAE oil and gas companies are going to

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investigated and evaluated. The adoption of innovative technologies in the oil and gas industry and their effects on efficiency operations will be measured through evaluating the effect of innovative technologies on each element or variable of efficiency operations that include quality of data, process efficiency, product cost efficiency, task efficiency, process flexibility, and quality of operations. The operations management theory as well as the innovation diffusion theory is used as the main basis of understanding relationship between the technological innovations and achievement of operational efficiency in the UAE's oil and gas sector operations. The small size of the population of the study and questioning only managers from ADNOC and its subsidiaries form the main limitations of the study. This study is of great importance since it aims to introduce oil and gas companies to the best cost efficient innovative machines and ways that can help in increasing the operation efficiency and decreasing the costs of production while maintaining high quality of exploration, processing and production of oil products. This research will introduce oil and gas managements to the innovative technologies that would help in increasing the operation efficiency and reducing the costs of production so that oil and gas companies can become more profitable and less influenced by the external threats and the reduction of the global oil prices.

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