The role of Artificial Intelligence in Transforming the Operations of the Abu Dhabi National Oil Company

By

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ABSTRACT

The research sought to understand the impact of Artificial Intelligence (AI) on the operations of Abu Dhabi National Oil Company (ADNOC). Utilising qualitative data from a sample of 15 participants, semi-structured interviews were conducted, and responses were thematically analysed using the probe technique to provide holistic insights. The main findings of the study revealed the transformative journey faced by ADNOC in adopting and integrating AI into its traditional operations related to oil and gas. AI emerged as an important tool that substantially altered the operational domain of ADNOC; the influence was far-reaching beyond the advantages related to the efficiency of the functions and processes. The analysis of the participants' responses revealed that AI's influence extends across multiple domains of operations; it has revolutionised overall practices in oil and gas fields. This includes production planning, reservoir management, maintenance of oil and gas fields, asset management and exploration of oil and gas operations. Moving beyond just the impacts of AI in multiple areas of oil and gas operations, the key findings also reveal the motivating factors that are behind the adoption and integration of AI into existing processes. The study also shows that the main hurdles and negative aspects hindering the adoption of AI include such as compliance issues, cybersecurity threats, legacy systems, concerns about data quality, scalability, change management and cost implications. The research findings offer valuable insights into the transformative journey, challenges, motivating factors, and implications associated with incorporating AI into traditional operations. The key findings established the ways in which AI dramatically changed operations, including production planning, reservoir management, asset maintenance, and oil exploration. Theoretical contribution is towards enhancing the knowledge of how AI facilitates the agility of organisations in complex sectors. In practice, the study presents a pathway for an organisation to guide through problems related to compliance, cybersecurity, and integration of legacy systems. The practical implications of the study offer a roadmap for organisations to navigate the complexities of adopting and integrating AI into their operations, drawing from the best practices and lessons learned from the journey of ADNOC.

TABLE OF CONTENTS

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LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

AI	Artificial Intelligence
UAE	United Arab Emirates
ADNOC	Abu Dhabi National Oil Company
OGA	Oil and Gas Authority
CAGR	Compound Annual Growth Rate
IoT	Internet of Things
ML	Machine Learning
FL	Fuzzy Logic
ANN	Artificial Neural Networks
RSM	Response Surface Model
UK	United Kingdom
OGI	Oil and Gas Industries
NLP	Natural Language Processing
RPA	Robotics Process Automation
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TTF	Task-Technology Fit
UTAUT	Unified Theory of Acceptance and Use of Technology
PU	Perceived Usefulness
PEU	Perceived Ease of Use
KPIs	Key Performance Indicators

CHAPTER 1: INTRODUCTION

1.1 Introduction

This thesis presents a qualitative research study into the impact of AI on the oil and gas business based on a single case study of 1 organisation in the United Arab Emirates (UAE). The purpose of the study is discussed in this introduction Chapter, along with a summary of the thesis. The environment in which this study was done, and this research's background are presented at the beginning of the chapter. The purpose and goals of the study are then explained in further detail. The qualitative research methodologies that were employed in this study are briefly described. The research significance is demonstrated by highlighting the potential contribution of the study to knowledge, theory, and practice. Finally, a summary of the study's methodology is given. The overall organisation followed to report research findings and outcomes is also presented in this chapter. The chapter is completed with a summary to reflect the overall purpose and implications of the research outcomes.

1.2 Research Background

This section provides a background into the idea of AI and its impactful contribution in any industry. AI is playing a particularly crucial role in operational efficiency and data-driven decision-making, especially in the oil and gas sector, which remains traditional and resource-intensive (Lu et al., 2019). The global scenario for AI has already entered mature stages in finance and manufacturing sector (Charalambous et al., 2019); however, the integration of AI into state-owned oil and gas giants, such as ADNOC, remains in nascent and relatively obscure stages (Koroteev and Tekic, 2021). ADNOC is uniquely challenging in regional geopolitical dynamics and legacy infrastructure all of which form a set of barriers for adopting the cutting-edge AI solutions (ADNOC, 2020). In the backdrop of the UAE's ambitions to be the world's leader in AI by 2031, this study provides deep insights into how AI is transforming the operations of ADNOC and presents a case of actionability that is replicable in the transition challenges faced by complex organisations in the region and across the world.

1.2.1 Background Information on AI

AI had its origin in the year 1950 when Alan Turing published his article entitled "Computing Machinery and Intelligence," in which he refers to the possibility that a machine can imitate the

behaviour of people's minds, which proposes the Turing test; a test aimed at defining whether or not a machine is intelligent (Turing, 2012). In 1984 the first publication of applied AI was made; from this date, participation became increasingly active. A range of research works defined the essential feature of AI. There are various techniques used in AI, among which expert systems, neural networks, fuzzy logic, knowledge-based systems, and intelligent agents stand out (Kadhim, Alam, and Kaur, 2016; Ul Amin, Aijun, and Ali, 2015.; Tadeusiewicz, 2018; Robert, 2014).

Krishnamoorthy and Rajeev (2018) established AI techniques. They put forward that a large part of the research effort has been oriented to developing tools based on expert systems and artificial neural networks that demonstrate a unique capacity for adaptation to the particularities of a problem. However, it was in 2016 that the use of AI techniques increased, especially by large technology companies such as Google and Microsoft Corporation (Castro and New, 2016).

According to Gunning (2017), AI is attributed to simulations in machines that are developed to act similarly to human intelligence processes and imitate humans' actions and ideas effectively and systematically to generate efficient results. Wenger (2014) proclaimed that these simulations and machine-based processes include acquiring information, reasoning and perception, and concluding results. It has been evident that intelligent systems and advanced technology take over increasing tasks based on human decision-making. On the other hand, professionals have been utilising advanced technology to make improvements in decisions and add value to the overall business and investment decisions which is the ultimate goal of the profession (Duan, Edwards, and Dwivedi, 2019). AI, blockchain, and cloud computing, according to Dirican (2015), have a direct influence on business methods and operations. Dwivedi *et al.* (2021) summarised the AI process in business and put forward that data is collected and analysed using AI; blockchain assures data security, and cloud computing allows data to be exchanged. As a result, future experts should be involved in developing data transport, processing, and analysis technologies (Wenger, 2014).

In the age of AI, the manufacturing and production industry is constantly changing, and manufacturing and production will inevitably follow the trend of the times. According to AlSheibani, Cheung, and Messom (2018), professionals must move ideologically with the times, continually learning and welcoming the arrival of the AI era with a positive attitude. Advanced technology and innovative processes are crucial today (Wright *et al.*, 2019). It has been evident that

intelligent systems and advanced technology take over increasing tasks based on human decision-making (Tkachenko, Kuzior, and Kwilinski, 2019). Consequently, AI is changing the manufacturing, production, and service industries as automation and big data are already influencing how organisations offer products and services to customers (Li *et al.,* 2019).

1.2.2 Artificial Intelligence and Global Industries

AI has become a critical aspect of 'lives in all domains, and many industries have incorporated AI to run their operations successfully. The role of AI is not hidden in the oil and gas industry; the sector has been using this technology in different areas of its field, such as field operations. The oil and gas industry has been one of the key beneficiaries of innovations in the AI industry. Several research studies have found that in response to AI technological advancements, many oil companies around the world are forming partnerships with prominent and emerging technology companies to explore ways to benefit from and expand their use in the future, while others have already begun to work with AI systems on a large scale (Min *et al*. 2020; Balaji *et al*. 2018; Lu *et al.* 2019). AI is being used by the Oil and Gas Authority (OGA) in various ways to help them find new oil and gas forecasts and increase output from current facilities (Ben-Naceur, 2019). The offshore oil and gas industries employ AI and data science to simplify access to the complex data required for oil and gas exploration and production (Li *et al.,* 2019). This enables businesses to find new exploration opportunities and improve the use of current infrastructures. Although it may be true that AI has benefits for many industries, the oil and gas sector may stand to gain the most. Oil and gas production is among the most profitable and risky businesses. The use of AI improves productivity, security, and business processes. According to Hall, and Pesenti (2017), the spread of AI will improve the operational efficiency of all operations in the future, resulting in considerable economic savings estimated in the billions of dollars. Moreover, according to the study of Di Vaio *et al*. (2020), AI-based technologies can be used for personalisation within a business organisation, which is a driving factor for the adoption of AI. From this perspective, Helo and Hao (2022) believed that AI has reshaped business organisations by enabling them to personalise their content, message, services and products. Companies are creating customercentric products and services by utilising advanced tools like AI, which enables them to maximise their profit. in addition, Sterne (2017) mentioned that AI-based technologies have enabled organisations to reach the target audience and understand their behaviour, these technologies have enabled organisations to understand the

specific group of customer demand for a specific product instead of a broader category, based on such analysis personalised product and services are generated that create values for the organisation. Thus, companies can save money through the timely detection of explosive sites and improve them before any major damage to the company.

AI is considered in manufacturing operations due to its vital role. The use of AI in manufacturing operations results from the fourth revolution in manufacturing operations (Park, 2018). Mao *et al.* (2019) reflected on using AI in manufacturing operations and found that AI has enabled the industry to improve business efficiency and generate value. Charalambous *et al.* (2019) also accepted that AI in manufacturing operations is a game-changer for the industry as it has decreased forecasting errors, errors of the demand planners, accurate sales estimation, and other benefits like business automation. AI is a widely accepted technology acting as a game-changer for many industries due to its revolutionary benefits (Park, 2018).

Chong (2018) claimed that AI is becoming one of the essential components in the education industry as it aids distance learning easier compared to traditional learning methods. Malik *et al.* (2021) stated that through the incorporation of AI in the service industry of Turkey, the decisions become streamlined, and the organisational operations become smooth, enhancing organisational efficiency. Balog (2020) argued that the revolutionary software of AI has made organisational operations more manageable compared to the traditional tasks that are now becoming an essential element in organisational operations in Kenya. Sarker *et al.* (2020) researched the banking sector. They proved that cyber security is among the significant threats to the service industry and that AI has secured the organisational information systems through cyber security, which is the selflearning and secure process for protecting the organisational information. Moreover, Eren (2021) researched the banking sector of Turkey and stated that the banking sector is widely using AI technology to provide 24/7 service to its customers through the Chatbot and also automated repetitive tasks with automation through the proper security protection thus resulting in the enhanced customer satisfaction and organisational efficiency (Malik *et al.,* 2021).

AI has also made data management easier for the banking sector, as manual data management is challenging to deal with the large data pool (Sarker *et al.,* 2020). This suggests that AI has increased organisational efficiency in the service and manufacturing industry and made organisational

processes smooth. To summarise, AI has supported the service industry to provide uninterrupted services by AI and facilitates organisations in the service and manufacturing industry to operate efficiently without the wastage of organisational resources. AI has revolutionised the service industry and devised a clear road map to progress using the latest technological trends (Xu *et al.*, 2018).

However, Jha *et al*. (2017) underlined that AI can be used in the oil and gas sector to effectively manage complex data in a simplified form that helps organisations to explore new opportunities for improving the state of the organisation. On the other hand, Lu (2019) underpinned that AI is a complicated tool that can create issues in the initial phase of implementation, organisations need to understand its various features and characteristics to effectively use it for organisational functions. Additionally, Dirican (2015) believed that a lack of understanding during the implementation of new technology can push businesses to undesirable outcomes for an organisation. in this perspective, Sabir (2015) elaborated that organisations should critically analyse the challenges and opportunities of technology before incorporating it within the organisational processes and practices, based on such analyse effective decisions can be taken regarding the adoption of new technology.

1.2.3. Artificial Intelligence and the UAE

Specialised international studies expect that the UAE's share of AI and digital economy investments will reach more than 31% or 100 billion dirhams of the Arab region and the Middle East, estimated to exceed 320 billion dirhams by 2030 (World Bank, 2022). Sircar *et al.* (2021) reported that AI has proven to be a cost-effective investment for the oil and gas industry. It is increasingly being used to improve upstream and downstream processes in the industry, from boiler diagnostics to actual drilling. The reports indicated that applications such as quality control, forecast planning, and predictive maintenance for exploration, production, and distribution broadly use AI in the oil and gas industry (Koroteev and Tekic, 2021; Kandziora, 2019; Li *et al.*, 2021). In this regard, Hassib and Shires (2022) also contemplated that three vital sectors are currently leading the use of AI applications in the UAE: cloud computing, cyber security, and the oil and gas industry. In terms of especially business development, efficiency improvement, data analysis, and proactive handling of supply chain disruption risks in the oil and gas industry, AI has played a critical role (Nguyen, Gosine, and Warrian, 2020).

The UAE was ranked first in the Arab world for its preparedness to embrace AI technology in a 2019 study on the "Government Artificial Intelligence Readiness Index," which surveyed over 190 nations globally to obtain its rankings (OxfordInsights, 2019). In 2017, the UAE Government unveiled its AI Strategy, signalling its dependence on various upcoming services, industries, and infrastructure initiatives leveraging AI. By 2031, the UAE hopes to dominate the world in AI thanks to this plan, which also intends to deploy AI more widely in fields including technology, energy, transportation, and education (Demir, 2022). The nation has established an AI ministry to develop a long-term AI policy. The ministry has suggested implementing an AI curriculum and launching six intelligent platforms to incorporate technology into the educational system. Twentyone thousand instructors and almost 275,000 pupils from 600 schools will use these platforms. By employing AI technology, the UAE hopes to increase its GDP by about 35% ($96 billion). It will assist the nation in saving $3 billion by reducing government spending by up to 50% (Azar and Haddad, 2021).

1.2.4. Organisational Background of Abu Dhabi National Oil Company

ADNOC, is one of the giant state-owned oil companies that is the world's 12th largest firm that employs AI technology to classify ADNOC as a tech-oriented firm (Almarashda *et al.* 2022). The cutting-edge facility in ADNOC headquarters collects real-time data from the company's subsidiaries and employs clever analytical models, AI, and big data to produce operational insights and suggestions (Braiki *et al.*, 2022). ADNOC recently completed the first phase of a multi-year AI maintenance initiative to improve asset efficiency and integrity throughout the company's upstream and downstream operations (ADNOC, 2020). The predictive maintenance technology developed by ADNOC uses AI tools such as Machine Learning (ML) and digital twins to improve equipment reliability and safety, reduce unscheduled equipment repairs and downtime, and save up to twenty percent on maintaining the equipment (Offshore Technology, 2020). ADNOC's approach to getting the most out of each barrel of oil and providing the UAE with the most significant returns possible continues to centre on the adoption of innovative technology, despite the unprecedented market circumstances that have arisen recently. The AI-based maintenance project is projected to be completed sometime at the beginning of 2023 (ADNOC, 2020). AIQ, an Artificial Intelligence Company is among the successful oil and gas companies through the conditions provided by a joint venture agreement between these two companies. With the commencement of this project, ADNOC

has made significant progress toward automating all of its operations (Offshore Technology, 2020). In addition, ADNOC has taken initiatives to implement AI functions in the extraction phase, which helps the company reduce the significant costs associated with the process.

1.3. Main Context of the Research

In terms of previous studies (Kuang et al., 2021; Li et al., 2017), the evolution of and progress made in Artificial Intelligence (AI) indicate that AI has a significant impact on the transformation of many industries. Manufacturing and finance industries have used AI for operational excellence and innovation (Charalambous et al., 2019) globally. On the other hand, business giants in the oil and gas industry, such as ADNOC, have integrated advanced technology to increase decision-making and increase value to investment processes, and operational efficiency (Min et al., 2020). The oil and gas industry has started to use AI in the management of the reservoir and production optimisation, but these implementations are rarely comprehensively understood at the organisational level, especially in State Owned Enterprises under specific regional and structural conditions (Koroteev and Tekic, 2021). This presents a gap in the literature: AI's adoption, challenges and effects on large scale, region-specific organisations such as ADNOC (in the UAE), and how national strategies around leadership in AI by 2031 manifest.

This gap is filled by the current study which focuses on how AI will transform ADNOC's operations in terms of practical applications and theoretical implications. It explores key unanswered questions related to the specific drivers and barriers to AI adoption in state owned enterprises and how they affect organisational agility and resilience. Furthermore, the study also examines how broader impacts on human resources, operational risks and compliance are impacted in a very highly regulated industry. This research contextualises these issues with a view to offering insights that are relevant to other organisations globally.

1.4. The aim, Research Objectives, and Research Questions

1.4.1. Aim of the Research

The main purpose of this study to explore and discuss the role of AI in transforming oil and gas industry operations in the UAE, specifically focusing on the ADNOC case.

1.4.2. Research objectives:

The established theoretical models are used to frame the research objectives: Technology Acceptance Model (TAM) and Task-Technology Fit (TTF). Specifically, for resource intensive sectors like oil and gas, these frameworks provide the basis for understanding the drivers, barriers and organisational impacts of AI adoption. The study aligns the research objectives with these theories to provide a nuanced understanding of the implementation of AI at ADNOC. The following research objectives are crucial to achieving the stated aim of the study:

- To discuss the role of AI technology in transforming operations in ADNOC.
- To identify the areas of the oil and gas industry that are influenced by the implementation of artificial technology.
- To determine the drivers and barriers to implementing artificial technology in oil and gas companies in the UAE.

1.5. Research Rationale

There have been many studies (Charalambous et al., 2019; Wanasinghe et al., 2016) on the operational benefits of AI in manufacturing and finance, however, this aspect of AI research is very limited in the oil and gas industry of the Middle East, particularly state-owned enterprises. This research addresses a gap by examining the application of frameworks such as the Technology Acceptance Model (TAM) and Task Technology Fit (TTF) in the context of ADNOC.

Existing theoretical models typically take place in a private sector or consumer setting, leaving a gap in their applicability to state owned enterprises operating in a unique regional and structural context. For example, TAM has focused on explaining user behaviour by using perceived usefulness (PU) and perceived ease of use (PEU) factors, however, this study takes TAM a step further and applies it to understanding organisational agility and resilience in a highly regulated sector. In the same vein, TTF also evaluates the suitability of AI technologies with ADNOC's operational processes and the gaps in knowledge of how task technology fit affects adoption outcomes.

This research fills an important gap in the theoretical study of how AI adoption drives organisational transformation in state owned enterprises, ADNOC, by integrating these theories. The study also

analyses how AI adoption in ADNOC fits with the UAE's strategic vision for AI by 2031, providing both theoretical insights and practical implications for policy and organisational decision making.

1.6. Scope of the Study

To begin, the scope of the research is limited in that it will only examine one company's operations inside a single sector. It was significant to restrict one's attention to just one business, even though there were time limits, restricted accessible work hours, and the author's personal and limited money. It is also imperative to emphasise that the discussion about AI occurs more generally rather than concentrating on the particular goods or services offered by individual businesses. It is not seen as reasonable to explicitly spell out and study all possible other factors which do not directly impact how AI is used in practice, as the interest of this study is to understand the value creation of AI in the UAE oil and gas sector and company ADNOC context. It is vital to emphasise that the scope of this research is restricted to the investigation of AI only as a technological notion. Therefore, if other businesses use technology design processes that are typically similar to AI but do not label it AI, these methods are not addressed in our research since they are not considered AI.

1.7. Research Significance

This study is significant because it aims to determine the role played by AI in transforming oil and gas operations in large organisations operating in the UAE. The potential role of AI tools and technologies is discussed in the current proposed study by considering the case of ADNOC. Several studies in the past have identified the significant role AI technologies played in transforming how businesses operate. For instance, Egamkulov and Sharapova (2020) claimed that AI tools and technologies could impact business processes in several ways, such as cost-saving, bringing efficiency to operations, improving decisions through big data and analytics, and other applications. Therefore, the particular significance of this study lies in the potential benefits and roles that AI can play in improving organisational operations in the oil and gas industry. Studies (Li *et al.*, 2020; Choubey and Karmakar, 2020) have demonstrated the potential benefits of AI specific to the oil and gas industry. Li *et al.* (2020) identified the applications of AI in oilfield development and other areas like predicting the dimensions where oil can be produced, optimising plans, identifying oil residuals, determining issues like fractures, and improving the process of oil recovery. The researchers conclude that intelligence oil development is on its way as the potential of AI-related technologies in the oil industry is promising.

On the contrary, Choubey and Karmakar (2020) demonstrated the effective implementation of AI to improve operational decision-making in the oil and gas industry. The authors reviewed the applications of AI and ML, beginning with the exploration of crude oil until its completion as a final product and distribution. The data generated in the oil and gas field is significant as its proper utilisation and integration can help improve the management's decision-making capabilities. For instance, using data analytics and predictive diagnosis can help detect issues and solve complex problems in less time. ML and other techniques are beneficial for dealing with real-time issues in oil and gas fields, including leaks, fractures, and other problems. Historical and real-time data can help solve different issues related to oil and gas developments and improve the overall efficiency of operations in large organisations. It is implied that the present study is critical because it highlights how AI can transform business operations in the UAE's oil and gas field. AI has been anticipated to be the most common disruptive technology (Lu *et al*. 2019). Oil and gas companies have used this technology for operations of drilling diagnosis, digitalised twin modelling, pipeline assessment, management and risk detection, predictive maintenance and recognition of seismic reservoir recognition (Kuang *et al*., 2021).

Specifically, it also assesses what different areas in large oil and gas companies can be influenced through AI integration and how the operations might be changed to make to conclusive effect on the organisation's operational excellence. For instance, studies (Sircar *et al.*, 2021; Kerf *et al.*, 2020) claimed that AI applications could guide the drilling process in large organisations to demonstrate accurate decision-making and reduce the risk of oil fires, accidents, and spills. Enormous oil and gas companies are involved in several processes to achieve operational efficiency. The case of ADNOC is selected in the present study to demonstrate a specific in the UAE context and provide implications for other large organisations in the UAE oil and gas industry. According to its website, ADNOC has completed the first phase of the predictive maintenance project, which aims to integrate predictive analytics into its operations to maximise the efficiency of operations (ADNOC, 2020). The technologies related to AI, such as digital twins and ML, are stated to predict and detect equipment issues and stoppages and reduce the consequences of unplanned equipment maintenance, which will also reduce downtime. The company expects it will lead to 20% maintenance cost-saving after completing four phases of AI implementation (ADNOC, 2020). However, the completion of all four phases of AI has not been confirmed on its website, indicating

a gap in knowledge about this area. An investigation into how AI has impacted the specific operations of large oil and gas companies would be beneficial in revealing its impacts. Thus, the current study is significant as it contributes to knowledge about how AI can enhance operations in large oil and gas companies like ADNOC and how this might impact different organisational processes.

In addition to these, despite numerous studies cited above having demonstrated the potential areas where AI contributes to oil and gas operations, there has been a lack of evidence about the successful implementation of AI in large oil and gas companies in the UAE. The study would reveal the driving factors and barriers large oil and gas companies like ADNOC in the UAE face. A look into the personal experiences and opinions of workers directly involved with oil and gas operations in ADNOC is beneficial to reveal what issues they face during AI implementation. It reveals how AI implementation has impacted the processes in particular areas of oil and gas operations in ADNOC and what might be the solution to address the determined barriers to speed up AI implementation. Furthermore, the revelation of barriers and drivers of AI implementation in large oil and gas companies is helpful for other large companies interested in adopting AI for operational transformation and excellence. Thus, this study is also significant because the determination of drivers and barriers of AI in the oil and gas industry would deepen the established understanding of the limitations in this area, specifically in the UAE context.

This research work substantially contributes to the existing knowledge and practice by revealing how AI applications transform gas and oil operations in large organisations. This is likely to reduce the gap about how large organisations in the UAE, like ADNOC, have been impacted by implementing AI in their operations. Furthermore, other organisations planning to implement AI will get help from this outcome and ensure that they address the determined problem efficiently and effectively. The findings will highlight the significance of exploring the impact of AI on oil and gas operations. Furthermore, reporting the perceptions of 'ADNOC's employees and workers provides comprehensive information to inform practice about barriers and drivers of AI implementation in large oil and gas organisations.

1.8. Summary of the Chapter

This chapter has introduced the problem and discussed ways of approaching a solution. The chapter introduces the topic relevant to study variables, including AI and its impact on ADNOC's operations, considering the background and the UAE context. The organisational background is presented to demonstrate the case of ADNOC and its commitment to integrating AI into its operations. It is demonstrated that ADNOC has already started integrating AI in its operations, such as predictive maintenance projects, to save costs and reduce downtime due to equipment maintenance. The context of the study is established to educate the readers about the aim, main research questions, and objectives. It is revealed that the study is focused on examining areas where AI implemented has influenced operations related to oil and gas. The case of ADNOC is decided to explore how AI has transformed its operations and what issues were faced. The study explores determining the barriers and drivers of AI implementation in large oil and gas companies. The research rationale is included to justify the selection of research, and the significance section demonstrates the significant contributions to knowledge, theory, and practice. The chapter also highlights the nature of the study and its scope to specify what the research will include and exclude. The researcher has determined and reported the delimitations and limitations related to the research work. In a nutshell, the chapter reflects and stresses the importance of exploring AI applications in large oil and gas companies. The case of ADNOC is selected to determine the impacts of AI in specific areas of oil and gas operations. It reveals the issues faced by ADNOC as barriers to AI implementation in its operations and drivers that likely speed up the process of AI adoption—for instance, revealing why ADNOC has not completed its four phases of AI implementation as per its predictive maintenance project yet. The researcher incorporated a qualitative research design to ensure the achievement of all the formulated research questions and objectives. The case study strategy provides a substantial foundation for the researcher to concentrate on 'ADNOC's case. Furthermore, the interview tool demonstrates the effectiveness of gathering quality data about the drivers and barriers associated with AI implementation in the oil and gas industry. Next, a literature review chapter giving an overview of previous studies through a critical lens to determine gaps in the existing line of research related to AI implementation in the oil and gas industries is included.

1.9. The Organisation of the Research Work

The dissertation is organised into the remaining four chapters to provide information about the different phases of research that were completed to produce this piece of substantial research work. The first chapter is an introduction in which the topic has been introduced with relevance to its significance, context, aim, objectives, and potential contribution to both knowledge and practice. This chapter has also highlighted the study's main scope, potential outcomes, and limitations. The second chapter of the dissertation is Literature Review; this is a detailed examine the general background of the included variables of the study. The chapter includes a critical analysis of many of the previous studies published in a similar research area. The studies in the literature review chapter are of theoretical and empirical significance. These studies have been included to provide an overview of established research and what is already known about the research area. The purpose is to determine the existing knowledge gaps and identify what can be done to fill them. After the gap analysis and specifying the contribution of the study with relevance to gap filling precisely, the dissertation moves forward to chapter 3, which is methodology. In this chapter, the data collection process is reported along with the systematic process followed to ensure that data is collected effectively, keeping ethical considerations in mind. Chapter 4 is Data Analysis and Discussion, which includes a detailed view of how collected data were analysed using the chosen technique, which is thematic analysis. The chapter includes the process, including codes and theme generation, to reach final themes addressing the formulated research questions and objectives. A discussion section is dedicated to comparing the present study's findings with previous studies included in the literature review and their findings. The last chapter is Conclusion and Future Work. This chapter provides an overview of the research process and reports the outcomes of this study. The chapter highlights the limitations of the research and concludes whether the researcher could meet the research objectives. The chapter ended with a discussion of potential future developments.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This section provides comprehensive discussion on the concepts of AI and their contribution towards transforming the operations of oil and gas companies and empirical studies conducted on the similar domain. These empirical studies will not only be used to reflect on the role of AI in transforming the operations of oil and gas companies, but the chapter will also use this research for finding out the drivers and barriers in the application of AI in oil and gas companies. These studies will encompass various dynamics of the current study. These studies included encompass the identification of drivers of AI incorporation in oil and gas industry and those areas which are influenced by the integration of AI. The studies identifying the barriers in its implementation are also discussed. The chapter also highlights the need of current study while addressing the gap in existing literature which provides the foundation for further research. Furthermore, this chapter entails the theoretical concepts which assist in understanding the Implementation of modern technology in the field of oil and gas industry based on various factors in current study. Lastly, the chapter includes a summary of the key findings that have been extracted from the review of the existing literature.

2.2 Theoretical Framework

Marangunić and Granić, (2015) highlighted that various theories/models explain the adoption of new technology in an organisation for instance Technology Acceptance Model (TAM), Tasktechnology Fit (TTF), Theory of Planned Behavior (TPB), Unified Theory of Acceptance and Use of Technology (UTAUT). Granić and Marangunić (2019) discussed that TAM provides three stages for acceptance of technology that is based on external factors, cognitive responsive and affective response. External factor comprises the features of the system that can accelerate cognitive response which is based on perceived usefulness (PU) and perceived ease of use (PEU) (Granić and Marangunić 2019). The cognitive response then leads to an effective response that defines the attitude regarding the usage of the new technology (Granić and Marangunić 2019). Likewise, Kamal, Shafiq and Kakria, (2020) mentioned that this theory shows the behaviour as the response of the PU and PEU and behavioural intention. Similarly, Al-Emran, Mezhuyev and Kamaludin (2018) added that TAM explores two criteria that can impact the intention of an individual regarding the utilisation of novel technology such as perceived ease of use (PEU) and usefulness (PU). This

concept assists individuals to understand the behavioural intentions of users regarding the new technology. As per Fathema, Shannon and Ross (2015), this theory can enable business organisations to explore the possible advantage that can be obtained by adopting any innovative technology. This theory was used by prior researchers to understand the behaviour related to computer usage. Verma, Bhattacharyya and Kumar (2018) discussed that PU is the potential to which an individual believes that utilisation of the technology will improve performance whereas PEU is based on the idea in an individual believes the utilisation of the new technology will be effortless. The utilisation of this theory facilitates gaining deep insight into the individual's attitude towards the use of the new system.

Further research found that behavioural intention may be replaced with attitude toward behaviour, which is an effective judgement of the probable outcomes of the behaviour (Huang, 2023; Ammenwerth, 2019). The greater the affective response, the more likely that the behaviour will occur. The influence of PU on actual usage might be direct, emphasising the variable's relevance in predicting behaviour (Ammenwerth, 2019). Moreover, PEU does not have a direct impact on user behaviour, it does support the effect of PU. According to this concept, if an application is projected to be simple to use, it is more probable that the user would find it beneficial, which will increase the likelihood of technological adoption (Huang, 2023). According to the study of Granić and Marangunić (2019), TAM has a major theoretical contribution, and it has practical outcomes, as it offers the testing of the usability of technology, it helps to understand the motivation of the individual to adopt the technology.

As per Joo, Park and Lim (2018), TAM acts as a significant theoretical tool that assists organisations to predict the behaviours of their customers regarding the application of technology. Scherer, Siddiq and Tondeur (2019) highlighted that this technology is widely used to examine consumer attitudes regarding technology for instance e-commerce platforms, online shopping tools and chatbots that enable online trade. For instance, TAM was beneficial to understand the acceptance rate of e-commerce chatbots that can influence the intention of purchasing. This model was used to gain insight into the repeated and potential customers in online shopping. However, TAM was able to predict the behaviour of the individuals who were already associated with the online stores.

In this regard, Dumpit and Fernandez (2017) underpinned a criticism that was made about TAM, that it cannot provide a full picture of the reasons for the usage and acceptance of technology in business; it can provide an insufficient explanation to the individual behaviour regarding the adoption of technology. Furthermore, Kusumah (2017) highlighted that one limitation of TAM is based on the variable affecting the user behaviour that is inevitably evaluated by subjective means for instance behavioural intention (BI) and interpersonal influence, as these are based on subjective norms. In this regard, Taherdoost (2018) added that behaviours cannot be effective measures or quantified in any empirical research, as it depends on the subjective factors for instance values, norms and beliefs that shape personal traits and attributes. Hence, it can be stated that the surroundings or social interaction of an individual can affect the use of technology. Likewise, Kamble, Gunasekaran and Arha (2019) found that TAM cannot be effective to comprehend the usage of technology in the context of the university, business and organisation, but this model conceptualised the purpose and perception of an individual.

On the other hand, Salloum (2018) highlighted that compare to this model, the theory of planned behaviour (TPB) offers more details regarding the intention of individuals towards the usage of a new system. According to this theory, the behaviours of individuals are affected by the intention that can be determined through perceived behavioural control, subjective norms and attitudes, additionally, there are also possibilities that external factors can prevent or enforce behaviours despite intention (Cheng, 2019). According to the study of Taherdoost (2018), TBP does not account for the influence of contextual factors such as culture, history, and norms on user behaviour. Furthermore, Mutahar *et al*. (2018) believed that TBP is limited in terms of its applicability to technological settings, this theory assumes that intention is the primary predictor of behaviour, but in some technological settings behaviour may be influenced by factors beyond intention, such as automation or user preferences. Furthermore, the theory does not take into account the impact of external factors, such as economic or political contexts, on behaviour (Baby and Kannammal, 2020). Finally, the theory does not account for the complexity of decisionmaking processes in technological contexts, which can involve multiple actors, different levels of control, and non-linear feedback systems.

Unified Theory of Acceptance and Use of Technology (UTAUT) is another model that assists to understand the acceptance of technology that can be influenced by social influence, performance

and effort expectancy and facilitating conditions, this theory claims that the adoption of any technology is directly associated with these four constructs (Dwivedi *et al*., 2019). Koul and Eydgahi (2018) discussed that the first three constructs of UTAUT are directly associated with the intention and behaviour of usage whereas the fourth construct is associated with the user's behaviour, therefore these constructs are used to examine the usage behaviour and behavioural intention. They can be significant to identify potential areas of improvement and develop strategies to increase technology adoption and usage (Dwivedi *et al*., 2019). The moderating variables in this model are age, gender, voluntary use and experience which can facilitate comprehending the usage behaviour. Manis and Choi (2019) stated that this model is an extension of TAM, and it can provide a stronger understanding of technology usage behaviour. Additionally, Ammenwerth (2019) stated that UTAUT can be used to help identify user needs and preferences, which can inform the design of better user interfaces and improved technologies. This model can also be used to analyse the effectiveness of technology-related marketing campaigns, as well as to evaluate the success of technology implementations.

Alhashmi, Salloum and Abdallah (2019) believed that despite its many advantages, UTAUT does have some limitations, for instance, this theory does not consider the external environment in which a user decides to accept and use technology. For instance, organisational culture or political environment can significantly influence user acceptance of technology. It is important to consider these factors to better understand user behaviour and thus increase the likelihood of successful technology adoption. Furthermore, Ajibade (2018) highlighted that technology is not always userfriendly, and UTAUT does not take into account the potential risks associated with technology use, such as security and privacy concerns. Finally, UTAUT is based on the assumption that users are rational, but this is not always the case. Therefore, organisations should use other models and frameworks to complement UTAUT when assessing technology usage decisions (Ajibade 2018). Additionally, Rouidi *et al*. (2022) stated that UTAUT does not apply to all technology scenarios: The UTAUT model was developed to explain user behaviour regarding technology adoption. However, the model may not apply to other technology scenarios such as the adoption of new software or the use of a new technology platform. Therefore, it is important to understand the specific context before applying the UTAUT model.

Moreover, Shachak, Kuziemsky and Petersen (2019) discussed Task-technology Fit (TTF) as another theoretical concept that facilitates the evaluation of the suitability of a novel tool for specific tasks. This concept is significant to understand the compatibility and suitability of certain tasks with certain technologies. Napitupulu *et al*. (2020) stated that TTF is implemented in various organisational contexts to analyse the effectiveness of technology and task combination. BuabengAndoh and Baah (2020) highlighted the main components of the TTF which are based on TaskTechnology Interaction, Task-Technology Compatibility and Task-Technology Outcome. As per

Altalhi (2021), TTF is significant to understand the interrelationship between technology (software, hardware, and data), individuals (users) and tasks (activity). As per this concept, technologies should be compatible with the work environment of the employees to ensure higher productivity and satisfaction level (Spies, Grobbelaar and Botha, 2020). Dharanikota and Marakas (2021) highlighted that the concepts of TTF are complex, and it is difficult to implement these concepts empirically. There are multiple constructs, which limit the application of this theory in various scenarios and situations. Furthermore, Lin and Tajvidi (2022) added that TTF has a limited discussion about the situational and psychological factors of an individual that leads to individual differences. Such kind of differences can influence the outcomes of technological usage. The resulting diagram which reflects the theoretical framework of the study is presented in Figure 2.1.

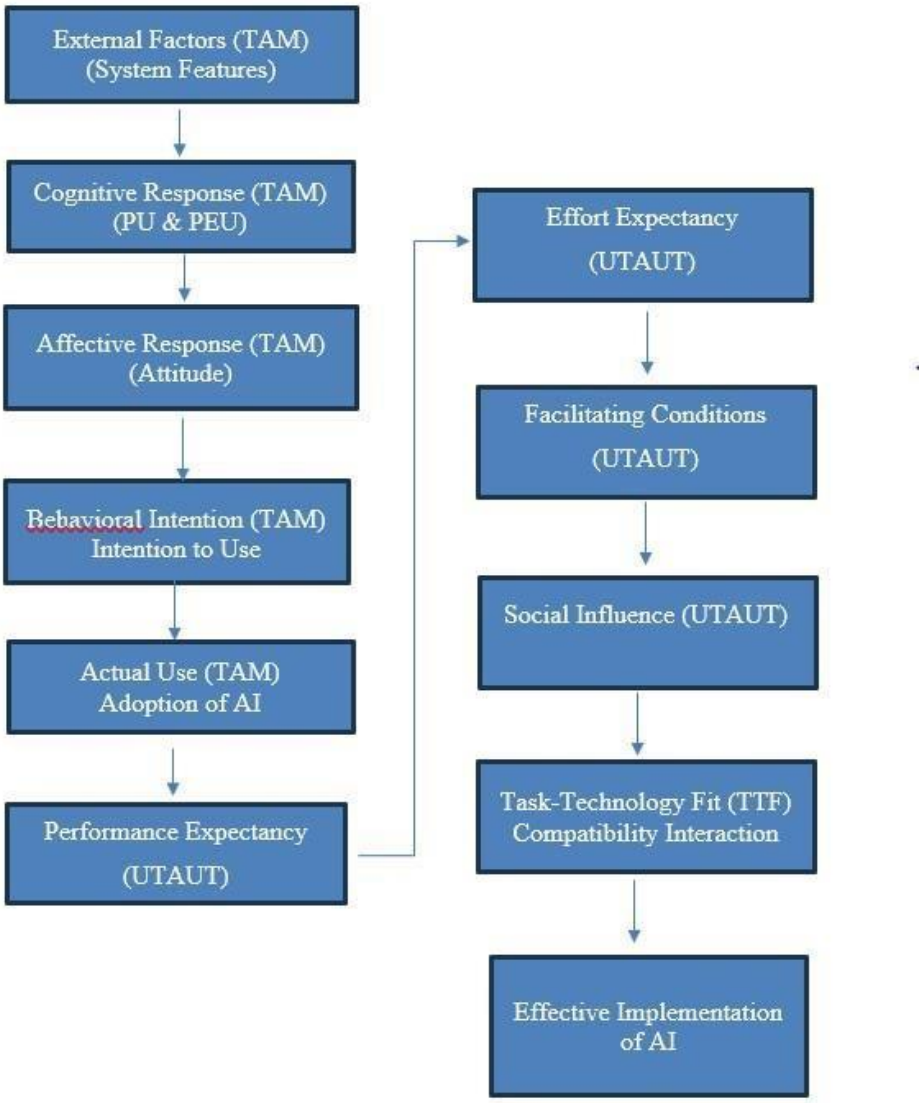

Figure 2.1: Theoretical Framework

2.3 Empirical Studies

2.3.1 To discuss the role of AI in the transformation of operations in oil and gas companies.

According to Lu *et al.* (2019), the industry of gas and oil is one of the prominent industries in the market globally. The oil and gas market concerning the use of AI is valued at about $2 billion by the year 2019. Statistical evidence revealed that this value will be estimated to reach $3.81 by the year 2025 at a Compound Annual Growth Rate (CAGR) reaching up to 10.96% (Ahmad and Zhang, 2020). ML and AI application in the oil and gas sector is used for the interpretation and analytics

of data to assist in forecasting future trends, the discovery of new reserves and increasing production in already present reserves (Hanga and Kovalchuk, 2019). However, Choubey and Karmakar (2021) figured out that the use of AI in the form of the Internet of Things (IoT) and cloud-based technology is an emerging technological domain that is acceptable in the sector of oil and gas, but its adoption rate is comparatively slow. This is because gas and oil companies are required to engage and train professionals in AI.

AI projects play an important role in transforming businesses and adding value that leads them towards improved performance (Hanga and Kovalchuk, 2019). Reconfiguration of processes is one of the best ways of improving organisational performance by bringing improvement in operations (Wamba-Taguimdje *et al*., 2020). Wanasinghe *et al*. (2016) in their research, highlighted the positives of adopting AI technologies. The authors highlighted the need for AI technologies for improving operational efficiencies in the oil and gas sector. The study found that continuously low prices of oil are forcing companies to deploy smart and innovative technologies not only to increase their assets but their operational efficiencies as well. These technologies by enhancing the operational efficiencies of oil and gas companies, tend to reduce their environmental risks, health-related risks, and safety issues while maximising their asset portfolio. The benefits of AI are not limited to risk management and maximising the portfolio, but it also contributes towards enhancing capital productivity and operational cost. The study outcomes unveiled the fact that the IoT is one of the major aspects of AI technologies that help oil and gas companies in reducing their operational cost by becoming digitally transformed organisations. Continuing with the positive role of AI applications in the oil and gas sector, Kuang *et al*. (2021) commented on the role of AI in exploring and developing products. The study found that ML helps transform operations in the oil and gas industry because it helps identify lithology, reservoir parameter estimation, and logging curve reconstruction. The study found that the potential technologies in the domain of AI that contributed significantly to the production efficiency of the oil and gas sector include automatic processing and interpretation technologies, fast and intelligent imaging tools, professionals software platforms, production equipment, intelligent fracturing technology intelligent rotarysteering drilling, intelligent seismic nodal acquisition systems, and real-time controlling and monitoring zonal injection and production technologies.

Ahmad (2021) discussed the role of AI technologies from the perspectives of consumption, distribution and trade. The study found that digitalisation has changed the way of operating in the oil and gas sector. New digitalisation powered by AI technologies helps oil and gas organisations integrate energy demand, supply and renewable sources into the power grid which helps optimise the decision-making potential of companies and therefore their operations (Ahmad, 2021). The reason that AI technologies are actively used in oil and gas companies in the exploration and production process of oil includes productivity efficiency. Duan, Edwards and Dwivedi (2019) pointed out that AI is used as an advanced technological tool for making long-term decisions. For this purpose, offshore solution providers of AI utilise advanced AI tools and integrate them with advanced analytics to generate reports which help in making decisions about marketing, supply chain and financial activities of the oil and gas companies. Furthermore, transport and logistics are complicated processes in the oil and gas sector which require AI to help mainstream businesses through the planning and execution of transportation services. In this way, AI helps the teams in coordinating and aligning the operations to reduce the duration required for shipping. Anis and Siddiqui (2015) highlighted that working in the oil and gas sector with heavy machinery is quite harmful, therefore, leading to the increased requirement of AI and IoT sensors to assist in the collection and delivery of valuable information to the systems so that accidents at the workplace could be prevented. AI applications assist oil and gas companies in developing interconnected digital networks for supply to increase the flexibility of the processes. Oil and gas companies in this way could efficiently overcome the issues of technology by integrating AI software into the existing system. This is the reason AI increases production and returns for oil and gas companies (Lu *et al*., 2019).

The use of AI in the oil and gas sector has several advantages associated with improved productivity, security, resource availability and business processes for monitoring controllable processes (Gupta and Shah; 2022; Flichy and Baudoin, 2018). So, AI could be utilised in different ways for addressing the issues of the oil and gas sector. The application of a decision support system based on analytics is important for oil and gas industries for manually analysing data to draw cost intrinsic insights. AI algorithms can help analyse multiple streams of data to provide technical recommendations based on business requirements through the utilisation of various machinery and sensors (Tayebi *et al*., 2022). Gupta and Shah (2022) stated that in this way AI improves the

operational efficiency of processes by enhancing the capacity of strategic decision making thus, reducing the expenses and failure risks. Data analysis through the implementation of AI assists the oil and gas companies globally in the management and monitoring of their plants even remotely. With the application of AI tools, oil and gas industries could easily digitise the records and automate the process of data analysis

Oil and gas after extraction is required to be stored in a central repository from where it is transferred through pipelines (Devold, 2013). Different temperatures and other external aspects result in the degradation and corrosion of parts in oil and gas components (Devold, 2013). This degradation results in the weakening of pipelines which could be prevented by the use of AI. The use of AI and IoT helps in the identification of corrosion indicators through the detection of initial signs of damage by analysing the recorded data for several parameters (Devold, 2013). This can be done by analysing different factors with the help of graphs and predictive intelligence (Parjane and Gangwar, 2022). Kumar and Barua (2021) inferred that varied forms of the algorithm are integrated into AI solutions that predict the probability of corrosion through the utilisation of predictive intelligence and knowledge-based graphs. Moreover, considering the danger of the oil and gas environment it is important to adopt several techniques to avoid and prevent an issue related to the exposure of workers in the oil and gas sector to toxic chemicals and fumes due to the exposure to varying temperatures. Furthermore, Flichy and Baudoin (2018) pointed out that the oil and gas sector require the application of AI in varied divisions. Due to the fluctuation in oil pricing, the industry requires the optimisation of the production of oil and gas. It is essential to improve the durability of an oil well. For this reason, several factors are required to be considered important such as flow rates through the application of AI and ML algorithms that help in the collection of data from varied installed sensors. This facilitates the generation of real-time updates for maintaining favourable operational settings.

The system related to the management of the reservoir requires the application of an AI system as the central part of oil and gas production (Koroteev, and Tekic, 2021). This helps in generating advanced arrangements for the optimisation and maintenance of the reservoir (Hanga, and Kovalchuk, 2019). Incorporation of AI in the processes can help in the collection and utilisation of data from the reservoir and the devices that are installed for capturing data from the surrounding facilities (Olajire, 2015). On the contrary, the use of control devices and valves for inflow along

with the downhole sensor systems is the most suitable and easiest solution for saving efficient productivity to maximise the cumulative extraction by utilising smart and effective technologies (Hanga, and Kovalchuk, 2019). Improved control is required in major oil fields that require fast decision-making by considering the challenges associated with it (Koroteev, and Tekic, 2021). The smart oil field would be developed by creating a comprehensive technology on oilfield infrastructure through the digitalisation of instrumentation systems and the creation of a networkbased exchange of knowledge to optimise the production process (Mohaghegh, 2005). According to Holdaway (2014), the petrochemical industry requires the integration of AI for the exploration of the oil field, drilling, reservoir and production engineering, Therefore, AI technologies are considered imperative because of their rapid speed of response and robust capacity required for generalisation. For this purpose, ML demonstrates the effective potential for enhancing the approaches related to the traditional reservoir. Several algorithms of ML including fuzzy logic (FL), Response Surface Model (RSM) and Artificial Neural Networks (ANN) are used in the field of engineering reservoirs which is included in the learning classification. Oil and gas companies have examined the impact of technical transition in the inspection of natural gas and oil through a specified collection of data by utilisation of a microstructured grid (Tung *et al*., 2020). Technical transition with the adoption of AI plays a substantial role in the offshore gas and oil industry during the last 50 years resulting in reduced cost and enhanced deposits. In oil and gas companies, different type of data is collected from surfaces to enhance the potential of hydrocarbons. The sensors are used as the prominent tools for the collection of this data in large numbers. Therefore, ML methods provide a relationship among input variables that helps in predicting the output (Hanga and Kovalchuk, 2019).

Furthermore, the application of AI in the industry of oil and gas is rapidly developing in different stages of operations related to the oil and gas industry including intelligent drilling, production, pipeline and refinery. With the development and application of AI algorithms, different AI technologies could be applied in development and exploration procedures. The utilisation of the ANN method in the field of exploration helps in reducing the risks associated with exploration and improving the rate of success of exploration wells (McMillan and Varga, 2022). Considering the field of drilling, advanced equipment including automatic drilling and intelligent drill pipelines has substantially reduced the cost and improved the levels of drilling.

The empirical evidence above shows that AI has the ability to transform the oil and gas operations. Yet, its integration into production optimisation processes in resource intensive and state owned enterprises such as ADNOC has not been explored. From a theoretical perspective, this study uses Task Technology Fit (TTF) to evaluate how ADNOC's AI technologies fit with ADNOC's operational needs. For example, intelligent drilling systems or IoT based monitoring are aligned with TTF's task congruence focus on optimal performance and risk reduction. Technology Acceptance Model (TAM) also gives us insight into the perceived usefulness (e.g. cost savings, safety improvements) and ease of use (e.g. automated decision making systems) of AI technologies in driving adoption at ADNOC.

This study addresses this critical gap by exploring these theoretical dimensions to understand how AI can leverage technological advancements in resource intensive enterprises to achieve both organisational agility and resilience through alignment of operational tasks with technological capabilities to facilitate adaptability and efficiency.

2.3.2 To identify the areas of the oil and gas industry that are influenced by the implementation of AI.

Influence of AI on Exploration in the Oil and Gas Industry

Before getting into the details of AI implementation in the exploration operations of oil and gas production, it is vital to understand the key operations that the petroleum industry performs in the process of oil and gas exploration. The 3D geological model operations result in the exploration of petroleum reserves and this operation is based on the petrophysical and geophysical studies with the computation of data gathered in the studies (Holdaway and Irving, 2017). The petrophysical and geophysical studies are the combination of three main aspects: (i) Seismic Survey of the Reservoir, (ii) Analysis of Lab core and digital core, (iii) Well Logging. This area (exploration) of oil and gas industries includes all these operations and AI is meant to facilitate these operational tasks by catalysing the working time of all these operations (Vernik, 2016). Seismic traces include a variety of sensor recordings through Seismic surveying. These traces consist of time patterns which depict the elastic strength of waves which are caused as a result of the surface vibrator and subsurface layers formation from reflected boundaries (Holdaway and Irving, 2017). Seismic traces include a variety of sensor recordings through Seismic surveying. These traces consist of time

patterns which depict the elastic strength of waves which are caused as a result of the surface vibrator and subsurface layers formation from reflected boundaries (Kuang *et al*., 2021). This process requires the high-performance computation of data and for this reason, this process is strongly offline.

Techniques supported by deep learning are being implemented for modern pattern recognition to speed up the process of seismic operations by 10 to 1000 factors (Choubey and Karmakar, 2021). According to Lowell and Erdogan (2019), AI technology may not be able to save the cost of these exploration operations, but the process can be optimised in terms of time. Similarly, AI will also eliminate the inaccuracy of interpretation that will further ensure the mitigation of loss probability in the exploration of oil and gas wells. Furthermore, the result of petrophysical interpretation is dependent on the preciseness of the export (interpreter) and this interpretation takes a lot of time. Hanga and Kovalchuk (2019) stated that the experiment was conducted in the petroleum industry which employed the data from historical good logging and combined it with new wells data in ML technology. The result of this experiment showed 92% accuracy of interpretation as compared to manual interpretation. Yet, the main takeaway from this experiment was the difference in the period of interpretation. The ML-based interpretation took 1000 times less time than manual interpretation.

Thus, from the arguments and findings of previous research in this domain, it is evident that AI-based techniques are faster in processing the operations of explorations including good logging, core analysis, and identification of the area for drilling. Similarly, as per Li *et al*. (2020), companies cannot replace their exploration operations completely with AI technology, but this technique can assist companies in the physical part of good logging. Similarly, once the time consumed in this operation is reduced through AI assistance then companies can have more time to explore more wells for extra drilling activities.

Influence of AI on the development of fossil Products in the Oil and Gas Industry

After the construction of the geological mode, the next process is managed by the reservoir engineers to construct a geological model (Sircar *et al*., 2021). According to Sharifi, Ahmadi and Ala (2021), reservoir engineers execute the upscaling of 3D cells (produced in a geological model) to decrease and enlarge the number of cells. Similarly, the reservoir modelling software is utilised by reservoir engineers to manage the flow of reservoirs during multiple product development

operations which include the procedures related to good operations and well drilling. Daneeva *et al*. (2020) asserted that the procedure conducted in the reservoir modelling predicts the overall production of oil/gas in the coming 10 to 24 years for a specific field development schema. Here the major task of reservoir engineers is to perform reservoir modelling multiple times for the selection of optimal field development plan and field development scheme. Furthermore, the study by Hassan (2020) argued about the different contexts of optimality for different companies based on the size of the companies. For instance, for mid to large-sized entities, the optimality can be to maintain the production in the long run at some adequate level while investing a fixed amount on production and field development operations. Likewise, reservoir engineers not only perform operations related to Greenfields but also are critical for operations related to brownfields (Shukla and Karki, 2016). According to Pichtel (2020), brownfields contain previous production details that assist the engineers to correct the earlier models by comparing them with history. Ribeiro *et al*. (2020) argued that comparing the history is a problem which has no innovative solution yet in the petroleum industry, thus reservoir engineering is vital for handling practical workflows. Scholarly data indicate that AI can be applied in reservoir engineering in two ways. According to Li *et al*. (2021), the major usage of AI in reservoir engineering is linked to the computations which can be performed through the application of conventional tools of reservoir modelling. The nature of flows in the reservoirs can be identified with the assistance of AI-enabled modelling tools which conduct quantitative solutions through the calculation of partial differential equations (Simensen and Thune, 2018). Furthermore, Bello *et al*. (2015) indicated that the process of computations is a complex and time-consuming task as it involves the computation of up to billions of 3D grid cells. Similarly, even if the companies employ advanced workstations, the process takes a lot of effort and time by decreasing the quantity of computation process runs. Regarding this aspect, Ullevik (2017) argued the significance of AI technologies by indicating that the major purpose of these advanced technologies is to speed up the process of computations. Further, Simensen and Thune (2018) added that advanced surrogate models of the reservoir along with novice computation engine contingent on deep natural networks consisting of highly classified mathematical problems solving capabilities. Thus, this technology speeds up the operation as compared to traditional computation while maintaining the same accuracy.

The second main aspect where AI can benefit to oil and gas industry is upscaling in which the AIbased system gathers information from multiple geophysical scales and merges it into a single geological as well as a hydrodynamical reservoir (Feder and Rassenfoss, 2019). Nagy and Hajrizi (2018) indicated that upscaling process consists of subjectivity in the process as there is no specified or scientific method of upscaling. For instance, reservoir experts utilise their experience and perception while performing this process. Sharifi, Ahmadi and Ala (2021) illustrated that due to this subjectivity of the process the probability of expert bias increases which can also lead to inaccurate decision-making in the upscaling process. Furthermore, Sircar *et al*. (2021) stated that deep learning algorithms can be utilised to bring objectivity to the process. For instance, the technology can be trained by inserting examples from the previous manual process. In this way, the AI can make objective decisions while accelerating the process as well. Moreover, this type of technology trained through historical operations can be employed on other production tasks in the petroleum industry to increase the pace and precision of processes (Sircar *et al*. 2021).

The construction of a well development of the field is quite a costly process (Devold, 2013). Similarly, companies need to utilise drilling sensors' data to ensure that the drilling of wells results in profit as per the initial high investment of companies during drilling (Shukla and Karki, 2016). Similarly, the major aim is to ensure maximum productive time with minimum failure risks during the drilling process. Additionally, less drilling will also lead to less cost incurred in the exploration of wells. Mohammadpoor and Torabi (2020) highlighted that the drilling process utilises a huge amount of data and this data is recorded through three different sensors. First, the surface sensor measures the mechanical parameters in real-time during the drilling process. Second, the sensor which measures physical parameters that are formed behind the drilling bit is classified as loggingwhile-drilling. Third, the sensor which measures the bottom hole assembly mechanical data is categorised as a mechanics-while-drilling sensor. Pichtel (2016) stated that all these sensors produce data in the manner of time series which is utilised in the managing and controlling drilling process. Furthermore, Ribeiro *et al.* (2020) argued that AI can make all these processes more precise, safer and faster while reducing the non-productive time by 20 to 40%. Similarly, the probability of making wrong predictions and failures can be decreased by 90%.

Influence of AI on the Production aspect of Oil and Gas Exploration

AI-enabled tools are attractive and beneficial for producing reservoirs and green fields. The literature depicts that ML-enabled applications let companies utilise them for guess maintenance options while ensuring optimality in the operations (Sircar *et al*., 2021; Li *et al*., 2021). According to Sharifi, Ahmadi and Ala (2021), a ML usage is an option that oil and gas companies can consider ensuring increased productivity while keeping the cost of production as low as possible. Moreover, Nguyen, Gosine and Warrian (2020) also indicated that the pumps utilise different sensors to assess the vibrations, temperature, and pressure which are used in the production operations and can be made more efficient through AI technologies. Likewise, Balaji *et al*. (2018) argued that there is enough evidence which illustrates that data backed approach leads to evidence of failure in the production process as well as lower the cost of maintenance.

Furthermore, apart from maintenance, these AI-enabled applications can also be utilised in the process of good treatment as well. Jaara, Hamdan and Mushtaha (2022) illustrated that the operations related to good treatment in the production process are done to prompt the hydrocarbon inflow to the historical well or to enhance the rate of flow in the recent drilling well. There are two main procedures which are conducted for good treatment such as chemical treatment and hydraulic fracturing, but both these procedures are highly costly like that of well construction operations. According to Patel *et al*. (2020), the treatment of good operation is a risky process because of two major reasons. The first reason is linked to the data which is derived from a physics-driven model and raises the chances of inaccurate prediction of wellbore formation. Similarly, the other reason is linked to the bias of experts' while making the final decision on appropriate good treatment procedures. Majstorović (2022) stated that the major reason for bias is the subjectivity of decisions which is based on the assumption of experts. Thus, for these reasons, the AI experts working in the petroleum industry recommended AI techniques to make this procedure more effective. In this relation, Ribeiro *et al*. (2020) argued that instead of investing a huge amount in well treatment operations, the oil and gas companies can utilise the historical data from the previous well treatment operations.

Influence of AI on Safety Aspects in the Oil and Gas Industry

Scholarly data suggests that AI implementation is a vital and significant aspect of maximising the efficiency of production and fined operations (Jaara, Hamdan and Mushtaha; 2022; Sircar *et al*., 2021). The literature also indicates that the not only operational benefits but also there are many safety-related benefits through the implementation of AI in the petroleum industry (Bello *et al*. 2016). According to Temizel *et al*. (2019), oil field processes and operations are dangerous for people working in the field as it increases the chances of risks due to multiple factors such as handling heavy equipment, operating in high pressure and temperature environment, non-covered rotary equipment, and extremely risky chemicals. Similarly, Bello *et al*. (2016) indicated that there are applications based on ML that can easily detect the violations being done on the part of workers related to safety protocols. Thus, companies can utilise this to take precautionary measures to avoid any harm to workers as well as machinery. Furthermore, Nguyen, Gosine and Warrian (2020) added that deep learning along with the pattern recognition technique assists petroleum companies in detecting the dressing of workers for particular operations through live video streaming. Lastly, Hassan (2020) also argued that predictive analytics alarm also enables the proactive alarm system in any operational process to prevent any harm in terms of safety, health, and environment.

Influence of AI on Supply Chain Mechanism of Oil and Gas Companies

After the pandemic hit all businesses across the world, the oil and gas sector was not an exception (Sharifi, Ahmadi, and Ala, 2021). According to Nia, Awasthi and Bhuiyan (2021), the situation of lockdown forced the world to restrict their movement which ultimately impacted the worldwide demand for oil and gas-related products. Moreover, Abd Rahman *et al*. (2021) described that decreased crude prices and different political tensions across the world had impacted the petroleum industry in terms of excess supply and introducing new innovative strategies. Similarly, Majstorović (2022) argued that once the world got back to normal functioning, the demand for petroleum products will rise but companies have to adopt to the new normal situations by adopting improved activities and supply chain processes to sure higher profitability at a lower cost of production, transportation, and distribution costs. So, companies must adopt innovative strategies which can provide them with opportunities of decreasing the cost of operations including supply chain operations. Jaara, Hamdan, and Mushtaha (2022) illustrated that AI can also transform the

supply chain mechanism of oil and gas companies by making the whole process more informed through a data-driven approach.

According to Sireesha *et al*. (2018), the major mistake that oil and gas production companies make is the wrong prediction of demand for petroleum products. Similarly, Sircar *et al*. (2021) also argued that when companies miscalculate the demand, they had to bear a huge amount of loss. AI is quite proactive in terms of predictive and network planning which enables companies to utilise it to forecast the market demand for petroleum products. Shukla and Karki (2016) stated that when petroleum companies get to know about the exact demand for petroleum products in a specific area, they can put their focus towards that area to meet the market demand. Similarly, this practice will also decrease the operational cost that oil and gas companies invest in the supply chain process. As stated earlier that oil and gas production and exploration consist of operations which are related to downstream, upstream, and midstream. According to Ribeiro *et al*. (2020), the supply chain is critical in upstream operations as any delay in the material and equipment can cause oil and gas production companies a huge amount of operational loss. Here, AI assists the companies to develop a system which can automatically coordinate with the warehouse team and operations to ensure the presence of required material at the place of operations when needed without any delay.

The operations related to the storage of petroleum products and their transportation are a major aspect of the oil and gas industry which is categorised as midstream operations (Duan, Edwards and Dwivedi, 2019). According to Choubey and Karmakar (2021), there are many ways in which AI can assist the midstream operations of petroleum companies. First, companies can plan and execute the appropriate route by using AI-based calculations which can drastically reduce the cost of transportation. Moreover, the major challenge that the petroleum industry faces in the transportation process of petroleum products is the wastage of products during their journey to the targeted location in the form of the oil spill sea and oil wastage on roadsides. Mohammadpoor and Torabi (2020) stated that oil wastage in the sea which ultimately causes damage to ocean life as well can be reduced by employing AI-based detection tools which caution ship crew in case of any leakage of oil in the water. Thus, the crew can immediately ask for emergency support which can provide buffer time to emergency response teams. This technology will not only reduce the environmental and safety of workers risk but also reduces the cost of financial loss that companies had to bear due to the wastage of petroleum products in the transportation process (Balaji *et al*.,

2018). Furthermore, Lu *et al*. (2019) argued about the benefits of utilising AI in the downstream operations of oil and gas companies. According to McMillan and Varga (2022), one of the major benefits of AI downstream is that companies can estimate prices and predict the demand for petroleum products in the market. Similarly, companies' relationship with customers is a vital aspect of downstream operations in the petroleum industry. Mohammadpoor and Torabi (2020) stated that companies can structure their strategies through the assistance of AI-enabled techniques to improve the company's relationship with customers. Thus, overall, the implication for AI in the down, mid, or upstream results positively through the reduction in the costs and productivity of activities in the supply chain process.

AI's transformative potential in the oil and gas industry lies in the areas it influences, but the integration of AI must be balanced with technological capabilities to specific operational tasks. Using the Task Technology Fit (TTF) framework, this thesis explores how AI tools such as predictive analytics and reservoir modelling fit with the operational needs of resource intense enterprises such as ADNOC. For example, the task technology congruence of the use of AI in seismic surveying has high task technology congruence because the faster and more accurate data analysis is essential for exploration success. In the context of ADNOC, Technology Acceptance Model (TAM) offers a lens to understanding how perceived usefulness (for example, cost reduction, improved safety) and ease of use (for example, automated supply chain systems) influence adoption of AI. These advantages however come with challenges to implement AI in these areas. For example, workforce training and data quality are important barriers to task alignment in exploration and drilling operations. Like the UAE, the integration of AI in its regulatory environment needs to be done in a way that takes into consideration unique constraints like diverse workforce dynamics and high capital costs. This study helps extend TTF and TAM frameworks to complex, resource intensive industries by addressing these challenges.

2.3.3 To determine the drivers of the implementation of AI in oil and gas companies

Kuang *et al*. (2021) believed that AI creates value for an organisation, the drivers for the adoption of AI in the energy sector are novelty, knowledge from data, production increase, accuracy, cost saving, personalisation and efficiency. Nagy and Hajrizi (2018) discussed that AI is a novel technology in the field of the energy sector that is used to optimise energy management, storage

and consumption, which is lead to the improvement of organisational functions. Furthermore, Shukla and Karki (2016) believed that various features of AI such as big data, the IoT and ML are adopted by oil and gas companies which leads to the improvement of production, optimisation of equipment, monitoring of various organisational area and ensures the safety of employees.

Furthermore, Haroon, Viswanathan and Shenoy (2018) stated that production increase is another driving factor that compels business organisations to adopt AI. Kandziora (2019) mentioned that the production in oil and gas companies can be maximised by the implementation of AI, as it enables organisations to identify the areas of inefficiencies, based on which timely decisions can be taken to overcome them. Furthermore, AI has the potential to carry out automatic functions due to which a large amount of production data can be significantly managed by organisations. Sircar *et al*. (2021) added that AI helps energy sectors to generate algorithms based on which precise and effective guide drill can be developed due to which risks of accident can be reduced, chances of an oil spill and fires can be managed which reveals the economic benefits of AI implementation (Batra *et al*., 2019). Automation enables saving cost, time and labour, as per Parschau and Hauge (2020) energy sector is highly labour-intensive and the workers are in a highly uncertain situation, therefore, the implementation of AI can assist in automating tasks and identifying the best practices by saving the life of employees and increasing their efficiency. Therefore, it can be stated that novelty and production increase are among the key drivers that fascinate various energy sectors to embrace this technology. Additionally, Fountaine, McCarthy and Saleh (2019) stated that AI can improve the revenues of an organisation by efficiently managing the tasks of many employees within a limited time, companies can easily accomplish their projects with limited labour work. It is a driving factor that compelled many business organisations to incorporate AI in their organisational activities.

In addition, Wanasinghe *et al*. (2020) highlighted that AI can improve the accuracy within the business organisation which drives oil and gas companies to adopt this technology for their organisational function. As per Gupta and Shah (2022), companies with AI have a high probability of minimising human errors, as this technology enables them to recognise the faults in the mechanism which can result in effective maintenance, monitoring and tracking of the organisational functions, thus the efficacy of the production line can be improved. Furthermore, Lu *et al*. (2019) believed that the implementation of AI adds value to an organisation by providing deep insight into

the business processes and patterns which strengthen decision-making processes, consequently, the organisational outcomes can be improved. As per the study by Shaw *et al*. (2019), oil and gas companies using AI-based technologies have obtained a competitive advantage by improving their organisational functions. Thus, innovation is another key factor that can drive oil and gas companies to adopt AI.

Moreover, Ahmad *et al*. (2021) stated that AI has cost-effective as it enables organisations to optimise their organisational functions and reduce risk which positively impacts the overall revenues of an organisation. AI is a cost-effective technology that can enable organisations to gain a competitive edge by improving the quality of services and products. Thus, it is influential to save costs and achieve a competitive advantage. According to the study by Lu *et al*. (2019), the oil and gas sectors face issues due to the high cost of drilling and other operational functions. In this regard, AI can be implemented to automate traditional processes and enhance operational performance as a whole. Likewise, Mohammadpoor and Torabi (2020) stated that the propelling factor of AI for oil and gas companies is based on its cost-effective outcomes as it eliminates the risk factors associated with drilling and the transformation of the outdated production system to novel predictive technologies. It is used to minimise the maintenance cost of the reservoir and equipment of the oil and gas sector. On the other hand, Shukla and Karki (2016) criticised AI as a costly technology that cannot be afforded by all organisations. Organisations with limited budgets can face challenges to manage the cost for experts and specialists which can act as a major challenge for the implementation of this technology. Likewise, Lu *et al*. (2019) added that the implementation of AI requires new skills and trained employees, therefore, businesses might require new resources and changes within their existing models that can impact their overall revenues. Likewise, Varian (2018) stated that the adoption of AI can create a talent shortage in an organisation, which demands hiring new employees which will impact the revenues of the company. Therefore, it can be stated that besides the advantages of AI, some organisations cannot adopt such innovative technologies due to their high cost in the initial stages.

AI promotes high security and safety standards in the energy sector. As per Zahraee, Assadi and Saidur, (2016), the energy sector can lead to a hazardous situation because of its high flammability, in this regard, AI can be used to track the issues and challenges that can be fixed in time to reduce their damaging consequences. Temizel *et al*. (2018) highlighted that changing temperature is

another risk factor to the safety of the energy sector by impacting the maintenance of the equipment, therefore, AI can be used to detect and predict the temperature changes that can impact the equipment within the energy sector. Hence, using AI can play a significant role in the safety and maintenance of equipment and machinery due to which various business sectors adopt AI to ensure safety.

Moreover, Helo and Hao (2022) highlighted that the rate of AI adoption is increasing due to its ability to manage huge and complex projects. This technology ensures effective planning and identifies various aspects of the complex project that results in efficient handling of various tasks that can affect the project. Besides, Lo Piano (2020) added that AI-enabled technologies are capable of generating quality reports for the project and recognising the risks that can hinder the accomplishment of the project. The usage of such innovative technologies helps managers in the efficient management of resources (Lo Piano 2020). As per the study of Lee *et al*. (2019), AI is critical to acquire deep insight into the project which results in the improvement of accuracy, productivity and decision-making. Henceforth, it can be stated that AI has an immense impact on the management of complicated and huge projects within the oil and gas sector.

Moreover, the study by Abduljabbar *et al*. (2019) discussed that business organisations using innovative technologies like AI have highly satisfied customers as compared to companies without advanced technologies. The satisfaction of customers is significant for an organisation to achieve its goals and targets. AI technologies are facilitating companies to actively resolve issues that can impact their relationship with customers. Additionally, Paschen, Pitt and Kietzmann (2020) mentioned that AI-enabled chatbots have assisted businesses in maintaining effective communication that improves the customer experience by automatically detecting the queries of the customers and providing proactive support. Furthermore, Koch (2018) highlighted that AI tools are utilised by businesses to obtain data regarding the perceptions of customers and guide the companies to align their products and services with the needs and demands of the customers which leads to customer satisfaction. Companies with satisfied customers have a good reputation and loyal customers that assist in the growth and progress of the company. Based on the above discussion, it can be stated that the key drivers for implementing AI in the oil and gas sector are cost-saving, personalisation, innovation, customer satisfaction, innovative solutions, project

management, effectiveness, minimising human errors and effective decision-making as shown in Figure 2.2

Figure 2.2: Drivers of implementing AI in the oil and gas sector; Source: The Author

Human Resources as Driving Forces for AI Implementation in the Oil and Gas Industry Human intelligence is the major driving factor for the successful implementation of AI in the petroleum industry (Kuang *et al.*, 2021). As stated by Makridakis (2017), the adaptation of AI-based solutions is not generic like other organisational operations, thus it needs special attention from the organisations for positive results. Similarly, the AI-based solutions implemented by the third parties in the companies are also required to tailor-made the solution as per the data and business context of a company (Lu, 2019). Thus, companies must establish in-house teams made up of AI and data specialists to effectively utilise AI in their products and processes. Agbaji (2021) argued that this special team should support the implementation process of AI infrastructure by recommending tools for customisation that the companies can utilise in their processes and operations. Further, Wilson and Daugherty (2018) added that this team of AI and Data specialists will be inevitable for companies and will lead companies towards data-driven companies while assisting the oil and gas companies to successfully adopt innovative strategies based on AI in the coming 10 years. On

contrary to this, Oomen (2021) illustrated that the global job market lacks the availability of enough AI talent and acquiring and retaining AI experts is becoming a difficult task for companies across the world. Similarly, the emergence of tech giants such as Yandex, Google, Amazon, and IBM in the domain of AI is also not a healthy sign for the petroleum companies as oil and gas companies have to resist the negative perception of petroleum industries to compete with these tech giants (Agbaji, 2021). Thus, this resistance is not a cheap or easy job to perform for oil and gas companies.

Data as driving forces for AI implementation in the Oil and Gas Industry

The main foundation for the functioning of AI technology lies in the quality of data that backs the AI to make operational decisions (Oomen 2021). While the AI algorithm can make effective functioning through small datasets, bad data or inaccurate data cannot be manipulated in any way through the AI algorithm (Mathieson, Meehan and Potts, 2019). According to Hajizadeh (2019), the petroleum industry creates a large volume of raw data and there is no guarantee that this data can be employed in the efficient working of AI as the data lacks accuracy and quality. Thus, the quality and quantity of data is the major determinant of successful AI implementation in the oil and gas industry. Oomen (2021) illustrates that the collection of datasets should be done carefully by following the properly planned workflow in a particular situation by using a multi-year procedure.

Open Collaboration as driving forces for AI implementation in the Oil and Gas Industry AI was established as a result of open collaboration in academia through the inventions and research studies of multiple scientists (Nagy and Hajrizi, 2018). According to Ullevik (2017), these practices in research and development have given birth to the culture of free information transformation and open-source publishing of research findings. Similarly, businesses must understand the significance of open collaboration and embrace cross companies' and cross countries' collaboration practices to maintain the pace of digitalisation in the age of AI. Simensen and Thune (2018) argued that although tech companies across different sectors have started open innovation and collaboration, the petroleum industry has not yet started this practice of collaboration, particularly among competitors. According to Lu *et al.* (2019), although oil and gas companies claim to have open-access data and emphases on cross-company partnerships, there exist less open-source data about petroleum companies and the quality of data is also questionable. Feder and Rassenfoss (2019) added that there is only one oil and gas company in the world which has open-access data which is UK's Oil and Gas Company. About 130 terabytes of data are available on the National Data

Repository which contains information on about 3000 pipelines, 5000 seismic surveys and 12,500 wellbores.

The drivers of AI implementation in the oil and gas sector, such as cost savings, risk management, and production efficiency, align closely with theoretical frameworks like Technology Acceptance Model (TAM) and Task Technology Fit (TTF). For instance, the perceived usefulness of AI in automating production workflows and optimising reservoir management reflects TAM's emphasis on how technology improves organisational outcomes. Similarly, TTF explains how AI aligns with task requirements, such as predictive analytics for drilling safety and production monitoring, enhancing operational efficiency in complex environments.

In the context of ADNOC, these drivers take on added significance. For example, the adoption of AI aligns with UAE's strategic vision for digital transformation, supporting ADNOC's transition to a data-driven organisation. However, realising these drivers requires addressing barriers such as talent shortages and data quality issues. By applying TAM and TTF, this study investigates how these drivers influence AI adoption in ADNOC while also exploring the challenges that may limit its implementation.

2.3.4 To determine the barriers to the implementation of AI in oil and gas companies

There are many challenges that the petroleum industry is required to overcome to integrate AI effectively to gain its complete benefits (Chernikov *et al*., 2020; Bello *et al*., 2016). Some of the major obstacles in the petroleum industry include the management of mass data, ineffective risk management approach, and ineffective strategy for AI adaptation (Progoulakis *et al*., 2021; Ahmad *et al*., 2021). Having updated infrastructure and ample financial resources is key to successfully adopting AI in the operations of oil and gas industries (Abdelhamid, Ammar and Laid, 2021). According to Progoulakis *et al*. (2021), outdated infrastructure is the major barrier in the oil and Gas companies in the AI adaptation process. Similarly, the industry assembles huge data while cannot deal with the data effectively. Dudin *et al*. (2019) stated that companies also face great financial loss as a result of outdated infrastructure. Moreover, although AI is beneficial for petroleum companies it also costs a huge amount of capital as well in the incorporation process (Ragab, Yakoot and Mahmoud, 2021). Abdelhamid, Ammar and Laid (2021) also illustrated that acquiring suitable AI services providers and effective monitoring and management is quite a

complex task as it requires huge capital and time. While other challenges are equally important, the improvements in the other factors are also dependent on this factor. For instance, companies cannot acquire cyber security experts if there are no or fewer financial resources in place. Other scholars have also highlighted the major barriers to the development of AI technologies in petroleum companies (Li *et al*. 2021; Samylovskaya *et al*. 2022). Li *et al*. (2021) explored the challenges of adopting AI in oil and gas companies and identified three main aspects of challenges such as technology-linked challenges, people-related challenges, and process-linked challenges. Process-linked challenges include multiple aspects such as pressure to enhance revenue through cost reduction, management of business functions, processes, and downtime (Chernikov *et al*., 2020). Similarly, challenges which are linked to the people include the capacity of the available workforce to utilise new technology and the lack of experts in the field of AI especially current working people in the oil and gas industry (Bello *et al*., 2016). Lastly, technology-related challenges include the need to regularly optimise and supervise asset performance, enable the company's commitment to environmental factors, and enable a healthy workplace with less human involvement (Bello *et al*., 2016).

The commercial side of petroleum companies also poses a challenge for companies to implement AI technology which does not permit companies to try innovation due to multiple factors (Batra *et al*., 2019). For instance, absence of a complete model for business, no business acumen, and a lack of market preparedness to foster favourable conditions for companies as well as consumers. The managers in the petroleum sector are kept under constant pressure to minimise the maintenance and operational cost within the scope of the planned company's budget (Kuang *et al*., 2021). Similarly, Nagy and Hajrizi (2018) stated that a lack of incentives for managers that design new strategies does not motivate them to think innovatively to revolutionise the operations of petroleum companies.

The organisational structure is also a major determinant of organisational strategies to adopt innovative technologies such as AI (Mikalef *et al*., 2022). According to Ford, Steen and Verreynne (2014), majority of the petroleum companies employ a top-down approach in the management and governance of organisations. For instance, oil and gas companies' structures are quite rigid as employees strictly adhere to the operations, policies, and technology of the company. In this regard, Shafiee *et al*. (2019) stated that this rigid structure makes the adaptation process of innovative

technologies a slow or delayed process contrary to other industries such as the services and health industries that implement innovation way before the petroleum industries realise the significance of that technology. Moreover, the findings of Reuters (2017) also reaffirmed the fact that the top-down approach acts as the major hindrance to the bottom-up approach to implement innovation and the prompt incorporation of the latest technologies such as AI.

According to Wamba-Taguimdje *et al*. (2020) AI, applications are not beneficial without a configuration of other technologies. Managers must understand that AI technologies alone are not beneficial for companies, they have to consider the combination of distinctive AI technologies and will have to bring them together as per the organisational requirement to gain maximum profitability and competitive advantage. However, Majumdar, Garg and Jain (2021) found that the lack of skilled and qualified employees is a serious obstacle, experts say, which should be taken seriously, and oil and gas companies must take some serious initiatives to overcome the skills and experience gap. On the contrary, Lotosh, Platonov and Tkalich (2021) found a list of factors hindering the introduction of AI in different organisations. For example, the lack of necessary infrastructure, the fragmentation of the information systems, and the difficulty in interpreting the results are significant barriers to AI implementation.

From above analysis, the outlined barriers: legacy systems and regulatory constraints, reveal the importance of organisational culture and leadership in the adoption of AI. A theoretical gap exists in the research that integrates these factors into models such as the Technology Acceptance Model (TAM), and this study attempts to bridge this gap by studying how these barriers influence perceived ease of use and usefulness in the ADNOC context. The theoretical constructs of TAM and TTF are directly impacted by the barriers identified: outdated infrastructure and workforce skill gaps. For example, infrastructure challenges lead to decreased perceived ease of use (TAM) of AI systems because they are more difficult to incorporate into existing workflows. Just as skill shortages affect task-technology alignment (TTF) by creating mismatches between operational needs and capabilities, so too does the mismatch between operational needs and available capabilities. In this study, these barriers are examined with reference to ADNOC, and the ways in which they constrain organisational adaptability in a resource intensive, highly regulated environment.

2.3.5 Strategies to Overcome AI implementation Barriers

Several strategies are associated with overcoming the challenges related to the implementation of AI in the oil and gas sector (Hanga and Kovalchuk, 2019). Kuang *et al*. (2021) identified that these strategies include developing clear objectives and goals: Oil and gas companies need to define clear objectives and goals for implementing AI. This will help identify the most appropriate tools and strategies for achieving the desired results. For this purpose, the OGI need to adopt certain approaches that define the roadmap for setting up the AI projects. Analysing the status quo by taking inventory of the extent of digital maturity a company has to determine which sector of the oil and gas industry requires valuable improvements. The management of Oil and Gas Industries (OGI) requires developing AI goals to optimise operations. Quantification of possible benefits from AI is required to be determined for improving the efficiency of the process. The management of OGI must approach the implementation of AI with realistic expectations (Hanga and Kovalchuk, 2019). More expertise in technological requirements is required by maintenance effort and training to make operation in OGI easy with added value as compared to conventional methods. AI strategy is required to be developed which must be in line with corporate strategy globally. For this purpose, overarching goal related to the application of AI is required to be planned, companies have to define their operations and identify the functional areas that are required to be optimised with AI and determine the type of advanced technology and methods that are to be adopted for successful planning in OGI. Financial requirements for the implementation of AI are to be adjusted to analyse the successive organisational changes (Sharifi, Ahmadi and Ala, 2021).

Furthermore, Wanasinghe *et al*. (2020) stated that the success of AI implementation is dependent on how the operators accept the advanced technology which requires a willingness to get training for learning the method of adopting new technologies and processes so that organisational objectives could be efficiently achieved. In the oil and gas sector, experts in AI are required to provide practical experience to ensure the adoption of those processes and methodological approaches that help in overcoming the challenges associated with the operation of oil and gas companies. Additionally, Dudin *et al*. (2019) figured out that another strategy is about investment in the right technology: Investing in the right technology is essential for successful AI implementation. Companies should assess their needs and select the most suitable AI tools and platforms. The ADNOC is improving its AI investment despite being a late adopter. The report of

Global Data estimated that investment in AI by the oil and gas sector has increased to double from 61 to 119 since 2015 to the year 2020 (Reddicharla *et al.*, 2022). Companies that have made an early investment in AI have the benefit of exercising decreased cost and enhanced efficiency. ADNOC has also taken the initiative to successfully implement predictive maintenance which uses AI to anticipate equipment stoppage concerning the reduction of downtime required for maintenance. In this way, ADNOC has expected to gain maintenance savings of around 20% from this predictive initiative maintenance (Compare, Baraldi and Zio, 2019).

Solanki *et al*. (2021) argued that the oil and gas sector can improve the outcomes of business in upstream processes by integrating the data strategy and solutions for AI implementation.

Understanding the data is important in overcoming barriers as data is the main aspect of AI systems and ML. This data could be turned into a vulnerability despite it providing power to the AI system. Appropriate oversight of AI includes the documentation of sources for the development of AI models. The reliability of data has to be evaluated by looking for potential bias and operational concerns. Therefore, prioritising data security is essential for successful AI implementation for which companies should ensure they have adequate security measures in place to protect sensitive data from unauthorised access (Shaw *et al*., 2019).

Furthermore, Zhang *et al*. (2019) figured out that the adoption of sustainable measures includes a decrease in water usage as water is a vital component in the production processes of oil and globally OGI manages the recycling of 80-90% of this water to optimise the extraction process. Reduction of methane leakage is a cost-effective strategy adopted by OGI which is financially adaptable to reduce the emission of oil and gas methane by the utilisation of emerging AI technologies (Schneising *et al*., 2020). Moreover, utilising micro-refinery waste oil units helps in transforming the used oil into fuel that is an inexpensive alternative to be used in place of conventional oil disposal techniques. Innovations in the application of AI in oil and gas companies help in the improvement of the overall sustainability of industries by adopting more cost-effective processes (Wanasinghe *et al*., 2020). For instance, Mullakaev (2018) scrutinised that the use of ultrasound technology assists the companies of oil and gas in creating 3D pictures of the internal surface of oil wells which helps in making more advanced, informed, efficient and cost-friendly decisions. Likewise, the Internet of Things, enhancement capabilities, automation, emerging AI programmes

and reserve replacement help in finding and eliminating operational inefficiencies. Therefore, these are some significant strategies that help oil and gas organisations to minimise costs, become sustainable and reduce their carbon footprint.

The strategies outlined above attempt to overcome the barriers and improve the theoretical constructs of TAM and TTF. For example, workforce training reduces skill gaps, and thus improves perceived ease of use (TAM), and investment in AI infrastructure aligns with task requirements (TTF) by facilitating smoother integration of AI into ADNOC's operations. The application of these strategies will enable ADNOC to conquer adoption barriers and contribute to the larger theoretical discussion on the implementation of AI in state-owned enterprises.

Types of AI that can transform operations of ADNOC

AI tools and technologies can be utilised to identify areas for improvement, optimise operations, and reduce costs that can lead to developing better strategies for dealing with market volatility and maximising profit (Li *et al*., 2021). Mohammadpoor and Torabi, (2020) discussed that different types of AI can be used in oil and gas companies to transform their traditional practices and optimise their outputs. The usage of innovative tools can enable oil and gas companies to maximise productivity and unlock various opportunities that lead to organisational growth and progress. Similarly, Lu *et al*. (2019) highlighted different forms of AI for instance natural language processing (NLP), computer vision, ML, neural networks, Robotics process automation (RPA), Deep learning and the Internet of IoT. However, Orrù *et al*. (2020) argued that various forms of AI are used for the detection of potential failure and assist the business firm to manage the damage before the company face a major loss. Furthermore, Maniar *et al*. (2018) added that the oil and gas sector has utilised AI-based technologies for regular inspection of their operations which can lead to effective maintenance and management. Various sensors along with AI tools are used for the management of data that assist companies in shifting the time-consuming and costly traditional methods to digital ways to ensure better products and services. in this regard, Ghoddusi, Creamer, and Rafizadeh (2019) stated that ML is a subcategory of AI that is used in AI for the management of huge datasets that are collected from different surfaces, this technology is beneficial to decrease inefficiencies with the operations, for instance, causes of energy waste. Additionally, Khan and Al-Badi (2020) stated that ML can be used to identify issues in the reservoirs and provide solutions

that can assist in saving energy wastage. Mazumder, Salman and Li (2021) stated that ADNOC can use ML to predict the behaviour of customers and develop more efficient ways of operating.

Moreover, Tariq *et al*. (2021) highlighted NLP as a type of AI that assist machines to communicate and understand humans by processing natural language data. This technology can be effective for automating the process of customer services and analysing the feedback of the customers. Likewise, Dong *et al*. (2022) mentioned that NLP can be used in oil and gas companies in various ways, for instance, a large set of unstructured data can be analysed automatically to detect the relevant patterns and extract deep insight into the operational performance based on which organisation can make an effective decision. Moreover, Aminzadeh, Temizel and Hajizadeh, 2022) added that the utilisation of NLP can be significant for generating predictive plans and models that can be used to forecast the forthcoming trends and demands that can positively impact the processes of production and services in energy sectors. Furthermore, the implementation of NLP can be critical to programme organisational tasks, for instance, document reviews, trends, news and contracts that can improve the efficiency of the company (Castiñeira *et al*., 2020). However, Thomas *et al*. (2019) highlighted a risk associated with NLP that can impact the outcomes of an organisation, for instance, NLP can increase the risk of cyber threats to the organisation. This technology can be vulnerable to malicious attacks due to which business organisations can lose their confidential and sensitive data. Thus, effective management can assist organisations to take benefits from NLP and maximise their organisational outputs. Zhang *et al*. (2020) elaborated that multiple business firms are adopting NLP to comprehend and analyse the feedback from customers to acquire a better understanding of the demands and preferences of the customers. Therefore, NLP can be significant for energy companies like ADNOC to strengthen their organisational outcomes. Moreover, Milana *et al*. (2019) identified that the oil and gas sectors can implement another form of AI, for instance, IoT to improve asset tracking, optimise operations, and develop new services as this technology plays a significant role in the collection and exchange of data. The usage of IoT will further improve the effectiveness and efficiency of the company by significantly tracking and monitoring the equipment. However, Balaji and Silic (2022) criticised that like other AI tools, IoT can also create issues for business organisations due to the concerns related to data privacy and increased security risks.

Likewise, Kovács and Walker (2022) mentioned that identified that RPA is considered a major tool that can be adopted by oil and gas sectors to automate repetitive and mundane tasks, this technology can facilitate to reduce in the amount of time and resources spent on manual document processing and reduce the risk of errors. According to the study of Fernandez and Aman (2021), RPA technology continues to evolve, and it is expected that more applications and uses of this technology will be identified that can be significant for further improving the operations of the energy sector. In this perspective, Ivančić, Suša Vugec and Bosilj (2019) identified another AI subset for instance artificial neural networks (ANN) that are biologically inspired. This tool is used for a variety of tasks such as pattern recognition, feature extraction, classification, reinforcement learning, and prediction. As per Fauzi, Aziz and Amiruddin, (2019), neural networks can be used in the oil and gas industry to improve productivity, reduce costs, and increase safety. Neural networks can be used for a variety of tasks such as to acquire appropriate predictions when equipment is likely to fail so that maintenance can be scheduled in advance and repairs can be made before failure occurs. This helps to reduce downtime and improve productivity. Likewise, Tellez Gaytan *et al*. (2022) added that ANNs have become an important tool for the operations of the energy sector. These networks are capable of learning complex patterns that are not easily identified by traditional methods and can be used to optimise energy delivery, detect fraud, and improve predictive maintenance, for example, ANNs can be used to optimise the operation of renewable energy sources such as wind and solar power, to create more efficient energy systems. Nevertheless, Hanga and Kovalchuk, (2019) criticised that ANNs can also introduce new risks and vulnerabilities in energy networks, as they can be subject to malicious attacks and manipulation.

Furthermore, Epelle and Gerogiorgis (2020) discussed another sub-category of AI for instance Deep learning that mimics the workings of the human brain in processing data and creating patterns for use in decision-making. This tool uses algorithms to parse data, learn from it, and make determinations with minimal human intervention. Meribout *et al* (2020) stated that oil and gas companies have initiated to use of deep learning to improve safety and efficiency. Muradkhanli (2018) stated that deep learning can be utilised to optimise the location of oil and gas reserves and to identify potential new sources of energy which is significant to save costs and increase profitability. In contrast, Sireesha *et al*. (2018) criticised that the models of deep learning are difficult to interpret, making it difficult to understand the root cause of certain decisions or

outcomes. This can be problematic for oil and gas companies, who may need to explain complex decisions or results to regulatory bodies. Similarly, Biezma *et al*. (2020) mentioned that deep learning is effective for problems with simple inputs, but it may have difficulty modelling complex problems with multiple variables. This can limit its usefulness for oil and gas companies, who often have to deal with complex problems. Additionally, Hajizadeh (2019) stated that deep learning is a relatively new field and there is a shortage of experts in this area. This can make it difficult and costly for oil and gas companies to find the right talent to implement these models.

Based on the above discussion, it can be stated that oil and gas companies like ADNOC can embrace various types of AI such as ML, computer vision, NLP, deep learning, RPA and IoT to improve the safety, efficiency and sustainability of operations and increase their organisational outcomes. However, the company should ensure effective management to avoid negative consequences.

2.4 Literature Gap

Three significant gaps in understanding AI adoption in the oil and gas sector, specifically within state-owned enterprises such as ADNOC, are reviewed in this light. Research on how AI can contribute to operational efficiency, cost reduction and predictive analytics in resource intensive sectors is extensive (Lu et al., 2019; Koroteev and Tekic, 2021; Younus and Raju, 2021), but fewer studies examine how established theoretical models such as the Technology Acceptance Model (TAM) or Task-Technology Fit (TTF) can be applied to explain how AI adoption is aligned with organisational tasks, culture and regulatory constraints.

Knowledge Gap:

Most of the existing studies are aimed at benefiting from AI on reducing operational cost and making predictive analytics (Sharifi et al., 2021; Shaibu et al., 2021). But they do not investigate how AI impacts organisational agility and resilience in state owned enterprises such as ADNOC. However, this gap is critical because TAM and TTF have not been sufficiently applied to sectors with unique challenges, such as regulatory constraints and diverse organisational cultures (Kuklina, 2021; Koroteev and Tekic, 2021). This study fills this gap and extends these theories to external constraints that are applicable to ADNOC's environment.

Population Gap:

Much of the research on AI adoption ignores the geographic and cultural differences of the UAE. For example, the UAE's workforce is very diverse with employees of different nationalities working in different regulatory environments (Chaudhry et al., 2021). Studies such as those by Samylovskaya et al. (2022) and Bello (2021) have examined AI in particular places (Russia and Nigeria), but few have looked at the UAE. This study closes the gap by examining the cultural and regulatory hurdles to AI adoption in ADNOC, a state owned enterprise operating in a vibrant and multicultural environment.

Methodology Gap:

Previous studies have adopted a quantitative or mixed method approach often using surveys to collect data from employees or general stakeholders (Zeynalli et al., 2019; Moritsch, 2022). Quantitative research on managerial perceptions of AI adoption, specifically in relation to decision making and leadership, is scarce (Pagani and Champion, 2021; Abdulrahman et al., 2021). To fill this methodological gap, this study employs qualitative methods to gain insights from ADNOC managers in order to gain a better understanding of organisational readiness and leadership in AI adoption.

Theoretical Contribution:

The contribution of this study is to extend TAM and TTF with factors such as organisational culture, leadership dynamics and regulatory constraints. It also contributes to the discourse about AI adoption by investigating how these factors affect perceived usefulness (PU) and task-technology fit in ADNOC's operational environment. Additionally, the research poses critical questions regarding the interplay between technology adoption and organisational resilience and contributes to theoretical understanding in resource intensive and state owned sectors.

2.5 Conceptual Framework

This study's conceptual framework fills the gaps identified in Section 2.4 and draws from the theoretical foundations presented in Section 2.2. It bridges the practical limitations and theoretical insights, matching the questions and objectives to targeted contributions to TAM and TTF. The triangular design highlights the connection between the study's gaps, research questions, and theoretical contributions.

The identified gaps—knowledge, population, and methodology—form the basis of this framework and directly inform the research questions:

- Knowledge Gap: Research that explores AI's role in facilitating organisational agility and resilience in state-owned enterprises is limited. This leads to the research question: *"How is AI technology changing operations in ADNOC?"*
- Population Gap: The UAE context is unique and understudied in terms of its cultural and regulatory context. This guides the research question: *"Which parts of ADNOC's oil and gas industry are affected by the use of AI?"*
- Methodology Gap: There are no prior studies that examine managerial perspectives with a qualitative approach. This informs the research question: *"What drives and what impedes the adoption of AI in ADNOC?"*

The challenges identified are addressed using this framework, which extends theoretical models such as TAM and TTF. This study extends the scope of TAM by incorporating external factors (e.g., cultural diversity, leadership dynamics, and regulatory challenges) to state-owned enterprises operating in complex environments. Additionally, this research uses TTF to explore task technology alignment in resource intensive sectors such as ADNOC to better understand the impact of AI on operational performance.

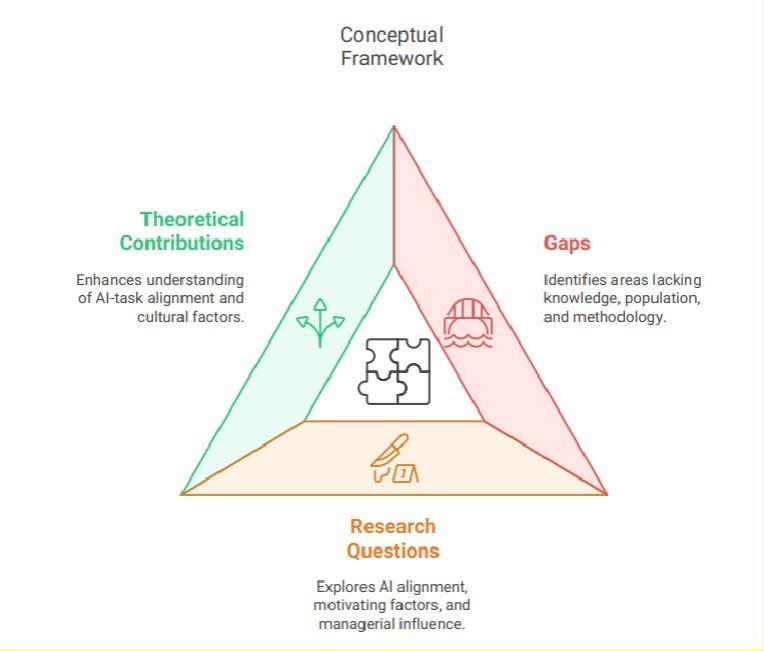

Figure 2.3: Conceptual Framework, Author's Contribution

The conceptual framework (Figure 2.3) is illustrated as a triangular structure to show how the logical progression from gaps to research questions to theoretical contributions is depicted. The top corner (Gaps) is the starting point in this triangular framework, indicating where we need to focus, such as knowledge of AI organisational impact, UAE specific challenges and methodological limitations. As shown in the bottom left corner (Theoretical Contributions), the study fills in these gaps to advance TAM and TTF. In the bottom right corner (Research Questions) you can see the inquiries that are driving this research, and which gaps they fill in with theoretical advancements. It also pulls together the study's coherence: connecting gaps to research questions that can be acted on and theories that can be measured. It provides a practical road map to explore AI adoption in resource intensive industries such as ADNOC, while making theoretical progress.

2.6. Chapter Summary

The literature review indicates that the oil and gas industry can derive transformative benefits from AI by means of predictive analytics, process optimisation, risk reduction and improved operational efficiency. Machine learning (ML), natural language processing (NLP), and computer vision are all AI technologies that are used for fault detection, seismic interpretation, reservoir optimisation, supply chain improvements. But AI is still an emerging technology and cannot be applied in

resource-intensive industries, such as oil and gas, without a delicate balance of technological capabilities and organisational readiness.

Challenges identified include the cost of errors, the lack of high quality data, and the shortage of available specialists with domain specific knowledge of both AI and the operational nuances of the oil and gas sector. These barriers can mean that AI implementation becomes inefficient and also pose a risk to human safety and organisational resilience. Companies like ADNOC should prioritise addressing these barriers (through investments in talent development, improved data governance and cross-organisational collaboration) because the literature points to it as a high priority.

The chapter from the theoretical perspective highlights a gap in the application of existing frameworks like Technology Acceptance Model (TAM) and Task Technology Fit (TTF) to state owned enterprises in the oil and gas sector. These gaps are associated with the special regulatory, cultural and organisational problems firms like ADNOC experience. This study bridges this gap by extending these theories to incorporate leadership, organisational culture and regulatory constraints that may affect the adoption of AI technologies. The chapter also provides practical strategies to overcome barriers to AI adoption such as setting clear objectives, using predictive maintenance and creating an environment of innovation in organisations. In addition, the identified gaps are integrated into a conceptual framework that links these gaps to research questions and theoretical contributions. This framework provides a foundation for the understanding of drivers, barriers, and impacts of AI adoption in the oil and gas sector, and guides the research design and objectives of this study.

3. CHAPTER THREE: RESEARCH METHODOLOGY

3.1. Chapter Introduction

The chapter for research methodology explicitly explains the different layers of Saunder's Research Onion Model as discussed by Ghazinoory and Aghaei (2023). The different sections of this chapter will explain the research philiosophy, design, approaches, and strategies utilised for the current study. In the last sections, the researcher explains the ethical considerations and conclusion.

3.2. Research Methodology

The method and techniques employed for the continuation of the present study area are elaborated on and justified in the current section of the dissertation. The study is executed by considering Saunders's research onion as a reference model, and all the techniques are selected from those offered by this model. Saunders's research onion has been conceptualised to provide step-by-step complete guidance for the execution of the research. Therefore, the research philosophy, approach and strategy selected based on Saunders's research onion are highlighted in this section.

According to Saunders and Lewis (2017), systematic research is conducted to investigate issues that help people comprehend them better. This section provides logical justifications and explanations for the methods of conducting research. In this view, Saunders' research onion (Figure 3.1) provides guiding principles, with each new layer assisting the researcher in selecting the appropriate research methodology and offering a rationale for the chosen course of action at each level of the study.

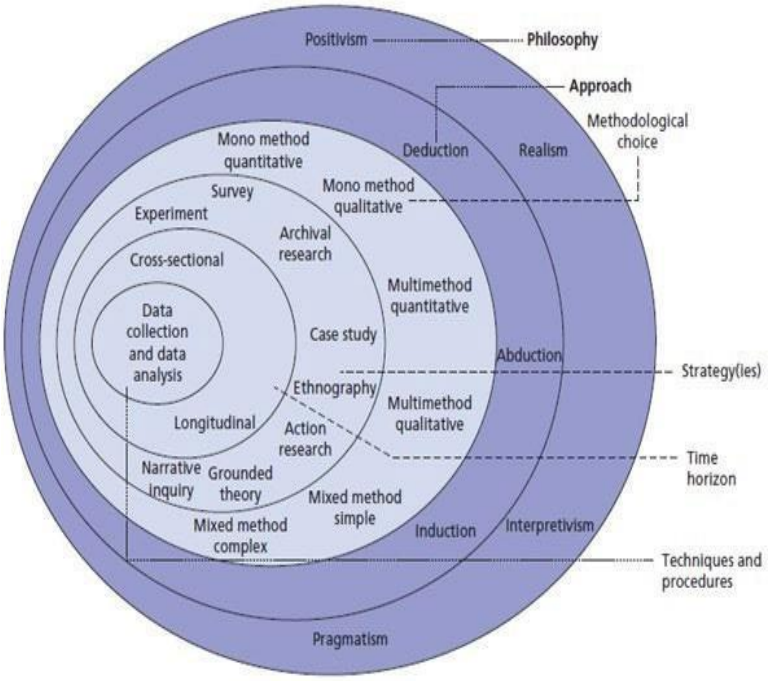

Figure 3.1 Saunders Onion. (Saunders et al., 2015).

Guiding framework offered by Saunders et al. (2016) of the research onion is used to outline and methodologically approach systematically the research. But it is not a rigid tool but a flexible model through which researchers can make informed decisions about research design, strategy and procedure. It is structured, but it is important to realise that not all methodological choices are included in this model. For example, Bryman (2016) criticises that while the research onion gives clarity to the research design, it may oversimplify the complex methodological decisions by putting them in the linear layers. Bell et al. (2018) also note that the framework does not necessarily accommodate mixed method or emergent methodology that may occur in the course of the research process. This research onion has been used as a framework to systematically guide the selection of the philosophy, approach, strategy, and techniques, while keeping the door open for other relevant methodological considerations where appropriate. The research onion layers have been carefully aligned with the research objectives and questions of this study, while acknowledging that some context specific methods fall outside of its scope.

3.3. Research Paradigm

The research paradigms offer a comprehensive perspective on knowledge growth, achievement, and acquisition. In other words, the fundamental focus of research is determined by its components,

which are determined by research paradigms. The researcher shows how an epistemological paradigm is applied to interpretivism studies to learn more about humans, their cognition, and descriptions of how various human experiences and behaviours arise (Khaldi, 2017)

Moreover, in a research study examining realities is done using ontology in interpretivism research (Rahi, 2017). In addition, the research paradigm is based on a generalised scope and frequently addresses the "what" aspects of research projects. For example, what is management? In addition, what tactics does the organisation employ? In other words, things are being observed by employing this study paradigm. Conversely, as demonstrated by Davies and Fisher (2018), ontology is used to identify similarities or distinctions between these items or groupings of things. Considering these aspects, the current study has used the ontological research paradigm due to several reasons. In addition to this, ontological can facilitate the researchers in exploring the relationship between the different variables of the study (Kaushik and Walsh, 2019).

Table 3.1 Research Paradigms

Research Paradigms	
Ontology	✓ This paradigm explores realities or different aspects of the real world. ✓ Finding similarities or differences between things or groups of things ✓ Example: Exploring relationships or impacts among them.
Epistemology	✓ Knowledge is derived from human experiences, and reasoning is observed to preview how these experiences change over time. ✓ Observing human behaviour and experience, including customer behaviour, and employee behaviour.

This research paradigm is ontologically situated in constructivism, with reality being socially, culturally and organisationally constructed (Bryman, 2016). This is in line with the research objective to explore AI adoption at ADNOC, which acknowledges the multi-faceted realities of the organisation, which is state owned, subject to regulatory constraints, and diverse in its workforce. The study is epistemologically an interpretivist stance that focuses on the subjective understanding and coconstruction of knowledge between the researcher and the participant (Alharahsheh and Pius, 2020). The research collects experiential insights through semi structured interviews with

managers, and analyses the phenomenon of AI adoption through thematic analysis. Subjective knowledge creation is a vital emphasis for understanding how individuals perceive and react to AI within the unique organisational context of ADNOC.

In this paradigm, the "reality" under study is the effect of AI in the oil and gas sector on operational transformation, agility and resilience. This reality is dynamic ontologically, influenced by organisational culture, leadership and external constraints. The research epistemologically aims to understand how knowledge about this reality is constructed through the experiences and perceptions of stakeholders engaged in the adoption of AI. The study's objectives are well suited to this paradigm as it allows one to explore complex, context dependent phenomena that cannot be fully captured using the quantitative approaches. The contribution of the study is twofold: it advances an understanding of AI adoption in state owned enterprises by situating the research within a constructivist ontology and interpretivist epistemology.

3.4. Research Philosophy

Among the available research philosophies are positivism, pragmatism, critical realism, the current researcher has chosen interpretivism research philosophy. From this, positivism was founded, positivists believe in objectivity and proving or disproving hypotheses and positivism came from foundationalism and empiricism. As contrast, interpreivism is closely related to the constructivist ontological concept — it believes that the reality is socially constructed and contextual (Lincoln, Lynham and Guba, 2011; Bryman, 2016). This is suited to the study of organisational phenomena such as AI adoption in ADNOC (Khaldi, 2017; Creswell and Poth, 2018), in which cultural, regulatory and managerial factors are important. As its epistemological stance, interpretivism is purely subjectivism in that the very aim of interpreting is to try and understand the 'lived experiences, perceptions and perspectives' of individuals (Scotland, 2012; Flick, 2014). The researcher and participants co create knowledge, shaped by contextual factors such as ADNOC's unique operating environment (Alharahsheh and Pius, 2020; Crotty, 1998).

The study uses interpretivism to explain the various realities of the participants, and to offer a rich understanding of how AI is experienced and enacted within a complicated organisational setting (Lincoln, Lynham and Guba, 2011). The research could explore the socially constructed meanings of AI adoption through the lens of interpretivism in conjunction with constructivist ontology and

subjectivist epistemology in alignment because it compliments these ontological and epistemological orientation with quantitative paradigms like positivism (Žukauskas, Vveinhardt and Andriukaitienė, 2018).

On the other hand, positivism is the theory of finding and analysing hypotheses based on the observable social facts. It makes use of the majority of quantitative approaches including experiments, surveys, and statistical analysis to make conclusions. In contrast, pragmatism has an allowance to study different kinds of real through combination of objective and subjective methods (Bhatta, 2018). But such dependence on practical applications can produce complications in terms of research depth and consistency (Nickerson, 2022). Positivism and pragmatism have their merits, but they are not deep enough to provide a deep interpretation of how complex phenomenon, such as AI adoption in ADNOC's cultural and managerial context, can be. Therefore, interpretivism offers the best lens to accomplish the research objectives by taking a qualitative insight and contextualised understanding (Alharahsheh and Pius, 2020; Khaldi, 2017).

Previous literature supports the selection of interpretivism. For example, Žukauskas, Vveinhardt and Andriukaitienė (2018) applied interpretivism to investigate the connexions between leadership practises and organisational phenomena. Like this study, interpretivism is also used to capture the context specific factors that influence AI adoption, including regulatory challenges, managerial perceptions, and cultural diversity. This research aligns with its objective to provide an in depth understanding of AI adoption in ADNOC because it integrates interpretivism.

Table 3.2 Research Philosophies

Research Philosophies	
Positivism	□ Positivism is used in quantitative studies. Examples: Quantitative methods of surveys, statistical data, and analysing of numeric values associated with the variables
Pragmatism	□ Pragmatism supports multiple realities and multiple data collection methods. Example: The Quantitative method is used to analyse the qualitative ones.

Interpretivism	□ Interpretivism is used in qualitative studies for in-depth evaluation. Examples: Observations, interviews, and focus group discussions

3.5. Research Approach

In this section, the most used research approaches identified by Saunders *et al*. (2019) are discussed followed by the explanation of the selected research approach for the present research.

3.5.1. Deductive Research Approach

The deductive method is a logical method that presupposes the existence of general truths. Thambinathan and Kinsella (2021) studied that deductive reasoning is a method of obtaining confirmation based on prior assumptions and observations. This deductive approach is generally carried out mathematically, then proven and re-confirmed against the mathematical formulation. The deductive approach can be described in the figure below.

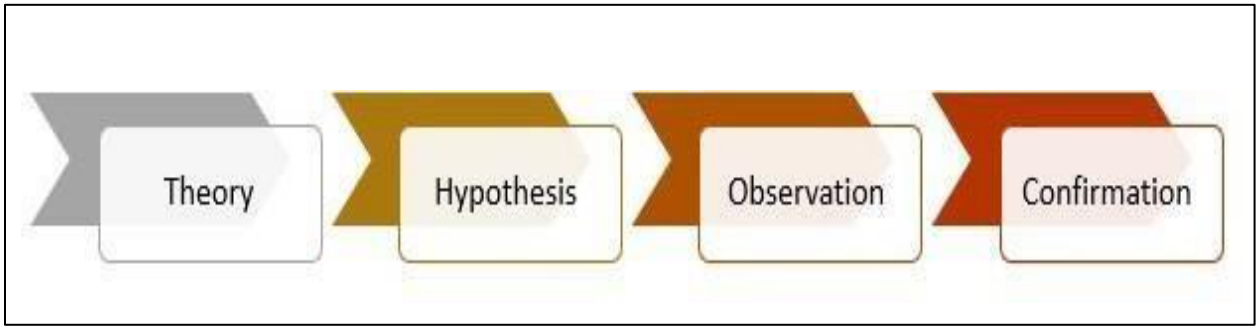

Figure 3.2 Deductive Approach

3.5.2. Inductive Research Approach

The inductive research approach follows the opposite path to deduction, as the chain of reasoning establishes the ascending connection in which the researcher starts from the particular to the general. In this case, the specific findings lead to the general laws. The inductive approach develops a hypothesis based on the results of experiments or observations (Gaus, 2017). A tentative hypothesis will emerge from this pattern. The pattern of observations leads to the formation of a hypothesis. After repeating the process, a hypothesis appears. A 'bottom-up' strategy is a method of conducting research. The following figure illustrates the inductive technique.

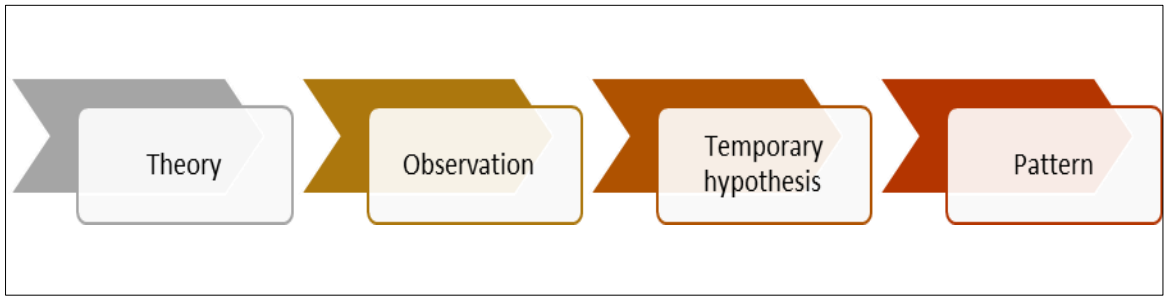

Figure 3.3 Inductive Approach

3.5.3. Abductive Research Approach

The research approach entails explaining the phenomena utilising both qualitative and quantitative data gathering and analysis methodologies in a fully integrated manner. Moreover, Abductive reasoning can assist researchers in digging deeper into their data, allowing for a more complete grasp of historical truth in social research (Opie, 2019).

3.5.4. Selected Research Approach: Inductive Approach

The use of an inductive approach aids in research and knowledge development through themes based on elements of business continuity strategy (Glesne, 2016). To do this, the interpretive philosophical attitude of the epistemological paradigm complements the qualitative study (Taylor, Bogdan and DeVault, 2015). The inductive technique also helps with the discovery and comprehension of text-based facts. The study's chosen inductive methodology enhances the analysis of qualitative information gleaned from interview questions and aid in understanding how collaboration and knowledge sharing affect continuity planning for health services in the UAE. Additionally, the qualitative data obtained through an inductive method may be used to identify strategies for maintaining the availability of healthcare services in the UAE's healthcare system during a pandemic crisis (Tuffour, 2017). Furthermore, Jamshed (2014) indicated that using an inductive technique enables researchers to develop the relationship between the studied variables.

3.6. Research Strategy

Research strategy involves gathering data, information and facts to confirm a hypothesis or answer specific questions (Oliva, 2019). Like other disciplines, research strategies are categorised based on their philosophical positions (positivism and interpretivism) and the extent of the researcher's

involvement (independent of the research process and his involvement in it. These strategies include case study, ethnography, survey research and action research. Researchers can benefit from considering different approaches to gain a better and more comprehensive view of the research process.

A case study is a scientific research approach that examines a specific instance in-depth and in detail (Mottron, 2021). This approach falls under the category of descriptive research in terms of scientific research methodologies. In this strategy, the researcher picks and investigates a case from many angles. This strategy aims to examine and understand the dimensions of the case under investigation in great detail. As a result, the case study is conducted more qualitatively, emphasising processes and their comprehension and interpretation. Unlike experimental research, case studies do not include manipulating the independent variable and observing its effects on the dependent variable (Rashid *et al*., 2019). An inter-case analysis is when a case study examines many instances simultaneously. The researcher gets the required data from different cases in diverse methods in this strategy. As opposed to this, Ethnography, one of the research approaches focusing on accurate knowledge of the culture of the study community, has attracted the attention of anthropologists and, recently, sociologists. The purpose of ethnography is to provide an accurate and in-depth description consistent with the participants' worldview in the social environment under study (Jones and Smith, 2017). In this regard, the people's social action is depicted in a way that is understandable and approved by them. The ethnographic research process and the active role of the researcher in it are based on a set of principles and criteria that make the research report of great importance to achieve this important point. Ethnographic research is a qualitative study in which the researcher observes and interacts with individuals in their natural surroundings (Hammersley, 2018). This strategy captures and explains events and processes in their natural settings. Different from ethnographic studies, action research is a commonly utilised approach in education research. According to (Banegas and de Castro, 2019), action research's methodological approach would enable researchers to provide information and knowledge for more effective application, promoting circumstances for actions and situation changes. The survey method studies the distribution of community characteristics through data collection. Some consider this method to be equivalent to collecting information through a questionnaire. Still, surveying is more than just collecting data and is one of the research methods. Although questionnaires are widely used in this method, other

techniques can collect information, including interviews and observations. According to Nayak and Dhaigude (2019) a survey is a collection of regular, consistent procedures for gathering information about people, families, or bigger groups and a tool to get information about a group of community members' ideas, beliefs, opinions, habits, or traits. Survey research processes and methods are based on the responses and feedback from the participants involved in the data collection process. They are carried out with the help of special techniques (research tools) - conversations, interviews, questionnaires, and tests.

3.6.1. Selection of the Research Strategy: Case Study

A case study approach is used in this investigation. A case study concentrates on an in-depth examination of a specific person, organisation, or event to examine the rationale behind theoretical foundations (Harrison *et al*., 2017). The benefit of this approach is that it focuses on the case of ADNOC, and therefore gathers rich, distinctive, and in-depth data to produce a comprehensive assessment. Using case study, the researcher is able to achieve a thorough overview of the issue by carefully analysing the subject under consideration. The researcher required an extensive focus on the case of ADNOC for which case study is suitable, Bhatta (2018) asserted that a case study's primary focus areas include events, personal behaviours, organisations, and outside environments (Bhatta, 2018).

Some of the scholars contributing significantly to the application of case study strategy include Steenhuis and de Bruijn (2006), Stake (1995), and Yin (2018). The definitions of the case study vary throughout the various writers' works on case study technique. For instance, Yin (2018) defines a case as a current occurrence that is taking place in a real-world setting, particularly when the lines separating a phenomenon from its setting are blurred, and the researcher has limited influence over the wonder and setting. One of the challenges of case study strategy is achieving validity and generalisability of the findings (Yin, 2013). However, Yin (1997) provides useful insights to understand how case study should be employed in terms of “three-featured profile”. The first is related to incorporate triangulation where compilation of information from different sources about single case or multiple cases is used, which can be both qualitative and quantitative. The second is related to achieve richness or depth of the data which specifically includes incorporating contextual information and the examining the research phenomenon at hand in its real-life context. Though Yin (1997) identifies the use of case study primarily conducted using secondary sources, it is

stressed that case study data must include firsthand instance from the field. Lastly and the most important feature of case study method is to understand the importance of generalising the findings. The generalisation depends on “development, testing, and replication of theoretical propositions (analytical generalisation)- rather than any notions based on the selection of numeric samples”. This provides a substantial basis for the present study to investigation the case of ADNOC in triangulation of secondary sources, contextually inclusive information and generalisation of the findings.

3.7. Research Design

. The current study has selected mono-qualitative design instead of other options such as mono, mixed, or multi-method approaches. In research, a mono-method refers to using a single research methodology, whereas a multi-method refers to applying multiple techniques. The two main types of research methodology are qualitative and quantitative, respectively. A qualitative inquiry focuses on qualitative data that is not numeric or subjective and offers a way for the investigator to examine the evidence by employing their thoughts, opinions, and values. It is a more exploratory sort of research. Moreover, the qualitative approach is more subjective and includes analysis and discussion of less critical parts of the study, including attitudes, views, and beliefs. In addition, the qualitative approach is more involved with realising people's viewpoints and giving relevance to their perceptions and thoughts. As per the study by Aggarwal and Ranganathan (2019), when it is required to learn about human nature or experiences, to evaluate a certain technique in-depth, to examine a single case study or a specific number of examples, or to understand a phenomenon for which the researcher used a qualitative approach. On the other hand, the quantitative approach emphasises a broader viewpoint in which the data are supported by quantitative information, i.e., mathematical and statistical statistics that are not presented in narrative formats and are not supplied by individuals in a series of verbal or argumentative exchanges (Khaldi, 2017). Furthermore, the quantitative approach frequently starts highly itemised and structured; discoveries can be carefully categorised into groups and displayed in statistical figures. While a questionnaire is commonly employed as the data collection tool in quantitative research, the researcher plays a key role in processing qualitative data (Bavdaz *et al*., 2019). Survey and questionnaire methodology, organised strategies, and numerical procedures, such as mathematical analysis, are examples of well-known

quantitative approaches in sociology. Datasets are then presented with logical techniques for an in-depth review to support findings.

The reason for selecting is that the researcher utilised a mono-method approach, integrating qualitative ways to gather data and create a specific dataset that allowed the researcher to examine the role of AI in the transformation of oil and gas industry operations in the UAE. Additionally, the researcher chose interviews as the tool for gathering qualitative data because this instrument was a suitable alternative to the other data collection methods.

3.8. Time Horizon

. This particular study anticipates being conducted at a specific period while collecting the data from the desired respondents and ensures to fulfil the research objectives. The researcher chose the cross-sectional timeframe because it enabled the researcher to critically evaluate and compare the results from the collected data from different variables and a specific time instead of repeating the research process repeatedly. Therefore, the researcher employed a cross-sectional method to critically evaluate the role of AI in transforming oil and gas industry operations in the UAE.

3.9. Sampling Methods

3.9.1. Probability Sampling Technique

In probability sampling, the group of people are randomly selected, which is beneficial to build strong implications for the whole population. The probability techniques include simple random sampling, stratified, systematic, and cluster, as shown in Figure 3.4.

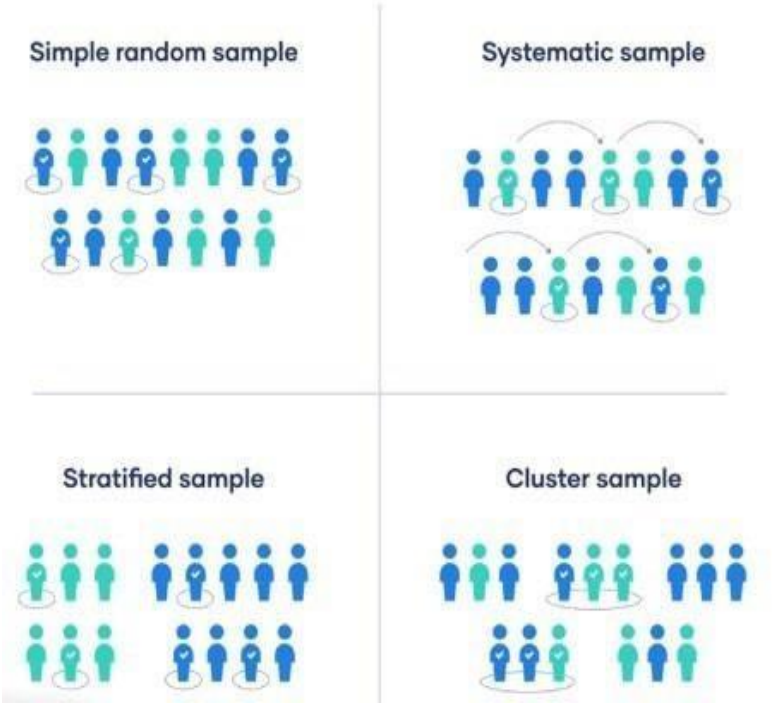

Figure 3.4 Probability Sampling Types, Source: (McCombes, 2019)

According to Rahman *et al*. (2022), probability sampling techniques are mostly used in quantitative studies where the researcher usually aims to accept or reject hypotheses and theories. However, the random sampling technique can also be incorporated into a qualitative where the study seeks to uncover information about the general population. Probability sampling is the most valid sampling technique when the researcher aims to produce generalisable conclusions. In the current study, the aim is to explore new insights into the role of AI in transforming the operations of oil and gas in OADNOC. The purpose is specific to the UAE context and requires information collected from a particular population having certain knowledge and experience. In addition to that, the research is not concerned with a particular hypothesis or theory acceptance/rejection. The study is exploratory and requires specific data collection from the right participants. For this reason, the researcher has not used probability sampling. Although probability sampling is argued to reduce the bias by providing equal chances to all selected individuals, it will not effectively respond to the main study questions requiring specific information collection. Thus, the researcher focused on the non-probability approach concerning its applicability and appropriateness.

3.9.2. Non-Probability Sampling

Non-probability involves the intentional selection of the participants based on either some criteria or the available time and convenience of the researcher. The common types of non-probability sampling techniques include convenience, snowball, and quota and purposive, as shown in Figure 3.5.

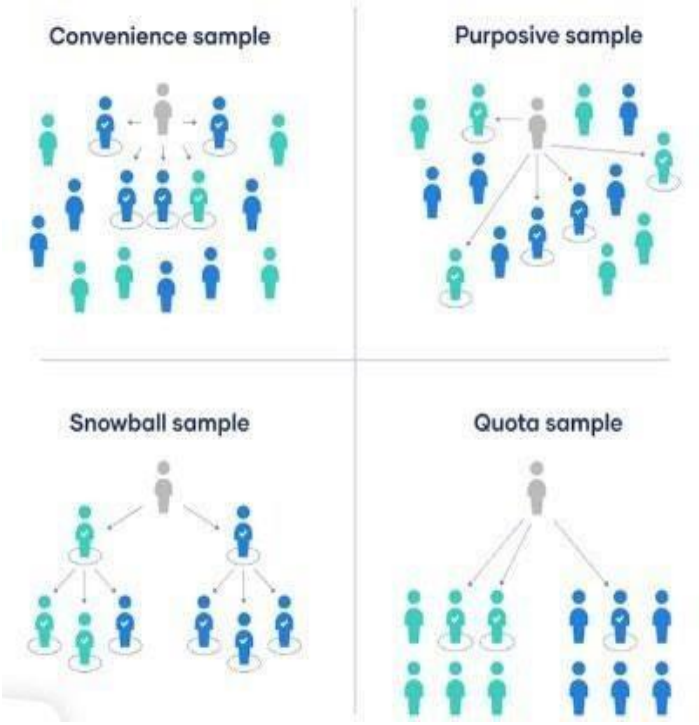

Figure 3.5. Non-Probability Sampling Types: (McCombes, 2019)

Non-probability is mostly applied in qualitative research, where the researcher aims to reveal new insights about the research problem that may require specific data collection. With the nonprobability sampling technique, a qualitative researcher can flexibly retrieve enough information from participants who can provide relevant and targeted data. This reduces the chances of encountering irrelevant information, which may slow the data interpretation and analysis process. Furthermore, Showkat and Parveen (2017) stated that non-probability sampling is best suited for qualitative designs where the researcher desires to understand an under-researcher population instead of testing a hypothesis about the broader sample. Based on the applicability of the current study, as the researcher aims to understand AI's impact on operations in a UAE context, the researcher explored non-probability sampling techniques. Among these, convenience sampling involves selecting participants using the available time and convenience of the researcher. For

instance, Etikan *et al*. (2016) stated that by using convenience sampling, a researcher may ask his family and friends to participate in the study voluntarily. These people are conveniently accessible and would not consume much time and effort. However, convenience sampling is unsuitable for the current study because the researcher is not acquainted with enough persons who have a background of working in ADNOC. Snowball and quota sampling are mostly used for larger populations where the time is short, and the researcher must recruit sufficient study participants. Smith and Dawber (2019) argued that individuals representing a population are selected based on their qualities and traits in quota sampling. These samples are then generalised to the rest of the people.

3.9.3. Selected Sampling Technique: Purposive Sampling

The purposive sampling technique is considered suitable for the current study due to its suitability and applicability. Campbell *et al*. (2020) claimed that purposive sampling is useful in gathering data from the right participants in the right amount as it allows greater control for the researcher. The researcher can select participants based on certain standards to gain the information needed to explore answers. For the current study, the researcher selected participants based on their experience level, professional position, knowledge, and background related to UAE gas and oil companies. As a case study strategy was incorporated, the case of ADNOC served the purpose of finalising suitable participants. Ames *et al*. (2019) argued that purposive sampling allows researchers to use their expertise to select study participants to gain the desired detailed knowledge. It is used mostly in qualitative designs and provides for achieving in-depth information about a research problem instead of making statistical inferences (Ames *et al*., 2019).

For the current study, the purposive sampling technique is considered beneficial because the population is very specific and small, and the researcher wishes to gather specific information about AI in UAE oil and gas large organisations. The sample size was decided to include 15 participants as considered adequate to identify issues around AI drivers and barriers faced by managers and other eligible employees in UAE large oil and gas organisations. People working in ADNOC specifically those with adequate experience and knowledge, include employees in senior positions like managers and other employees directly involved in the implementation of AI by other employees. In particular, these ‘other employees’ are operational staff, like data analysts, IT

specialists, and engineers that are participating in AI projects. They were involved with managing AI systems, operational monitoring, and feedback on alignment of AI with organisational goals. The sample size is justified for this study, as it will limit the data saturation during the research process. Data saturation is the point in a research process where enough data has been collected to draw necessary conclusions, and any further data collection will not produce value-added insights. The limitations include the researcher's high involvement, which increases the chances of bias element (Sharma, 2017). Thus, the researcher ensured that participants were selected carefully, assessing their knowledge and experience. The researcher ensured the relevance of participants by asking some basic screening questions like their familiarity with AI adoption, their roles in AI related projects and the limitations of AI tools in oilfields. For this purpose, the researcher asked some basic questions about adopting new technologies and questions specific to AI technologies. For instance, the questions related to the concept, its application in gas and oil operations and limitations of the AI tools in oilfields were asked to finalise the participants.

3.10. Data Collection Tools/Instruments

As the researcher has selected an interpretivism philosophy, qualitative data collection is considered suitable. The common data collection instruments that are relevant for assembling qualitative data involve observation methods, interviewing, focus groups and surveys through questionnaires, as shown in Figure 3.6. Each of these data collection instruments is subjected to advantages and disadvantages (Stratton, 2021). However, the suitability and applicability of each instrument were considered while selecting the data collection instruments for the current study.

Figure3.6 Qualitative Data Collection Tools, Source: (Canals, 2017)

Observation data collection tool is significant in collecting information about the research phenomenon, which can be done through the passive participation of the researcher (Muacevic and Adler, 2020). This means that the observation tool is appropriate for certain cases only where the researcher can engage in accurate observations by directly interacting with the environment where the problem occurs. The limitations of the observation tool are that it may not lead the relevant and specific information which can effectively identify and explain the research problem (Khakimova, 2019). The observation tool is unsuitable for the current study because AI's driving factors and barriers would not be effectively explained using incomplete information gained through observations. On the contrary, the focus group involves gathering qualitative information such as experiences, insights and opinions using a small group setting having similar backgrounds relevant to the research phenomenon. This data instrument was considered against its applicability in gathering effective data for the current study. Carey and Asbury (2016) highlighted a few limitations of focus groups, such as the overpowering of some individuals over others, which limits the passive personalities to express themselves fully. In addition, some participants may be reluctant to talk about sensitive topics and personal experiences if the data requirements demand to talk about

it (HERD, 2016). The researcher considered one-on-one discussions more suitable for the present context than focus groups. As opposed to this, questionnaires are mostly used for quantitative study design and as a fixed instrument containing standardised items/questions. The applicability of this instrument for the current study was analysed and deemed inadequate and ineffective. Although the questionnaire tool is mostly used in quantitative research, it can collect qualitative data using open-ended questions (McGuirk and O'Neill, 2016). However, the limitations include long written responses consuming more time to collect and analyse the data. Furthermore, this may not be suitable for persons with low writing skills or inadequate capability of putting feelings into words.

3.10.1. Selected Data Collection Method and Tool

The interview data-collecting tool is among the most common and prevalently used instrument for collecting rich qualitative data (Elhami and Khoshnevisan, 2022). As opposed to the questionnaire, interviews are fast and effective for retrieving information physically in a face-to-face conversation or through electronic mediums (Alamri, 2019). The right kind of participants can be selected for the study using an interview tool that supports the collection of detailed interview responses, reducing the chances of miscommunication. Thus, the researcher found the interview tool as the most suitable for the present context compared to the questionnaire.

3.10.2. Interviews

The interview data collection instrument includes three basic types considered when selecting this instrument, as shown in Figure 3.7. The interview types include semi-structured, structured, and unstructured interviews. As the name indicates, the structured interview tool is rigid and consists of a pre-defined set of questions the researcher asks during the data collection. There are advantages and disadvantages to using this interview type. For instance, a structured interview is beneficial because it gives direction and guides the researcher about what questions to ask during the interview.

On the contrary, the disadvantage of structured interviews lies in their rigidity and inflexibility, as the researcher cannot modify the questions or add more during the interview process (Magaldi and Berler, 2020). For instance, unstructured interviews might be useful for research where little information is available about the research problem and its background. However, unstructured interviews may not effectively retrieve information about specific research problems, leading to

more time and effort in gathering the targeted and relevant information. Thus, the semi-structured interview is considered beneficial because it gives the interviewer a certain level of freedom to modify or add more questions during the interview process as necessary.

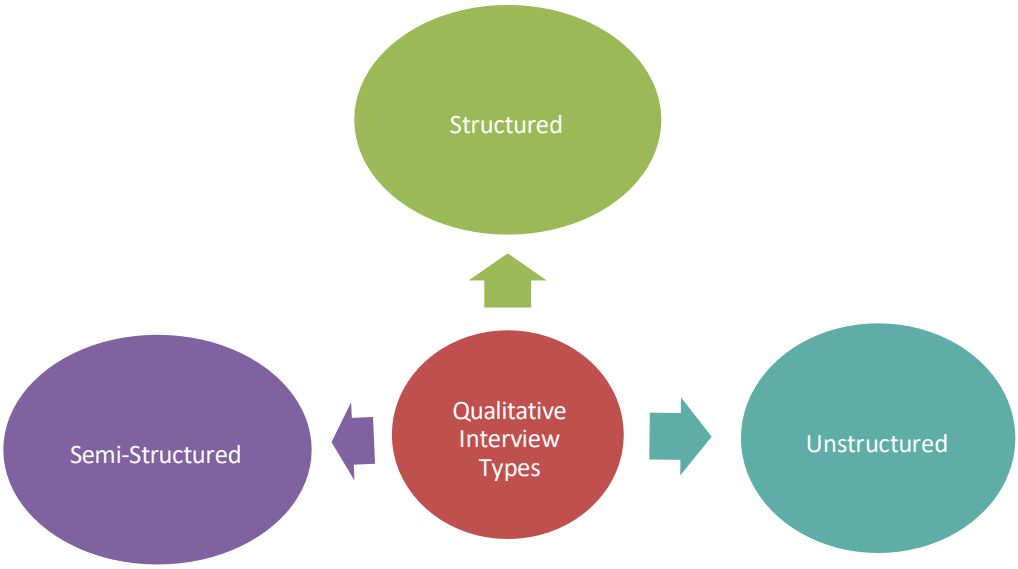

Figure 3.7 Interview Types for Qualitative Research, Source: (Alamri, 2019)

3.10.3. Semi-Structured Interview Tool

A semi-structured interview tool is selected for the current study. Adams (2015) highlighted that using a semi-structured type allows the interviewer to develop questions beforehand, so the researcher does not waste any time during the data collection process. The semi-structured interview types will enable the researcher to use close-ended and open-ended questions to reach clear and concise information. In addition to that, Kakilla (2021) highlighted that semi-structured interview allows probing to clarify the interviewees' responses, reducing the chances of misinformation and misunderstanding. Therefore, the study included a semi-structured interview guide to structure the questions. The researcher had an opening and easy question at the beginning of the interview to build the environment. The participants were asked first about their understanding of AI and their experience in the field. Gradually, the discussion moved to uncover how AI has transformed their work process, organisational operations, and workplace. The interview guide includes questions about *"What role AI has played in making overall function in*

*your department efficient?" u*sing a general to specific interviewing approach. The driving factors of AI adoption were aimed to be effectively captured using interview questions like *"What factors do you think triggered the management to have AI in* ADNOC*?"*.

The semi-structured interview guide was very useful for the present study as the author incorporated the correct use of this data collection tool. Adams (2015) mentioned that the researchers using a semi-structured interview guide must demonstrate the effective use of probe questions, such as close-ended questions as gateways to open-ended probing. Similarly, the interview questions should be carefully drafted, and it is best to pilot the questions first to validate them using few participants. The present study also piloted the questions using family and friends as an easily accessible population for validating the interview questions. The selected participants were invited to take part in the study. This included a letter to educate them about the purpose and outcomes of the investigation. The interview duration was kept at 45 minutes to 1 hour for each participant. The consent form was asked to be filled out by all participants to demonstrate that they were not forced. The consent form was emailed to the participants through email, and consent was taken in black and white. Although the author decided to conduct only physical interviews, some were also performed using phone calls and Zoom applications based on the convenience of the participants. The collected responses were recorded carefully to be analysed to find answers to the research queries. The semi-structured interview tool allowed follow-up from the participants, reducing the possibility of misunderstanding and increasing reliance on the responses.

3.11. Data Analysis Techniques

The data analysis techniques for analysing qualitative data include content, thematic, discourse, and narrative analysis. The researcher considered the suitability and applicability of the data analysis techniques to analyse the data effectively. The most used two types, thematic and content analysis, are compared to select the best-suited technique in the current study's data. According to Aacharya (2022), content analysis focuses on the words and the patterns in which these words are frequently used. Parveen and Showkat (2017) argued that the content analysis technique overemphasises words and tends to miss the context and cultural information behind the responses. It means that content analysis may not effectively analyse the current data related to the UAE cultural context and might focus more on words rather than their social meanings.

3.11.1. Selected Data Analysis: Thematic Analysis

The thematic analysis technique was used to analyse the responses from the interview tool of the acquired participant. As Javadi and Zarea (2016) indicated, thematic analysis can be used to assess several responses within a relatively short period. Themes are generated from recurrent responses to the data based on data display trends. The thematic analysis technique was employed by the researcher in order to obtain the flexibility to interpret and generate major analytical themes that will sufficiently answer the research objectives. A six step thematic analysis process as discussed by Maguire and Delahunt (2017) was used to systematically interpret and develop the data analysis relevant to the formulated questions and objectives. In Table 3.3, an abridged summary of each step, its tasks and outcomes achieved is provided. The detailed codebook used for this analysis is in Appendix 3. The present study had several features and advantages of thematic analysis, such as flexibility and effectiveness in finding information that is found in the interview responses. The selected technique, however, presents some limitations.

Table 3.3: Thematic Analysis Steps

Step	Task Undertaken	Outcome Achieved
1. Familiarisation	Transcribing and reading interview data	Key ideas and preliminary patterns identified
2. Generating Initial Codes	Coding raw data based on recurring concepts	Codebook created with 35 initial codes (Appendix A)
3. Searching for Themes	Grouping related codes into broader themes	Themes such as “AI Drivers” and “AI Barriers” identified
4. Reviewing Themes	Refining themes and validating relevance	Themes aligned with research objectives
5. Defining and Naming	Assigning clear definitions and sub-themes	Sub-themes under “AI Drivers” (e.g., cost efficiency)

6. Producing the Report	Integrating themes into findings	Detailed findings presented in Chapter 4

Thematic analysis limitations include credibility and trustworthiness. The reason for this is the researcher is actively involved in the interpretation of data. Nowell (2015) suggested that researchers should demonstrate that the analysis was performed exhaustively and with consistency and precision. This was done by the researcher to mitigate these issues and through using the six step thematic process rigorously as well as employing strategies such as keeping an audit trail of decisions, peer debriefing and reflexive journaling to ensure transparency. The initial code list and their hierarchies are also presented in Appendix 3 in order to demonstrate all the details. Table 3.4 shows only a part of the code mapping process in which the first-level codes were sorted into more general subcategories.

Table 3.4: Code Mapping

Initial Codes	**Themes**	**Evidence from Data**
"Lack of expertise"	Barriers to AI Implementation	“We don’t have enough specialists to manage AI.”
"Cost savings"	Drivers of AI Adoption	“AI reduces expenses significantly.”

An analysis of the data collected for the benefit of AI, and how AI is changing oil and gas operations in ADNOC, then gave rise to the development of initial codes. Table 3.4 shows how these codes were grouped into themes to ensure consistency in the process. According to Terry et al. (2019), thematic coding is a flexible and iterative process, they are created and modified until they are finalised. Table 3.5 summarises the major themes identified and indicates the supporting evidence. The data was then grouped into final codes that were grouped into initial themes and then final analytical themes were created based on the identified trend in the data.

Table 3.5: Themes and Validation

Theme	Validation Method	Supporting Evidence from Data
Drivers of AI Adoption	Frequency of mentions	Cited by 12 out of 15 participants
Barriers to AI Implementation	Triangulation with literature	Aligns with findings by Progoulakis et al. (2021)

The trends and the recurring useful responses to the test were analysed carefully and the major themes generated were used to address the research questions. Using NVivo software, the researcher was able to organise the data effectively and systematically for unbiased and systematic theme generation. Furthermore, the researcher was neutral during data analysis process to avoid bias criticised in qualitative research design. To remain neutral, strategies such as triangulation of findings with existing literature, and constant comparison of data during coding and theme development were used. To address the issue of neutrality, peer debriefing was done, and the themes were checked with the participants through member checking.

3.12. Ethical Considerations

Every research is subjected to ethical considerations in academics, research, and knowledge development. The researcher took approval from the ethical committee and an approval letter from the institution to display ethical considerations (see Appendix A). However, research ethics is typically related to how the research processes and outcomes may impact the stakeholders involved in the process and other living beings. Particularly, in qualitative research design, the involvement of human participants makes it imperative for the researcher to collect and analyse data keeping ethical considerations in mind. According to Dooly *et al*. (2017), research ethics includes taking informed consent from the participants. This means that participants should be aware of the purpose of the research and provide support to display that they are voluntarily participating in the study. Sivasubramaniam *et al*. (2021) argued that an unethical research practice involves forcing or bribing the participants to participate in the study, which results in low quality and unreliability of the data collected. On the contrary, an ethical researcher would obtain consent from the participants to

display their volunteer and active participation. The researcher obtained consent from all the participants using a consent form which included preliminary information to educate the participants about the study's purpose and outcomes.

The ethical considerations also include ensuring that participants are not disrespected or threatened during the data collection. Surmiak (2018) stated that some participants may hesitate to provide sensitive information regarding their employer/organisation. Similarly, Pieper and Thomson (2015) highlighted that treating the participants respectfully is a necessary aspect that novice researchers might overlook. Similarly, Elhami and Khoshnevisan (2022) claimed that trust should be developed between the researcher and the participant to gather the necessary data. The referent studies indicate that the researcher-participant relationship is key to collecting sufficient and relevant sensitive data. A non-healthy relationship between researcher-participant is likely to lead to insufficient and irrelevant data, which may not serve the purpose of the investigation. Therefore, the current researcher maintained a healthy relationship with all the participants through rapport and trust building.

Participants' reluctance is also linked to confidentiality issues and concerns over privacy and anonymity. Bos (2020) highlighted the significance of ensuring confidentiality and maintaining the anonymity of the participants. Thus, the researcher achieved this by maintaining the confidentiality of the data and ensuring the participants' anonymity. The participants' names were not used using pseudonyms, and their identities remained confidential. Dooly *et al*. (2017) stated that the researcher should maintain the integrity and consistency of the collected data to preserve quality and usability. The current researcher stored data in a cloud-based encrypted platform where integrity was maintained. Galdas (2017) argued that a researcher's unique perspective about the phenomenon's occurrence could interfere with the already collected responses. The qualitative researcher must remain isolated in terms of influencing his past experiences while interpreting the collected answers of the respondents.

3.13. Conclusion

The chapter highlights the overall methodological design of the current study. The research onion model was used to select the methodology layer by layer. The first layer is the philosophy selected as interpretivism based on how the researcher views and understands reality. Interpretivism

philosophy was chosen because it allows explicit investigation and an in-depth view of the selected research phenomenon. In the next layer of the onion model, a research approach is determined to develop an understanding and theoretical conception of the problem. Among induction, abduction and deduction, the researcher relied on induction as it allowed the generation of new insights specific to general direction. Data were systematically gathered by uncovering specific information about AI-based transformation in oil and gas operations and the drivers and barriers related to AI in ADNOC to provide a more general overview of AI in a UAE oil and gas industry context. The induction approach used a specific case of ADNOC to bring insights into general guidelines for large UAE oil and gas companies. The third layer of the model involved the discussion of the chosen methodology choice or the research design among mono, multi and mixed methods. As the researcher has selected interpretivism philosophy, an inductive approach, the research was structured and finalised based on a mono-qualitative research design. This means that a single data collection tool, such as an interview guide, was developed to serve the collection of rich and detailed investigations. The fourth layer of the onion required finalising the suitable research strategy among the available options, including survey, case study, action research, and ethnography. A comparison of these research strategies resulted in the selection and finalising of the survey strategy because of its suitability and applicability.

The fifth layer of the model is about the time horizon specifying whether the study was done during a certain period or in several intervals. As mentioned in the chapter, the study incorporated a crosssectional time horizon, meaning that data was gathered in a specific duration. The last layer discussed the selection of techniques and procedures. The researcher compared the data collection tools and found the interview tool the most suitable and applicable for the current study. Among the three mentioned types of interviews, a semi-structured interview was finalised. It provided the flexibility of the approach using a combination of open and close-ended interview questions. The research problem was explored in detail with the help of an interview guide, and the collected data was analysed using thematic analysis. Ethical considerations were kept in mind during the data collection and analysis stages. These include ensuring that participants are not included in the study using involuntary means such as bribing or forcing them. Furthermore, the personal details of the participants were not gathered to ensure that their identity remains confidential. A detailed

examination of how the relevant themes were developed from the codes and patterns is provided in the next chapter.

CHAPTER 4: DATA ANALYSIS AND RESULTS

4.1 Chapter Introduction

This chapter contains the details regarding how the collected data were analysed. The present study aims to explore the role of AI in influencing and transforming oil and gas operations in terms of identifying barriers and drivers that shape its implementation. The data analysis chapter is the critical aspect of research elaborated on in this chapter that is contingent on data assembled through qualitative research instruments. The interpretation of data and discussion part of the research has also been presented in this chapter. The case of ADNOC is taken into account and data is gathered to analyse the response from the participants. These participants are directly linked to the implementation of AI and are the key stakeholders impacted by the use of this technology in oil and gas fields. In this chapter, a step-by-step explanation is provided regarding how the collected data was analysed and the results of the analysis are also presented in the form of themes. Qualitative thematic analysis was performed on interview data collected via a semi-structured interview technique. The chapter presents the results of the analysis and the interpretation to provide insights into collected qualitative data.

4.2 Qualitative Data Analysis

The present study explored the areas that are influenced by the implementation of AI technology in oil and gas operations, using ADNOC as the exemplar case. To achieve the aim of the study, the researcher collected data from the participants who provided first-hand information about the issues or benefits they faced because of AI adoption and implementation. The participants were interviewed regarding the factors that they felt facilitated or limited the implementation of AI in oil and gas operations. Creswell (2007) highlighted that qualitative data analysis techniques facilitate the process in which the main research problem is examined in a natural setting instead of conducting experiments in a laboratory setting. Drawing upon this view, the researcher employed qualitative thematic analysis to systematically reveal useful information to address the objectives of the study by delving deeply into participants' responses. However, to narrow down the focus and

gain useful insights about issues or benefits that are faced during oil and gas operations in the presence of AI technology, the researcher has explored the operational areas of ADNOC by conducting 15 interviews with managers and employees from this company. A detailed overview of the selected participants and the data analysis steps and results are provided in the following sections.

4.3 Thematic Analysis

The thematic analysis method is opted for by the researcher to expand on the findings and interpretation of data. There are multiple reasons for which the researcher utilised this method to carry out the data analysis. First, this method provides the investigator the opportunity to critically explore the latent of any matter or problem deeply to get in-depth information (Terry *et al*., 2017). Similarly, Braun and Clarke (2006) who stated that acquiring the skills related to thematic analysis is vital as it not only assists in analysing qualitative data but also helps in performing multiple other forms of interpretation and analysis. Moreover, according to Clarke and Braun (2006), thematic analysis is a systematic process instead of a fixed methodology that provides freedom to the researcher to mould as per the stability and convenience of the researcher. Second, the other major benefit of employing this method is that it makes the overall analysis process easy and flexible (Neuendorf, 2018). According to Vaismoradi *et al*. (2016), the management of interview data becomes a lot easier as this method lets the researcher categorise data as per the repetitions in the data. Thus, the researcher can make multiple themes in accordance with the nature of the data. Similarly, this approach leaves no room for inaccurate interpretation by skipping any aspect of data. Lastly, the thematic analysis also enables the researcher to apply personal knowledge and experiences along with theoretical knowledge throughout the process of data analysis. This makes the interpretation logical which is based on all the perspectives such as previous theoretical and researcher's perspectives. Therefore, the interpretation and analysis of data are performed by applying the thematic analysis approach given by Braun and Clarke (2019). The researcher has followed the six-step process given by Braun and Clarke (2019) for qualitative data analysis. The process starts with the familiarisation with the data and is then followed by multiple steps which lead to the identification of themes and interpretation of data in a systematic way (Javadi and Zarea, 2016).

Although Braun and Clarke's (2006) thematic analysis process is useful and effectively employed in the present study for data analysis, it is necessary to acknowledge the limitations of this method. The most important limitation is that the original framework follows a linear process of developing and finalising themes from the identification of codes and patterns. However, the present researcher used an iterative approach and went back and forth throughout the thematic analysis process to ensure that the interview data was visited and revisited to ensure the robustness of the analysis. This also included alignment with the main purpose of the study, the researcher remained critical throughout the process to develop and finalise the comprehensive set of themes that most effectively addressed the research objectives. Additionally, the researcher remained reflexive to ensure that the interpretation and analysis activities were not influenced by preconceptions and presumptions about the subject matter (Braun and Clarke, 2019). Before moving on to the steps of the data analysis, the researcher first transcribed 15 interview data before proceeding further with the process of analysis of data. This was to anonymise any identifiable information of the participants as it is necessary that no personal information like email, or name is processed in the analysis stage. Along with this, the transcription process included analysing the tones of the responses to include additional details like sarcastic responses. Table 4.1 is given below which demonstrates the pseudonyms that are assigned to the participants to ensure anonymity while separating the responses of one participant from others. The selected participants had knowledge about how the adoption and implementation of AI were influencing oil and gas operations, mostly the participants were senior managers and had more than 5 years of experience working in the field.

Table 4.1 Participants Codes and Experience Level

Participants Pseudonyms/Codes	**Experience Level of the Participants**
A01	5 years
A02	6 years
A03	8 years
A04	7 years

A05	12 years
A06	7 years
A07	10 years
A08	5 years
A09	7 years
A10	6 years
A11	10 years
A12	5 years
A13	6 years
A14	9 years
A15	9 years

Once the interview transcripts were anonymised, the data analysis process was started.

Figure 4.1 is included below and provides a visual representation of the data analysis process using Braun and Clarke's framework for thematic analysis moving back and forth to finalise the themes.

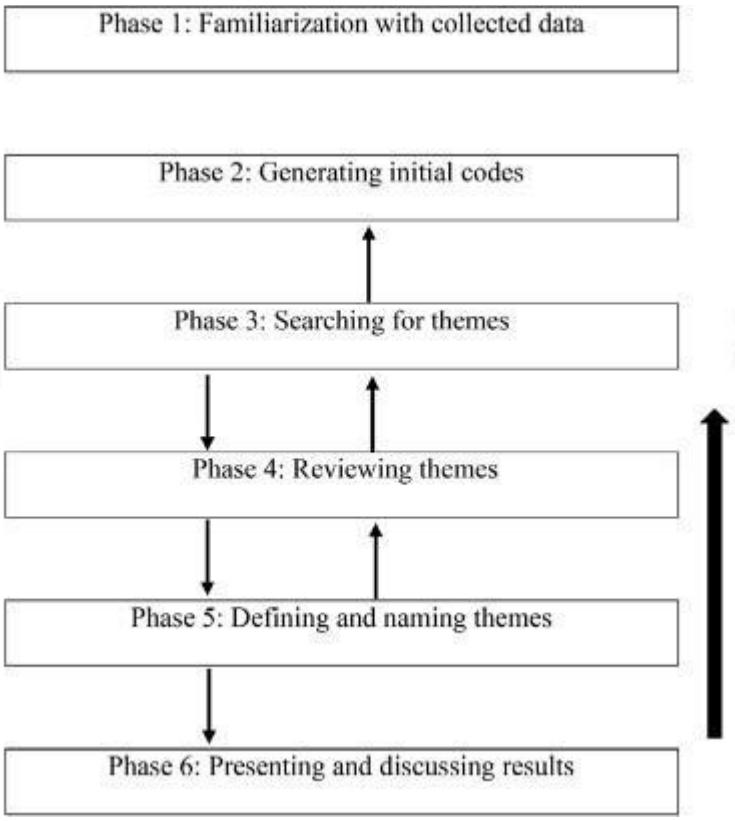

Figure 4.1 Thematic Analysis Process, Source: (Braun and Clarke, 2006)

The details of all the steps are provided below to provide a brief overview of each step and what was done during data analysis.

4.3.1. Step 1: Knowing the data or Data familiarisation

As shown in the image, the initial step in the process of thematic analysis is to get to know the data by using the strategy of reading the whole interview transcripts multiple times (Braun, and Clarke, 2019). During this phase, the researcher thoroughly went through the data and took notes to understand the overall impressions of the data.

4.3.2. Step 2: Initial Development of Codes from the data

During this step, the researcher prepared the interview data in a systematic and meaningful way. According to Maguire and Delahunt (2017), among multiple ways of coding the researcher can adopt any one as per the suitability and convenience. Thus, the researcher coded data in accordance with the thematic context and surface meaning of the data. During this process, the data was reduced extensively as the data was condensed into many codes.

4.3.3. Step 3: Exploration of Themes from Initial Coding (Searching themes)

Nowell *et al*. (2017) stated that the patterns extracted from the data which depict anything unique or significant concerning the research question or data are categorised as the theme. Similarly, Herzog, Handke and Hitters (2019) also argued that the creation of themes does not have any explicit rules or steps instead the researcher can create themes based on the similarities among the codes. Thus, the researcher grouped similar sorts of codes into one theme. Based on the similarities in the codes, the researcher (Table 4.2) identifies four main themes. Similarly, all these themes are also consistent with the main objectives of the study.

Table 4.2 Themes (Source: Author Created)

Theme 1	Influential Role of AI in the transformation of operations in ADNOC
Theme 2	Areas of the ADNOC that are influenced by the implementation of AI
Theme 3	Motivating Factors for AI Implementation in ADNOC
Theme 4	Hurdles in the implementation of AI in oil and gas companies in the UAE

4.3.4. Step 4: Reviewing the Themes

During this step, the researcher is required to revisit, alter, and review the themes which were generated earlier to assess multiple aspects (Forbes, 2022). The researcher explored the themes to investigate whether all codes fit in the assigned theme or if there is any need for modification in the themes.

4.3.5. Step 5: Definition of Themes (Naming and Finalising themes)

This phase is the last step in which the researcher refines the themes with the motive to determine the sense of each theme and what each theme depicts (Labra *et al*., 2020). Moreover, the researcher has to establish the link of subthemes with the main themes to bring clarity to the establishment of the process of the theme (Chapman, Hadfield and Chapman, 2015). In the current research, there

were no such sub-themes. Therefore, the researcher overlooked the themes and made a plan for the proceeding step which is to prepare the report.

4.3.6. Step-6: Report Generation

The last phase in the process of thematic analysis is the generation of the report in accordance with the themes and coding done during the initial phase of analysis (Xu and Zammit, 2020). This section of thematic analysis includes the description and interpretation of all the themes that the researcher has generated in the previous steps.

4.3.7. Theme 1: Influential Role of AI in the transformation of operations in ADNOC

The first theme, Influential Role of AI in the Transformation of Operations in ADNOC, describes the change that took place in the company's activities due to artificial intelligence. This theme is derived from participants' responses and focuses on three key sub-themes: Enhanced Productivity and Efficiency, Better Resource Allocation, and Enhanced Safety and Risk Management. The sub-themes outline how AI solves significant issues within the oil and gas sector, helping ADNOC deliver operational, sustainable, and strategic success.

The results for this theme were arrived at through inductive analysis guided by Braun and Clarke's (2006) six-step method for thematic analysis and Ritchie and Spencer's (1994) method of organising qualitative data. The responses provided by the participants were analysed and categorised into meaningful categories depending on emerging patterns and ideas. A mapping of the central theme and the sub themes is made to illustrate the thematic map and how they are connected. Furthermore, the participant's quotes as shown in table 4.1, table 4.2 and table 4.3 act as the prove to the findings.

This theme is in line with the theoretical frameworks of TTF as well as TAM. TTF shows how Operation needs of ADNOC are served by AI tools; how they address issues like resource management, safety improvement, and workflow. In this context, TAM reveals how the perceived usefulness and perceived ease of use affect the use of AI by stakeholders. The following is a discussion of the three sub-themes in detail and how they each help support ADNOC's AI transformation.

Theme 1 Emergence and Theoretical Aspirations

The first theme as revealed in this study came out clearly after a thorough analysis of the themes. First, the participant responses were categorised based on whether they mentioned automation, real-time decisions and safety advancements. These codes were then clustered into larger themes which for the purpose of analysis and organisation, were categorised into the three subthemes. This cyclical process of analysing the data made the conclusions more credible and aligned with the participants' experiences, as shown in the next sections. The overarching theoretical purpose of this theme is to fill the gap in known knowledge about how AI enhances operational readiness and adaptability in large-scale industries like oil and gas. As aligned with TAM and TTF, the findings present how AI can support ADNOC for solving its strategic concerns such as cost control, safety improvement, and sustainability. This study also supports these frameworks through the employed inductive approach and contributes to theory development by identifying novel patterns of AI usage in industrial contexts. A thematic map is also included, as highlighted in Figure 4.1, sub-themes are different but related elements of how AI is influencing the ADNOC operations. Each sub-theme contributes to the overall storey of operational transformation, as described below.

Thematic Mapping: Theme 1 and Sub-Themes

Figure 4.2 illustrates the relationship between the central theme, Influential Role of AI in the Transformation of Operations in ADNOC, and its three interconnected sub-themes: Improved Staff Productivity, Optimal Resource Utilisation, and Improved Staff Safety and Minimisation of Risk. In the middle is the main idea of the AI transformation within ADNOC's operating environment, which is the broadest application of AI within the organisation.

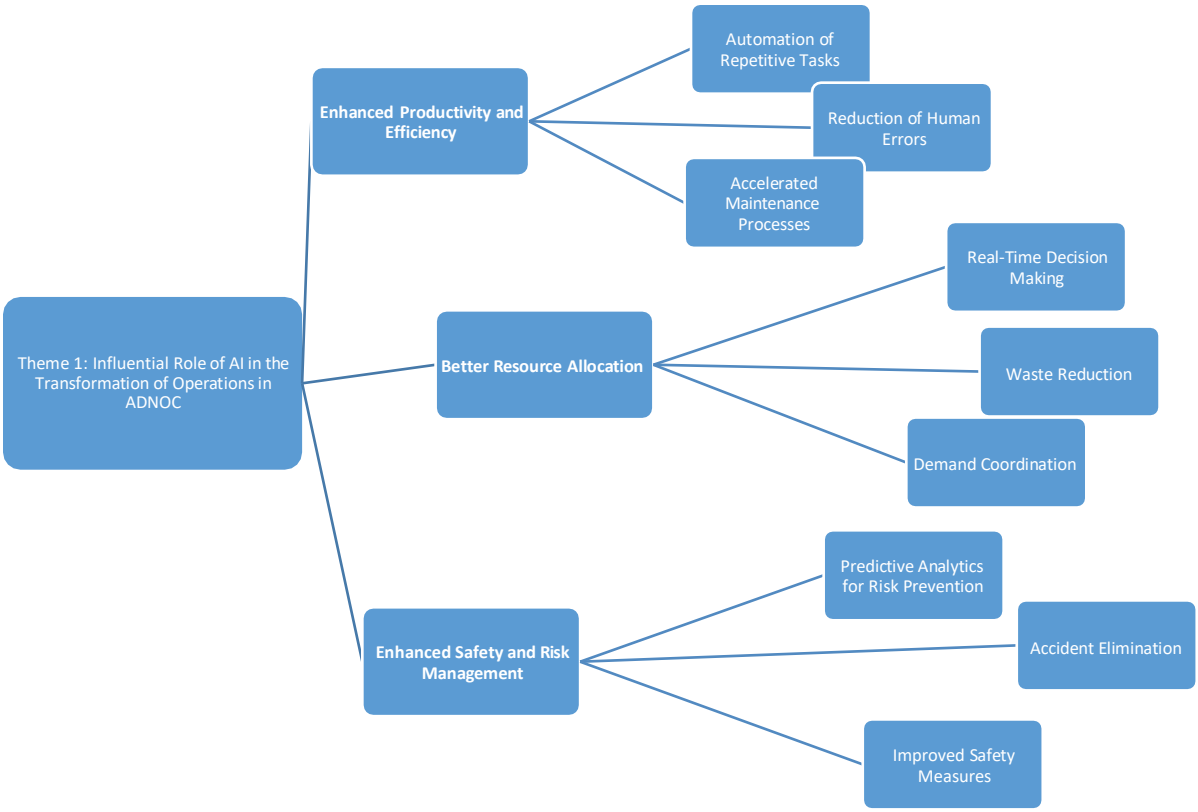

Figure 4.2: Thematic Map Theme 1

The first sub-theme, Enhanced Productivity and Efficiency, further splits as the foundational element of AI; detailing its role in automating work, minimising errors, and fast-tracking maintenance. This sub-theme paves the way for operations improvements by effecting changes right at the micro level of an organisation. Building on the preceding outcome, Better Resource Allocation is represented as another benefit of the insights driven by artificial intelligence. This sub-theme encapsulates some of the efficacy of AI to co-ordinate in meeting demand which is unpredictable, avoid behaviour that will lead to wastage, and make decisions in real-time. Such a location emphasises its function as a mediator between process improvement and overall organisational sustainability. The last sub-theme is the Enhanced Safety and Risk Management which focuses on the ability and impact of AI in risk prevention, accident elimination and general safety improvement. Placed beside the other sub-themes, this element illustrates how predictive analytics and anomaly detection fit into resource optimisation and productivity enhancement to create ADNOC's operational guardrails.

All three sub-themes presented here show that AI has a multifaceted effect, which is connected through chains of interlinkages that illustrate the ripple effect of the advancement's integration. The exact position of each sub-theme within the map illustrates the interaction of the various components, which support the improvement of overall operational transformation.

Sub-Theme 1: Enhanced Productivity and Efficiency

The first sub-theme captures ways through which AI enhances productivity by reducing inefficiencies, automating processes as well as offering better decisions. It is important here to note that participants highlighted the benefits of AI in saving time and reducing errors as well as increasing the overall accuracy. Participant A15 stated, *"AI tools have helped us in streamlining various operations like workflow, we used to spend hours in repetitive tasks which now are taken care of, in minutes. So, I would say that productivity is improved."* This quote sums up the most obvious advantage of automation that reduces human input and speeds up routine work.

Sub-Themes	Quotes from the Transcripts	Participant	Analytical Memo
Enhanced productivity and efficiency	*"AI tools have helped us in streamlining various operations like workflow, we used to spend hours in repetitive tasks which now are taken care of, in minutes. So, I would say that productivity is improved"*	Participant A15	Reflects the impact of automation in eliminating repetitive tasks and boosting productivity.
	"AI has brought automation with it which is proving to be beneficial for reducing human errors and increasing accuracy which is also boosting the efficiency of the operations"	Participant A03	Demonstrates AI's dual role in minimising errors and enhancing operational precision.

	"With AI, we are now able to determine the areas that are most likely deviating from its purpose, this has allowed us to speed up maintenance and increased efficiency of the operations, overall"	Participant A08	Highlights AI's predictive insights that accelerate decision-making and streamline maintenance efforts.

The table above provides extracts of interviews and analytical notes concerning this sub-theme. The table also reveals that participants pointed to the ability of AI in minimising human error and enhancing maintenance effectiveness. For instance, Participant A08 noted, *"With AI, we are now able to determine the areas that are most likely deviating from its purpose, this has allowed us to speed up maintenance and increased efficiency of the operations, overall."* This is in line with the capacity of AI in supply suggestive insights that would help in early intervention hence reducing on time wastage.

The results for this sub-theme are also consistent with the TAM framework which posits that perceived usefulness is a key determinant of technology acceptance. AI was considered by participants as helpful to enhance the performance of the tasks and to minimise the organisational constraints. Moreover, there is the evidence that AI tools are suitable for ADNOC's operation needs and would improve error rate and provide real time decision. On the thematic map presented in Figure 4.2, Enhanced Productivity and Efficiency is depicted as a second-tier sub-theme that supports the first-tier sub-theme of operational transformation which in turn is the foundation of the central theme. Relationships with other sub-themes such as Better Resource Allocation show how efficiency improvements in this area have a ripple effect on other areas of organisational performance.

Sub-Theme 2: Better Resource Allocation

The second subtheme is about how AI improves resource allocation using real-time analysis and forecasting functions. ADNOC participants explained how AI supports the organisation in efficient resource management and minimising wastage costs. This capability is more apparent in the oil and gas industry since resource limitation is likely to affect the operation's results. Participant A02

shared, *"The AI tools have been helpful in effectively allocating resources. The operations have been improved in terms of allocating resources based on real-time environment and demands, this has saved us costs by allocating resources efficiently."* This quote explains the connexion between AI's ability to optimally distribute resources throughout operations while matching them to the high variability in demand.

Sub-Themes	**Quotes from the Transcripts**	**Participant**	**Analytical Memo**
Better Resource Allocation	*"The AI tools have been helpful in effectively allocating resources. The operations have been improved in terms of allocating resources based on real-time environment and demands, this has saved us costs by allocating resources efficiently"*	Participant A02	Reflects the impact of automation in eliminating repetitive tasks and boosting productivity.
	"AI tools and technologies offer analytics that have facilitated and transformed decisions related to resources. AI has helped us figure out how to manage existing resources and work efficiently "	Participant A05	Demonstrates AI's dual role in minimising errors and enhancing operational precision.
	"AI tools have also predictive functions, the allocation of resources in real-time with predictive capabilities ensure that operations are optimised effectively and no resources are wasted"	Participant A11	Highlights AI's predictive insights that accelerate decision-making and streamline maintenance efforts.

The following quotes and analytical memos are also shown in Table above. Again, as depicted in the table, participants provided an unrelenting focus on the use of predictive analytics in the

management of resources. Participant A11 highlighted, "*AI tools have also predictive functions, the allocation of resources in real-time with predictive capabilities ensure that operations are optimised effectively and no resources are wasted."* This is true because AI is used to analyse data for decision-making that avoids over-allocation and resource wastage.

The results for this sub-theme provide a strong evidence for the TTF framework as they explain how AI instruments solve the problem of resource management at the level of tasks. With information on the required resources for the next period, AI helps ADNOC to operate in such conditions and be more prepared. TAM is also related, as participants' attitude towards AI benefits and ease of usage leads to the widespread implementation of the technology. In figure 4.2 Better Resource Allocation is also established as a sub-theme that comes after the improvement on efficiency that is brought by automation and serves a larger aim of cost reduction and sustainability. They emphasise the importance of AI in the achievement of ADNOC's operational goals due to the interconnection between these components.

Sub-Theme 3: Enhanced Safety and Risk Management

The third sub-theme focuses on the way in which AI can enhance safety and reduce risks in the operations of ADNOC. For its part, participants underscored how AI systems facilitate the real-time surveillance and prompt safety interventions, and help avoid mishaps and disruptions. Participant A04 noted, *"AI-based monitoring systems allow detecting issues and potential anomalies in the real-time environment which has improved the efficiency during field operations. This has overall enhanced safety management because prediction has reduced the chances of unwanted accidents and spill overs in the field, saving time and as well as human lives."* This has generally improved safety management because prediction has minimised the risks of undesired accidents and its spill overs in the field, time and human lives are saved. This quote shows how AI can minimise risks by pointing out risks which may occur if not controlled.

Sub-Themes	Quotes from the Transcripts	Participant	Analytical Memo

Enhanced safety and improved risk management	*"AI-based monitoring systems allow detecting issues and potential anomalies in the real-time environment which has improved the efficiency during field operations. This has overall enhanced safety management because prediction has reduced the chances of unwanted accidents and spill overs in the field, saving time and as well as human lives"*	Participant A04	Reflects the impact of automation in eliminating repetitive tasks and boosting productivity.
	"AI tools and models have been helpful for assessing risks that can hinder the efficiency of the oil and gas operations in the field. Using predictive insights we have been able to take measures to address the potential issues before they can lead to bigger consequences"	Participant A07	Demonstrates AI's dual role in minimising errors and enhancing operational precision.
	"... and the transformation I must say has been magical. I have to say this because of the AI simulations and modelling, the scenarios of various operations have been enlightening. This helps us to ensure that the existing measures in place are effective for new operations"	Participant A14	Highlights AI's predictive insights that accelerate decision-making and streamline maintenance efforts.

The table above highlights the fact that participants used the value of predictive safety measures quite often. For example, Participant A07 stated, *"Using predictive insights, we have been able to take measures to address the potential issues before they can lead to bigger consequences."* This

is a clear indication that AI support timely risk management, which enables ADNOC to handle safety issues well and avert operational interferences.

The results for this sub-theme confirm the expectations of the TAM framework since participants always identified that AI can help improve safety measures. Furthermore, the study enriches the theories of organisational resilience where AI has been demonstrated to enhance ADNOC's capacity to manage risks and cope with situations. In the context of the case, Enhanced Safety and Risk Management is presented as the sub-theme in Figure 4.2, which links to the operation efficiency and resource utilisation. This placement is consistent with the fact that these sub-themes are intertwined and their cumulative impact on operational change in ADNOC.

In general, the observations made under Theme 1 offer important insights to theoretical and practical fields of study. With the results aligned with both TAM and TTF, these theoretical frameworks are confirmed in the context of industrial AI adoption. Moreover, the relationships between the sub-themes can construct a novel holistic theory of operational change via AI, which would provide a more comprehensive approach to fixing the current approaches' shortcomings regarding safety, resources, and efficacy.

4.3.8. Theme 2: Motivating Factors for AI Implementation in ADNOC

The questions were asked to the participants regarding the areas which they thought were the most impacted due to the adoption and implementation of AI. The interview questions naturally led to the revelation of examples from the participant's experience that further enlightened how exactly AI has impacted the identified areas of oil and gas operation. The major areas which have been impacted, as retrieved from participant's responses, include reservoir management and exploration, oil and gas production planning,

One of the key areas that were found to be the most impacted, as per participants' experience, was the exploration and management of oil and gas reserves. About 80% of the participants highlighted that they have observed better management of reservoirs and as well as improvements in the exploration of oil and gas after AI. The advanced AI tools have transformed the processes involved in employing the seismic data, this has led to accuracy and efficiency in locating and finding oil and gas reserves. These tools have also reduced the chances of human error that led to increased costs and waste of resources in the past. The level of accuracy and precision these tools provide is

something needed previously but was unachievable. This gap has been filled by AI tools and technologies that have led to the discovery of potential oil and gas reserves with great precision that have greatly opened opportunities for finding more reservoirs with reduced margin of error.

Theme 2 is Motivating Factors for AI Implementation in ADNOC, which focuses on the factors that have led to the implementation of artificial intelligence in ADNOC. This theme arose from the responses where participants described several reasons such as environmental impacts, competitive advantages, regulatory compliance, safety improvements, cost reductions, and enhanced exploration and production. All of the above-discussed aspects facilitate an understanding of the strategic logic behind ADNOC's AI investment. Developed in accordance with Braun and Clarke's (2006) thematic analysis framework and Ritchie and Spencer's (1994) qualitative framework approach, this theme captures the complexity of AI's contribution to ADNOC's operational and strategic agenda. As shown in the thematic map, the central theme links to other sub-themes, each of which is a different category of motivation. Table 4.7 provides selected quotes for this theme, synthesised into four subthemes that emerged from the analysis: support, conflict, disconnection, and negotiation. Employees' reactions are consistent with this theme, which corresponds to the Technology Acceptance Model (TAM), concerning the overall perception of AI as a tool for innovation and the degrees of perceived usefulness and perceived technology. It also proves the TTF framework by showing how AI aligns with ADNOC's objectives and operation and strategy. The remainder of the paper presents findings related to each of the sub-themes in turn, incorporating participant quotations and authorial analysis.

Thematic Map: Theme 2 and Sub-Themes

The thematic map presented in Figure 4.2 shows the Motivating Factors for AI Implementation in ADNOC and their relationship with the central theme and the ten sub-themes. The core theme is at the centre of the map and gives an overall picture of the motives that were identified in the responses from the participants. Linked to the central theme, branches of every sub-theme are presented, which shows how different aspects of AI implementation converge in realising ADNOC's strategic objectives.

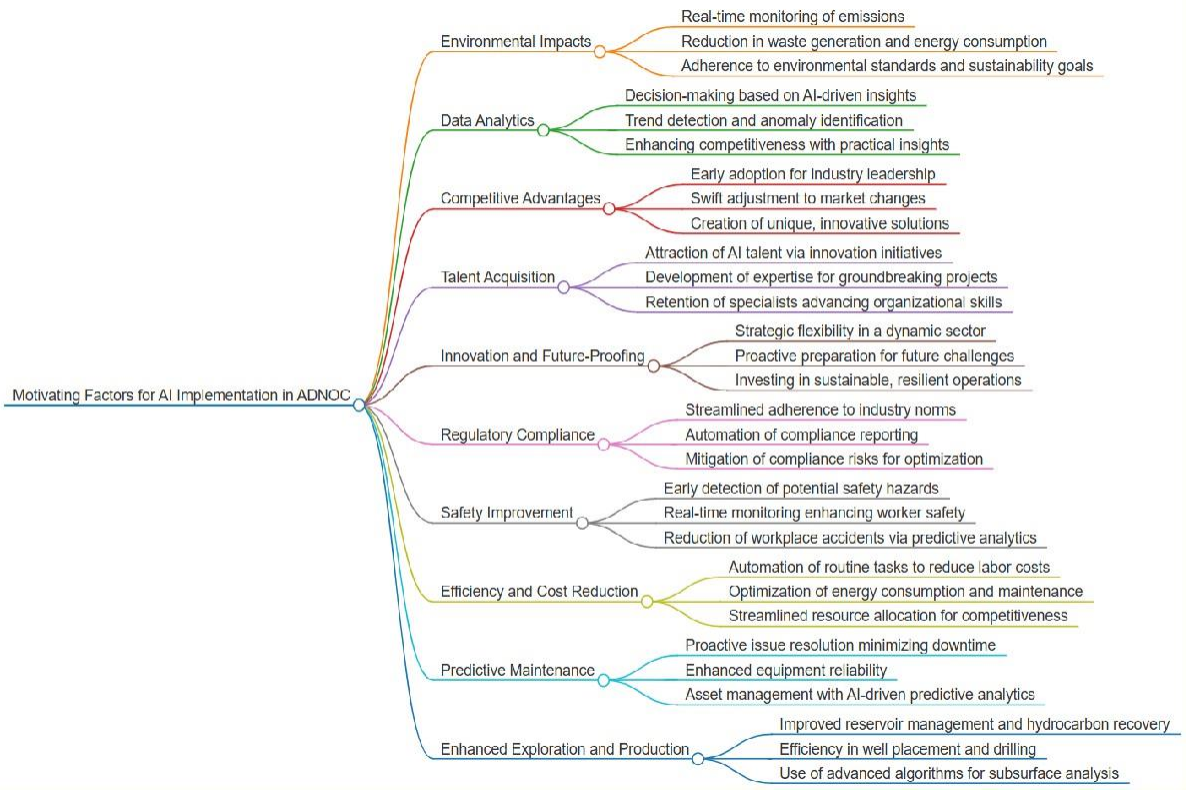

Figure 4.3: Thematic Map Theme 2

The map illustrates that AI implementation in ADNOC has multiple factors behind it, which are in line with sustainability, operations, innovation, compliance, and safety. Each sub-theme bifurcates into particular motivators and demonstrates the use and management of AI, as well as the strategic opportunities that arise from its use. For instance, the sub-theme, 'Environmental Impacts', overlays aspects such as real-time emission, minimising waste with themes of sustaining goals, and environmental friendly themes emphasising on the green nature of ADNOC. Likewise, the Efficiency and Cost Reduction sub-theme explains how AI is useful in processes, energy use, and costs which help ADNOC to gain a competitive edge.

Data Analytics and Competitive Advantages as sub-themes capture the core value of artificial intelligence in strategic management of organisations. The utilisation of AI to handle large volumes of operational data improves on the detection of trends and anomalies that assists in the formulation of strategies that can help bolster ADNOC's position in the oil and gas market. However, the sub-theme of Talent Acquisition and Innovation and the sub-theme of Future-Proofing focus on how AI is useful in attracting professionals and developing organisational competence and readiness for

possible future problems in the oil and gas industry. The sub-theme of Regulatory Compliance captures on the AI solutions in ensuring compliance with standard set industry, automating compliance reporting and compliance risk management which are fundamental in sustaining reputation and operational integrity of ADNOC. The Safety Improvement sub-theme shows how AI makes real-time monitoring possible, spots dangers, and decreases workplace incidents by analysing data. These sub-themes such as Predictive Maintenance and the Enhanced Exploration and Production are the operational core of ADNOC's business. Condition monitoring allows for a timely intervention to minimise equipment failure and increase uptime, while AI solutions improve the algorithms for reservoir and well placement and subsurface understanding for optimal resource recovery.

Overall, this thematic map synthesises the nature of these sub-themes to better explain how and why AI is adopted in ADNOC, based on operational needs, environmental contexts, and strategic goals. The organisation of the map not only the significance of each sub-theme but also the relevance of all of them to the ADNOC's long-term vision of tomorrow's technological and operational advancement. In this way, the thematic map is comprehensive enough to sum up the richness and versatility of the motivations behind ADNOC's AI implementation.

Sub-Theme 1: Environmental Impacts

The first sub-theme is the role of sustainability as a motivation for AI implementation in ADNOC. It is in this regard that participants acknowledged the usefulness of AI in achieving a reduction in the effects on the natural environment through monitoring and adherence to sustainable practises. Participant A05 stated, *"Real-time monitoring of emissions has allowed us to identify and address environmental inefficiencies, helping us align with sustainability goals."* This view also provides the vision of intelligent applications for enhancing environmental outcomes and maintaining compliance. The table below also indicates that participants often discussed AI in relation to waste and energy efficiency factors. Hence, this created confusion among the participants. Participant A07 shared, "*The reduction in waste generation and energy usage has been significant since implementing AI-driven insights."* These quotes demonstrate how AI fits into ADNOC's larger sustainability picture when it comes to the environment.

Sub-Themes	Quotes from the Transcripts	Participant	Analytical Memo
Environmental impacts	*"AI facilitates the real-time monitoring of emissions, so enabling the adherence of ADNPreOC to environmental standards and the mitigation of carbon footprint."*	Participant A03	AI-driven monitoring ensures ADNOC meets regulatory compliance while actively reducing its carbon footprint.
	"The implementation of artificial intelligence (AI) in our operations has resulted in noteworthy reductions in both waste generation and energy consumption, hence enhancing the efficiency of our processes"	Participant A08	AI optimises resource utilisation, contributing to waste reduction and improved energy efficiency.
	"Today, all industries—including energy—prioritise sustainability and environmental responsibility. AI helps ADNOC reach environmental targets by monitoring emissions and optimising processes in real time. Thus, ADNOC is better complying with environmental rules and promoting a cleaner, more sustainable energy future."	Participant A11	ADNOC leverages AI to align with sustainability goals, enhancing its reputation as an environmentally responsible energy leader.

The entry in above table provides the analytical memos to show how this sub-theme underpins the TTF framework and illustrates AI's capacity to address the particular requirements of the task when

it comes to monitoring the environment. Moreover, this sub-theme relates well with TAM's perceived usefulness since the participants see AI as being critical in delivering sustainable goals.

Sub-Theme 2: Data Analytics

Sub-Themes	Quotes from the Transcripts	Participant	Analytical Memo
Data analytics	*"The utilisation of AI-driven data analytics enables individuals to efficiently and precisely make decisions based on facts. Our team of data scientists is utilising AI techniques to extract significant insights from our extensive datasets."*	Participant A02	AI-powered data analytics enhances decision-making by transforming vast datasets into actionable insights, improving operational efficiency.
	"*Data drives the energy business, including ADNOC. Data analytics enabled by AI are vital for managing our massive operations data. These algorithms help us gain practical insights from complex datasets that humans cannot analyse. AI can discover trends, patterns, and anomalies, enabling us make data-driven decisions that are crucial to the company's growth and competitiveness."*	Participant A05	AI helps ADNOC process complex data, identify trends, and improve forecasting, reinforcing its competitive advantage in the energy sector.

Sub-Theme 3: Competitive Advantages

The need to deliver competitive advantage to ADNOC came out as one of the key reasons why AI was adopted. The participants explained how the adoption of AI technologies makes ADNOC a market leader that is capable of integrating new developments in the market. Participant A11 remarked, *"AI enables swift adjustments to market changes and the creation of innovative solutions*

that keep us ahead of competitors." This quote shows the ways in which AI increases the strategic manoeuvrability and innovative readiness of ADNOC.

Sub-Themes	**Quotes from the Transcripts**	**Participant**	**Analytical Memo**
Competitive advantages	*"By embracing AI technology at an early stage, we establish ourselves as a frontrunner in the business, distinguishing ourselves from our competition."*	Participant A09	Early adoption of AI positions ADNOC as an industry leader, reinforcing its competitive edge through technological differentiation.
	"The application of AI-driven advancements provides us with a competitive advantage, enabling us to swiftly adjust to fluctuations in the market."	Participant A06	AI enhances ADNOC's agility, allowing it to navigate market shifts efficiently and maintain a strategic advantage.
	"ADNOC understands that energy industry leadership demands innovation and technology leadership.AI-driven innovations enable us to quickly adjust to market changes, follow emerging trends, and create unique solutions. This makes ADNOC an energy leader and helps us satisfy our clients' changing needs."	Participant A12	AI adoption is integral to ADNOC's long-term strategy, ensuring continuous innovation, market adaptability, and customer satisfaction.

As presented in the table above, participants also noted that AI can help organisations to recruit talented workers and support organisational innovation. For instance, Participant A09 noted, *"The*

attraction of AI specialists and the development of innovative projects have been instrumental in advancing our organisational goals" The analytical memos in the above Table relate this sub-theme to TAM by showing the participants' views of AI as an enabler of innovation and market advantage. This sub-theme also helps support TTF by showing how AI technologies fit with ADNOC's requirements for differentiation.

Sub-Theme 4: Talent Acquisition

AI also helps in recruitment and retention of the best workers in the organisation. Some of the things that participants said include, ADNOC investment in AI makes the company an attractive employer to talented people. Participant A07 shared, *"The attraction of AI talent through innovative initiatives has been crucial for advancing our organisational goals."* This idea echoes the fact that implementation of AI enhances ADNOC's strategic plan of developing a competent and diverse human capital.

Sub-Themes	Quotes from the Transcripts	Participant	Analytical Memo
Talent acquisition	*"ADNOC attracts top AI talent with our cutting-edge technology and unique initiatives. Our AI focus draws energy specialists who want to change things."*	Participant A10	ADNOC's investment in AI enhances its appeal to top-tier professionals, positioning the company as an industry leader in technological innovation.

	"As we invest in AI and cutting-edge technologies, ADNOC attracts top AI talent and expertise. This talent pool is essential for AI development and implementation. ADNOC's commitment to innovation and the chance to engage on ground-breaking projects that can influence the energy market attract these specialists. Their experience boosts our skills and keeps us ahead of AI."	Participant A01	The adoption of AI is not only transforming operations but also redefining workforce dynamics. ADNOC's proactive approach ensures a steady pipeline of AI experts, strengthening its competitive advantage.

Table above summarises the main ideas of the participants, and it can be seen that they all stressed the role of AI in generating possibilities for skill enhancement and organisational development. The memos generated out of analysis underscore how this sub-theme is in harmony with ADNOC's overall goals of cultivating proficiency and developing organisational capacity.

Sub Theme 5: Safety Improvement

The third sub-theme relates to the use of AI in improving safety standards and reducing operations' risks. This is a clear indication that participants regarded AI as a tool that brings about better real-time monitoring and subsequent timely corrective action that enhances the safety of the workers as well as continuous operations. Participant A04 stated, *"AI-based monitoring systems have significantly reduced workplace accidents by identifying potential hazards in real time."* This quote therefore stresses down the real use of AI to provide sure shot results in areas involving risk such as oil and gas industry. Participants also spoke of the prediction function that AI offers, which helps ADNOC to deal with safety challenges before they become exacerbated, as explained in Table below. For example, Participant A10 shared, *"The early detection of safety hazards has been a game-changer for reducing workplace risks and ensuring operational stability."*

Sub-Themes	Quotes from the Transcripts	Participant	Analytical Memo
Safety improvement	*"The use of AI-driven analytics facilitates the early detection of potential safety dangers, hence mitigating the occurrence of accidents and guaranteeing a more secure work environment."*	Participant A03	AI enhances safety by identifying risks before they escalate. This proactive approach aligns with industry best practices in hazard prevention and risk management.
	"Real-time monitoring with AI has been a game-changer for ADNOC for enhancing worker safety."	Participant A07	AI-driven real-time monitoring ensures continuous safety surveillance, reducing response times and improving workplace security.

	"ADNOC prioritises worker and operation safety. By continuously monitoring sensor and source data, AI helps discover safety risks. It can detect equipment behavior anomalies that could cause accidents or monitor environmental conditions to protect personnel. ADNOC has reduced workplace accidents and safety incidents with AI-driven safety innovations, protecting our most valuable assets—our employees and our brand."	Participant A11	

The analytical memos in above table show how this sub-theme supports TAM by reproducing participants' belief that AI is a beneficial asset in the context of risk management. Moreover, it fits into the framework of organisational resilience proving that AI can help ADNOC become more prepared to respond to safety issues. As shown in Figure 4.3, the main theme of Motivating Factors for AI Implementation in ADNOC is linked to the sub-theme, which refers to a different type of motivation.

Sub-Theme 7: Predictive Maintenance

This study identified predictive maintenance as the key factor that sparked AI implementation in ADNOC. Several of the participants were keen to point out that, with AI being able to predict a number of things, equipment downtime, asset reliability, and maintenance costs are some of the areas that are reduced. This approach helps to prevent disruptions, which is always important in a field as demanding as oil and gas. Participant A06 noted: *"AI-driven predictive maintenance allows us to identify potential equipment failures before they occur, ensuring operational continuity and reducing costs associated with unplanned downtime."* This view shows how the shift from the reactive to the proactive approach has a strong value proposition. Several participants stressed that

the ability of AI to support analytics of equipment health and reliability improves decision-making about the equipment's performance and efficiency.

Sub-Themes	Quotes from the Transcripts	Participant	Analytical Memo
Predictive Maintenance	*"The implementation of AI has revolutionised our approach to maintenance, enabling us to proactively address and resolve issues before they escalate into significant challenges."*	Participant A10	The participant emphasises how AI shifts maintenance from a reactive to a proactive approach. This indicates that AI allows early issue detection, preventing costly failures and optimising operational efficiency.
	"The implementation of predictive maintenance strategies has resulted in enhanced equipment reliability, hence mitigating instances of unplanned downtime."	Participant A05	AI-driven predictive maintenance improves equipment reliability by reducing unplanned downtime. This supports the broader industry trend of using AI to enhance asset longevity and minimise disruptions.

	"ADNOC's critical asset management has changed since adopting AI for predictive maintenance. Traditional maintenance typically causes costly breakdowns and unforeseen downtime. However, AI predicts equipment failure using sensor data and prior performance. This proactive strategy lets maintenance personnel fix problems before they break, saving costly breakdowns and increasing equipment life. Consequently, ADNOC saves maintenance expenses and ensures operational reliability."	Participant A01	This comprehensive response illustrates the tangible benefits of AI in predictive maintenance. AI enhances equipment monitoring, extends asset lifespan, and reduces overall maintenance costs, reinforcing ADNOC's operational efficiency and cost-effectiveness.

As shown in the above Table, the analytical memos for this sub-theme are consistent with the TTF framework, as AI tools are well designed to fulfil equipment monitoring and predictive maintenance tasks' requirements. Furthermore, the TAM framework is supported by participants' expectation that AI is an essential tool for the management of assets and business continuity.

Sub-Theme 8: Enhanced Exploration and Production

Enhanced Exploration and production activities were mentioned by participants as the area where AI is being used most frequently. AI helps ADNOC to enhance the resource recovery by improving the reservoir management, well location, and subsurface assessment and reduce operational hazards. Participant A03 stated: *"AI allows us to improve reservoir management and optimise hydrocarbon recovery, which significantly enhances the efficiency of exploration and production*

operations." As highlighted in the analytical memos, which are presented in Table below, participants often remarked that the proposed AI-based algorithms improve decision-making in the challenging subsurface domain and help ADNOC increase its accuracy and efficiency in exploration and production.

Sub-Themes	**Quotes from the Transcripts**	**Participant**	**Analytical Memo**
Enhanced Exploration and Production	*"The employment of AI in data analysis has resulted in notable enhancements in reservoir management, hence facilitating a rise in the recovery of hydrocarbon resources."*	Participant A09	The participant highlights AI's role in optimising reservoir management through advanced data analysis. This supports the notion that AI-driven analytics enable more precise resource extraction, reducing inefficiencies and increasing hydrocarbon recovery.
	"The implementation of artificial intelligence (AI) algorithms is being employed to enhance the efficiency of well placement and drilling procedures, resulting in a notable increase in our production levels."	Participant A07	AI is directly linked to improved well placement and drilling, leading to increased production levels. This suggests that AI enhances decision-making in complex geological environments, contributing to overall operational efficiency.

	"AI has transformed ADNOC exploration and production. Advanced data analysis, machine learning, and AI algorithms are used in seismic, reservoir, and well drilling. These methods improve subsurface prediction, allowing well siting and drilling to maximise hydrocarbon recovery. This efficiency in exploration and production boosts yields, making ADNOC more competitive in the global energy market."	Participant A12	This quote provides a comprehensive overview of AI's impact on ADNOC's exploration and production. AI enhances subsurface prediction and well placement, ensuring optimal hydrocarbon recovery. The participant also links AI's capabilities to ADNOC's competitiveness, showing how technological advancements contribute to strategic positioning in the energy market.

This sub-theme supports the TTF framework as AI resolves problem-solving issues relevant to the resource extraction and geological analysis of tasks. Further, the participants' acknowledgment of the role of AI in improving operations supports the TAM framework because their perceptions of the tool's usefulness and ease of use are positive.

Sub-Theme 9: Regulatory Compliance

Another major driver of AI implementation in ADNOC is the compliance requirements in the organisation's operations. People described how AI helps to maintain compliance with the industry standards, to simplify the reporting of non-compliance and to manage the risks connected with violation of regulations. Participant A12 remarked: "AI simplifies compliance processes by automating reporting and ensuring we meet all industry standards effectively and efficiently." From this point of view, AI is crucial in preserving ADNOC's market profile and lessening the administrative load.

Sub-Themes	Quotes from the Transcripts	Participant	Analytical Memo
Regulatory compliance	*"Compliance with energy industry rules and standards is a must, and AI streamlines the process. AI automates compliance inspections and reporting, ensuring efficient regulatory compliance. This eliminates compliance risks and frees up resources for innovation and optimisation."*	Participant A04	The quote highlights AI's role in automating compliance tasks, reducing human errors, and improving operational efficiency. This supports the argument that AI is not just a tool for optimisation but also a strategic enabler for regulatory adherence in the oil and gas sector.

	"Artificial intelligence (AI) enhances the efficiency of compliance procedures, facilitating adherence to industry norms and standards. It is employed as a means to consistently and efficiently adhere to regulatory regulations."	Participant A09	This statement reinforces the theme that AI is critical in ensuring regulatory compliance. The emphasis on consistency suggests that AI minimises variability in compliance efforts, which aligns with industry demands for accuracy and reliability.

The analytical memos, included in Table above for this sub theme focus on how the AI compliance tools fit into the TTF framework, especially in relation to the call for accurate and automated compliance.

4.3.9. Theme 3: Areas of the ADNOC that are influenced by the implementation of AI

In this paper, the integration of the use of Artificial Intelligence (AI) in ADNOC has been described and the changes that have been realised in different fields are highlighted. In the feedback received from participants, three key areas have been pointed out which have been revolutionised by applying AI: Reservoir Management and Exploration, Production Planning and Drilling Optimisation, Management and Predictive Maintenance. These changes have provided a great impact in the efficiency of ADNOC, the accuracy of its operations, and decision making in real-time. AI enhances data handling, analysis, forecasting, and efficiency hence making it possible for ADNOC to shift to using analytical approaches. The TAM and the TTF framework explain how the integration of AI into ADNOC's operations can be understood theoretically. TAM posits that the use of AI is influenced by perceived benefits and perceived effect on operational performance while TTF postulates that AI is effective to the extent it is aligned to the tasks it seeks to optimise. The above theories are well illustrated by the case of integrating AI in ADNOC where the efficiency, automation of tasks, and optimisation of resource use have made it famous and adopted. Moreover, this research employs an inductive research strategy since the participant's experiences and feedback aid in constructing broader knowledge of AI's position in the industry.

In this particular case, the thematic map focuses on how AI will affect ADNOC operations in the future. To give a clear vision of how AI affects ADNOC's operations, a thematic map showing how Theme 3 relates to the sub-topics has been created in Figure 4.4. The following is a flowchart of how AI impacts main operational areas in order to show its importance in enhancing efficiency, automation, and decision making.

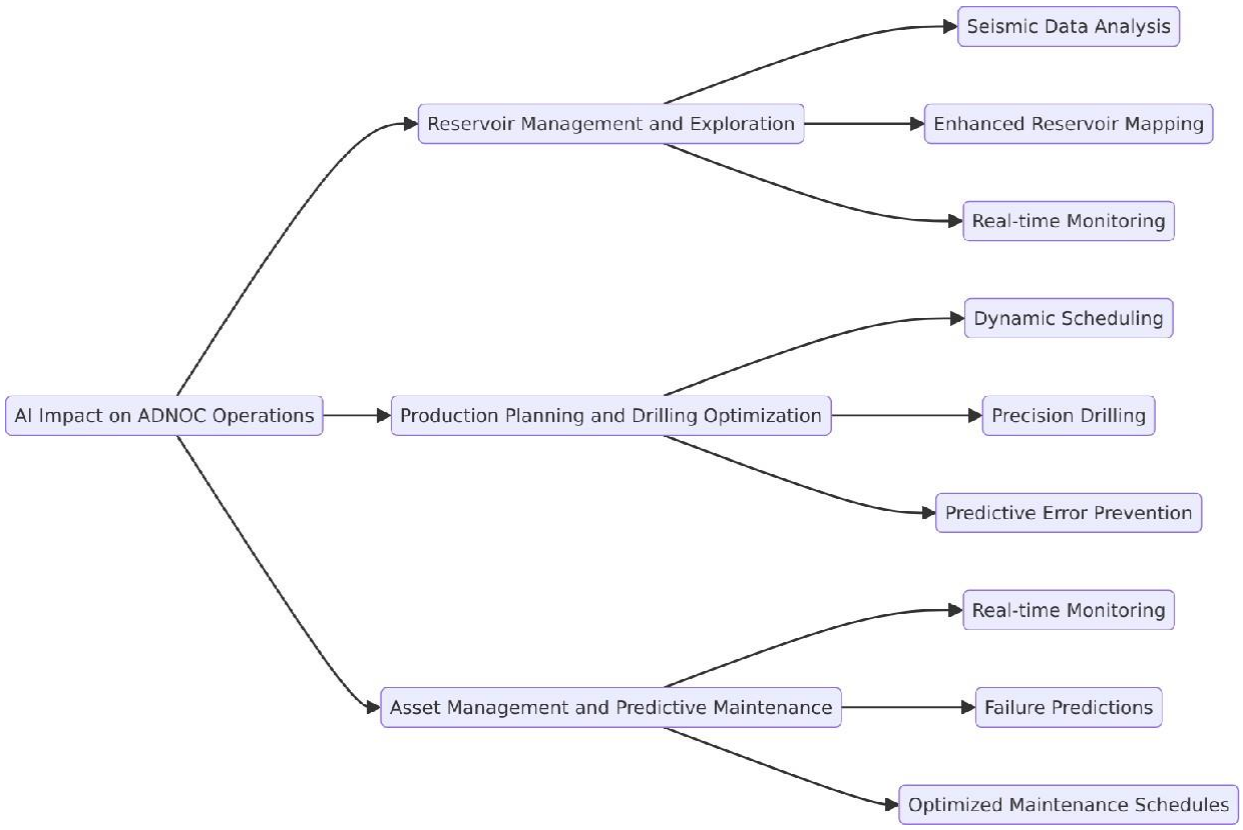

Figure 4.4: Thematic Map Theme 3

Reservoir Management and Exploration – AI has the capacity to analyze the generated seismic data to improve the definition of reservoir and monitor the reservoir in real time.

Production Planning and Drilling Optimisation – Realtime and Resourceful scheduling through AI and Exactness in Drilling and Error forecasting.

Property Management and Condition Based Maintenance –AI use in monitoring the condition of the assets, failure prediction, and maintenance schedule determination.

The inductive link between the research question and the emerging themes is that AI is a tool that is not just being implemented to automate processes but to transform decision-making and operational strategies in ADNOC.

Sub-Theme 1: Reservoir Management and Exploration

The first business function where AI has made a positive influence in ADNOC is in Reservoir Management and Exploration. Conventional reservoir exploration involved interpretation of

seismic data through interpretation by human beings, and this was not efficient. This has been made easier through the integration of AI that has helped in the analysis of seismic data, better mapping of reservoirs and the ability to monitor the condition of the reservoir in real-time. These AI advancements have helped in improving the accuracy of the results, lowering costs and helped in the proper utilisation of resources for the oil and gas exploration.

Interpretation of Seismic data is a very important step in the exploration of reservoirs. Seismic analysis tools used by ADNOC is an AI-based technology that is capable of processing vast amounts of seismic data and to differentiate between noises and geological signals. This has helped in improving on the identification of possible reservoirs. The role of AI in seismic data processing was described by A04 as efficient. The interviewer asked a follow-up question to Participant A04 to elaborate on how AI specifically has improved precision in detecting potential reservoirs. Participant A04 shared, *"Surely, AI allows us to process and analyse large amounts of seismic data, the results are with us in a matter of minutes. This kind of speed and details were never achieved previously and are really helpful in identifying patterns separating them from the noise to detect the oil reservoirs. It has changed how our operations were conducted before and has led to a reduced margin of error improving our exploration efforts".* This highlights that AI is not only beneficial for its practical implications such as oil and gas exploration but it also has a massive impact in terms of improving overall robustness and accuracy of the operations conducted for reservoir exploration and management.

Another participant shared,*"AI enables us to analyze a vast amount of seismic data and get the results in a matter of minutes. In this kind of level and detail, such speed was not witnessed before (A07)".* Here, it is evident that the use of AI has helped in cutting down the time taken to conduct geological evaluations and the dangers that come with it being done by hand. The enhanced accuracy in the mapping of reservoirs provides ADNOC with more accurate locations of the oil reserves hence minimising on the exploration of unproductive areas. In addition to exploration, AI has also enhanced reservoir management in aspects such as real time monitoring. Before, reservoir conditions were evaluated at certain intervals, and therefore, could not easily identify changes like pressure variations. It also enables ADNOC to monitor reservoir conditions at all times, which help detect operating issues in advance.

AI is also used in real-time monitoring of reservoirs, as seen in the example cited by Participant A09.

"The AI system detected unexpected fluctuations in reservoir pressure, and we were able to adjust parameters in real time to prevent issues."

This response demonstrates how AI is able to save operational costs by facilitating early decision making. Real-time analysis in the reservoirs, leads to the reduction of wastage of resources while at the same time maintaining constant production. These enhancements in the management of reservoirs can be related with the Task-Technology Fit (TTF) theory which postulates that the technology used has to correspond to the level of difficulty of the tasks which it is aimed at supporting. ADNOC's requirement of analysing seismic data, predicting reservoir's location and monitoring real-time variations show that AI fits the company's operational requirements. In addition, the Technology Acceptance Model (TAM) reveals why there is a high acceptance of AI within the ADNOC as it is perceived to be useful and increases efficiency in the exploration and management of the reservoir.

Sub-Theme	Data Unit (Quote)	Participant	Analytical Memo (Interpretation and Theoretical Relevance)
Reservoir Management and Exploration	*"AI allows us to process and analyze large amounts of seismic data, and results are available in minutes."*	A04	AI enhances **seismic analysis and reservoir mapping**, improving **Task-Technology Fit (TTF)** by reducing manual errors and increasing precision.
	"AI's ability to differentiate between useful seismic patterns and background noise has significantly	A07	AI-driven mapping aligns with **TAM's usefulness**, increasing efficiency and reducing exploration costs.

	improved accuracy in reservoir detection."		
	"The AI system detected unexpected fluctuations in reservoir pressure, and we were able to adjust parameters in real time to prevent issues."	A09	AI supports **proactive decision-making**, ensuring that **reservoir conditions are continuously optimised**.
	"AI analytics provide us with real-time reservoir performance data, allowing immediate corrective actions."	A11	AI's real-time insights align with **TTF's emphasis on technology improving operational efficiency**.

Sub-Theme 2: Production Planning and Drilling Optimisation

The use of AI in ADNOC's production planning and drilling optimisation has provided a positive impact in aspects of efficiency, precision, and minimisation of risks. Scheduling is a dynamic process that entails making changes frequently due to changes in the market forces, availability of resources, and constraints within the production line. The traditional production planning techniques used to be carried out through the use of historical information and managerial decisions, which are not suitable for real-time changes in demand and supply. The implementation of dynamic scheduling based on AI has helped ADNOC in real-time alteration of production schedules for keeping up with the market and operational efficiency.

Drilling optimisation is on the other hand important since it helps in the enhancement of the drilling process in order to reduce on the operational risks and increase the efficiency of the resource extraction. Automated drilling models of the subsurface conditions draw real-time data for the drilling parameters to be automated. This has led to a decrease in the level of drilling errors, cost of operation and the impacts on the environment. In addition, through error prediction in drilling, AI

has revolutionised the way ADNOC handles risk mitigation in its drilling activities since the company is in a position to predict and avoid major drilling mishaps.

Another benefit of using of AI in production planning is the ability of changing of the schedule in short term depending on the demand and availability of the resources. This has made the flow of production management to become more flexible and adaptive hence minimising on the time taken on the various processes. Real-time production performance tracking is achievable through AI-driven analytics; this offers decision-makers the opportunity to work on scheduling, resources, and other aspects with a definite aim of enhancing operational results at ADNOC. One of the participants described how AI helps in the planning of production by being able to make changes in real-time to ensure that plans match the market environment. This ability to change the production plans as often as necessary improves the operational flexibility and minimises resource wastage.

The use of AI in drilling optimisation has also been very significant. Drilling operations are very sensitive and any error that is likely to occur during the process needs a lot of analysis. Earlier, problems with the depth of drilling, instabilities of the subsoil, and failures of equipment hindered the progress of operations and added to the expenses. Through the use of AI, there are always drilling optimisation models that engage in analysing data from drilling operations and adjusting the drilling parameters in order to increase the accuracy of the drilling process. This has greatly minimised the chances of making mistakes when drilling and experiencing any form of delay. One of the participants described how AI makes real-time changes to enhance the drilling process: *"AI models assist the drilling operations in real-time, enhancing the accuracy and minimising the risks."*

AI has also been of significant essence in the prediction of errors that may occur in the operations of a business before they cause significant problems. In the conventional drilling operations, unforeseen subsurface conditions were the main causes of errors that could not be easily predicted. However, through the use of AI in its predictive analytics, ADNOC has been able to avoid the potential risks that may hinder the smooth drilling process before they happen. One of the participants described a case where AI analytics identified a potential subsurface problem that could have resulted into a major drilling mistake which the team was able to fix before it caused a

problem. This shows that AI has a capability of enhancing decision making and also ensure business operates as usual. The use of AI in production planning and drilling optimisation is consistent with the TAM since it has made it effective and efficient in the reduction of risks within the company. AI's role in this area also provides support to the Task-Technology Fit (TTF) theory that posits that the nature of the technology has to correspond to the nature of the tasks that it seeks to support. The adaptation of AI in dynamic scheduling, drilling accuracy, and risk assessment shows that AI is applicable in ADNOC's business environment to boost performance, accuracy, and decision-making.

The following table includes the participant responses on how AI has influenced production planning and drilling optimisation and the analysis of these responses.

Sub-Theme 2:	Quotes from the Transcripts	Participant	Analytical Memo
Production Planning and Drilling Optimisation	*"AI tools allow us to modify production plans dynamically using real-time analysis of demand and supply."*	Participant A06	AI enhances **production efficiency** by ensuring **real-time adjustments**, aligning production with **market needs**.
	"AI models provide real-time support to drilling operations, increasing accuracy and mitigating risks."	Participant A02	AI-driven **drilling optimisation reduces errors**, ensuring **safer and more cost-effective drilling processes**.
	"AI analytics help identify potential risks in drilling operations, allowing us to take corrective action before errors occur."	Participant A08	AI's **predictive capabilities improve risk management**, minimising **operational disruptions** and increasing **drilling success rates**.
	"AI-driven systems continuously analyze drilling parameters,	Participant A10	AI's ability to **optimise drilling conditions dynamically** supports **Task-**

	making real-time adjustments to optimise efficiency."		**Technology Fit (TTF) principles**, improving **task efficiency**.

The findings outlined above support the proposition that AI is increasingly becoming relevant in production planning as well as drilling within ADNOC. With the applications of dynamic scheduling through artificial intelligence, drilling precision models and using predictive error prevention systems, ADNOC has been able to improve on its operations and reduce drilling risks besides boosting the production. Another advantage derived from the use of the system is the efficiencies it has brought into managing operations – timely provision of insights supported by predictive intelligence. In conclusion, the integration of AI in ADNOC's production planning and drilling optimisation has offered new perspectives of handling the production planning by increasing flexibility and accuracy, and decreasing operational risks. This is supported by the Technology Acceptance Model (TAM) as it has been found to be very useful in increasing effectiveness and minimising losses in this field. Similarly, the Task-Technology Fit (TTF) model proves that AI fits ADNOC's operation as it can analyze real-time data, optimise the scheduling process, and avoid mistakes. In the future, the expansion of the use of AI in predictive drilling simulation and AI-based production analysis will be able to enhance the decision-making process and resource utilisation in order to maintain ADNOC's high standards in drilling and production.

Sub-Theme 3: Asset Management and Predictive Maintenance

Introducing AI into the asset and the maintenance management system has improved ADNOC's monitoring and subsequent prevention of equipment failure while raising the operational standards. In the past, asset maintenance plans were more of a breakdown maintenance where equipment used to be fixed or replaced when it failed and this was always costly, time-consuming and resulted in production downtimes. AI has helped ADNOC to adopt the approach known as predictive maintenance, where the chances of failure are noticed early enough and rectified before arising.

The real-time data analysis of the equipment's performance and prediction of when they will need maintenance has greatly helped in minimising breakdowns and in getting the most out of the assets. The use of machine learning algorithms, the monitoring of sensors, and the diagnosis of the problem

have made it possible to make the right decisions in terms of repair and replacement of the assets, thereby making maintenance efficient in terms of time and cost. This is in line with the Technology Acceptance Model (TAM) since the perceived benefits of AI in reducing the time lost and the longevity of the assets have made it common in the industries. It also relates to the Task-Technology Fit (TTF) as the use of AI to analyze intricate data of the performance of equipment and predict possible failures is ideal for ADNOC's asset management.

The first benefit of using AI in monitoring the performance of the assets is timely identification of prospective performance fluctuations. Under robotic monitoring, key parameters of equipment performance are always being monitored, warning signs of mechanical failure or signs of wear and tear, overheating and structural deficiencies are easily detected. This way, maintenance teams get to know about them in advance so that they can plan for the repairs before the equipment breaks down, therefore helping to avoid costly downtimes. AI was described by participant A08 in regard to predictive maintenance as:

The utilisation of AI helps us to identify when something is wrong and requires maintenance so that it does not cause a breakdown. Earlier, it was possible to schedule a maintenance but now, with the help of AI, it is possible to know the exact time when a particular component requires servicing. This insight has taken ADNOC from using fixed schedules of maintenance to a condition based maintenance, where equipment is only worked on when required thus cutting on costs of maintenance while at the same time ensuring that equipment is in perfect working condition.

In addition to failure prediction, AI is used for real-time asset management so that ADNOC is capable of monitoring assets' performance and remaining useful life. Some of the important benefits of using AI in managing assets include; AI-generated decision-support systems give managers accurate analysis of the trends in utilisation of assets to enable them to make right decisions about replacement and upgrading of the components. In the case of utilising AI in decision-making, the participant A05 provided an example of how this has worked in asset management.

It also aids in the constant supervision of the asset's performance to enhance the decision on replacement. This means that in the management of a given component, we can decide whether to repair it or replace it based on its actual performance data and not assumptions.

This response shows how asset management is made effective and efficient through the use of AI in that maintenance actions are not based on guesses or schedule but actual performance. AI-driven predictive maintenance has also assisted ADNOC in cutting down on costs since it avoids unnecessary maintenance. The old style of maintenance called for over servicing of equipment hence high maintenance costs without necessarily reflecting on the performance. AI has been applied in the maintenance workflows at ADNOC to make sure that it does not waste much of its resources. The application of AI with regards to asset management and maintenance aligns with TAM's focus on perceived usefulness and relevance, as the positive impact on the reduction of loss of operating time, and increase in asset lifespan has led to the acceptation of this technology within ADNOC. Furthermore, the integration of AI with TTF further proves that it is ideal for ADNOC's elaborate maintenance requirements as it provides the company with the capability to analyze data concerning asset's health, failure prediction, and maintenance schedule which is in line with the company's operation.

Table below shows the participant's feedback on the effects of AI in asset management and predict and prevent maintenance:

Sub-Theme 3	Quotes from the Transcripts	Participant	Analytical Memo (Interpretation and Theoretical Relevance)
Asset Management and Predictive Maintenance	*"AI allows us to detect maintenance needs before they become critical, reducing downtime."*	A08	AI enables **proactive maintenance**, aligning with **TTF's efficiency-enhancing potential** and reducing **unexpected breakdowns**.
	"AI-based analytics help us track asset performance in real time, allowing us to identify declining efficiency before it leads to failure."	A10	AI **improves decision-making** by providing **continuous asset health monitoring**, reducing maintenance costs.
	"We can now assess whether a component needs	A05	AI **enhances asset lifecycle management**, aligning with

	repair or replacement based on real-time performance data rather than assumptions."		**TAM's focus on improved organisational efficiency**.
	"AI has helped us eliminate unnecessary servicing, ensuring maintenance resources are allocated more efficiently."	A07	AI-driven **predictive analytics optimise maintenance planning**, reducing **wasted resources and costs**.

These findings affirm that the AI application has enhanced ADNOC's asset management plans, as well as monitoring and decision-making processes. ADNOC's transition from the outdated Reactive Maintenance to Predictive maintenance has helped it to reduce operational risks, increase asset life and productivity of resources; AI therefore plays a critical role in improving the overall efficiency of maintenance with ADNOC. Overall, integrating AI in asset management and predictive maintenance has helped ADNOC to make a shift from conventional and reactive maintenance approach to a smart approach. Through the use of real time performance monitoring, failure prediction, and proper scheduling of maintenance, ADNOC has been able to cut on its downtime, increase efficiency of its assets and bring down its maintenance expenses. This area is well in line with the perceived usefulness of AI as it has been deemed a highly useful tool in enhancing maintenance productivity and decision making at TAM. In addition, the ability of AI to analyse large volumes of asset performance data and predict possible failures is in line with TTF's approach of identifying the right technology that fits the operational requirements of ADNOC to maintain effective and efficient maintenance strategies that are affordable. In the future, the following actions could progress AI's applications in the area of maintenance: enhancing the AI-based prediction of maintenance; using AI robotics for inspections; and improving the maintenance prediction models powered by AI can all help to reinforce ADNOC's asset management plans, thus maintaining operational efficiency.

Altogether, the analysis of the experiences of all the participants reveals that AI technologies have proven to transform operations in a number of areas such as reservoir management and exploration,

production planning and drilling operations and as well as managing and maintenance of assets and critical components related to oil and gas operations.

4.3.10. Theme 4: Hurdles in the implementation of AI in oil and gas companies in the UAE

Although the application of artificial intelligence (AI) in the oil and gas industry has the potential to revolutionise the industry, there are various challenges that have limited the adoption of AI in the UAE. When asked about the challenges, the study groups these into data issues including quality and access, systems and infrastructure including legacy systems, compliance, security issues, integration, cost, cultural issues, and customisation and growth. These issues bring out the fact that the implementation of AI in an industry that adopts conventional practices, stringent rules, and high costs of operations is a challenge. From a theoretical point of view, the TOE model enables one to understand how technological, organisational, and environmental factors affect AI disruption. Institutional theory helps us to understand the regulatory and compliance issues that hinder the adoption of AI while Change Management Theory looks at the challenges faced in implementing change and the ways of overcoming the resistance. Altogether, the integration of such approaches creates the inductive connection between the practical problems of the industries and the theoretical knowledge, providing the systematic view on AI barriers.

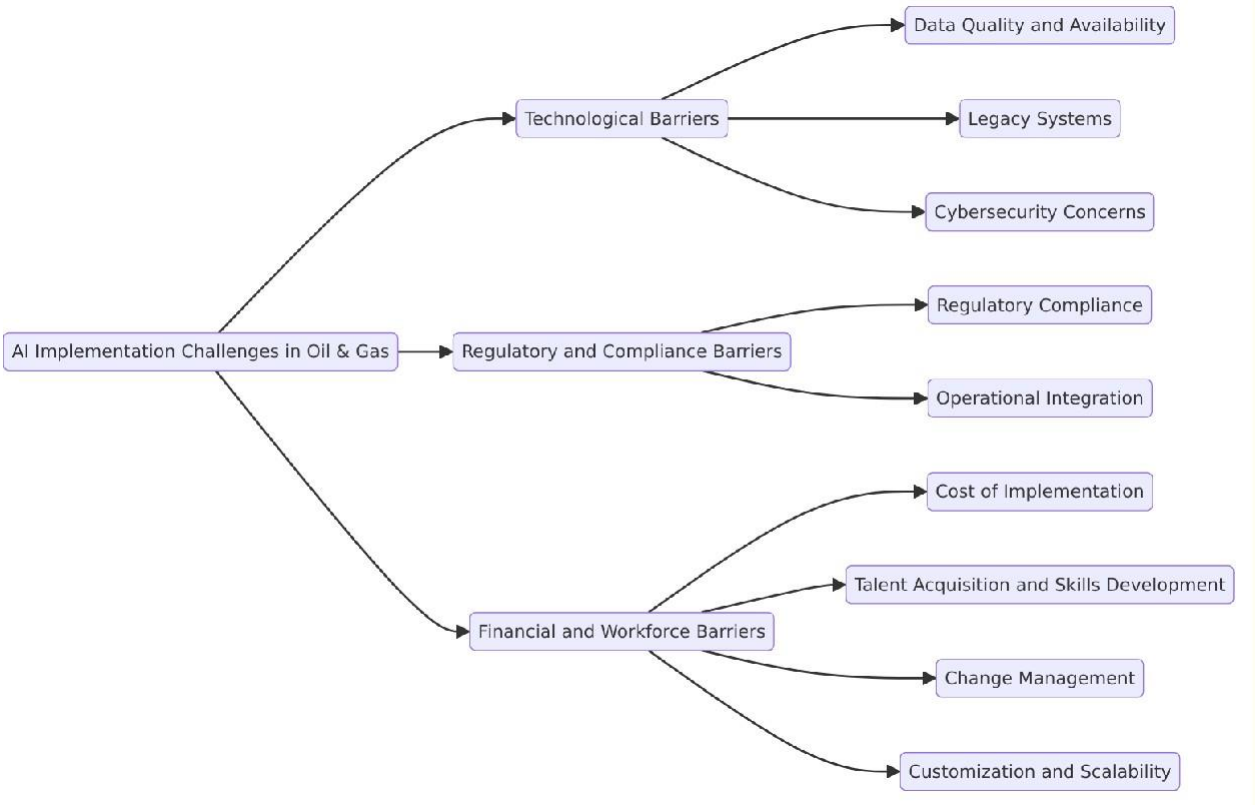

Figure 4.5: Thematic Map Theme 4

Figure 4.5 shows the key barriers to AI adoption in Oil and Gas Sector and categorises them into Technological Barriers, Regulatory and compliance barriers and Financial and Workforce barriers. These categories are interrelated factors that define the set of issues that an organisation faces to implement AI effectively. Technological Barriers section presents various issues including the quality and access to the data, problem of incompatible systems and security issues. These affect the performance of AI and its ability to fit in the existing operational systems. The next concept of the model, Regulatory and Compliance Barriers, focuses on the legal, industry and operational issues when it comes to the implementation of artificial intelligence. Regulation is another challenge in which organisations need to consider several legal requirements to ensure that AI projects meet certain standards. Lastly, operationalisation is still questionable as it is integrated into the existing organisational operations without interrupting them. The Financial and Workforce Barriers section covers issues that include the high cost of implementing AI, scarcity of competent human resource in AI fields as well as organisational adjustment issues among workers. Organisations must ensure that the expenses incurred in implementing AI technologies must be offset by the costs that are bound to be saved and the efficiency that is bound to be achieved. In

addition, change management is an important process that helps employees prepare to work with the help of AI solutions, as well as customisation and scalability that allows for further development of AI systems in the future. This thematic map (Figure 4.5) is an inductive connection of participants' findings and theoretical frameworks which show that the AI adoption in the Oil and Gas industry is a complex issue that involves technological, regulatory, financial, and workforce factors.

Sub-Theme 1: Data Quality and Availability

Data quality and availability are key to AI implementation. Data comes from sensors, equipment, and geological surveys in the oil and gas business. Keeping this data correct, thorough, and organised is difficult. ADNOC managers recognise the necessity of data governance and management. They prioritise data cleansing, standardisation, and centralisation. As stated by A15 "*"Data quality is hard. We're investing in data purification and integration to give our AI systems correct data. We're improving data governance and management. This includes data cleansing, standardisation, and centralisation."* These solutions adhere to the principles and practices outlined in the literature on data management. According to El Sherbiny (2023), the importance of data accuracy and reliability cannot be overstated in the context of AI projects. The dedication of ADNOC to data quality demonstrates a proactive stance towards data governance, which is in accordance with established best practices.

Sub-Theme 1	Quotes from the Transcripts	Participant	Analytical Memo
Data Quality and Availability	*"Data quality is hard. We're investing in data purification and integration to give our AI systems correct data. We're improving data governance and management. This includes data cleansing, standardisation, and centralisation."*	A15	Highlights the **necessity of structured data management practices** to improve AI efficiency.
	"The collection of exploration data can sometimes exhibit a high degree of	A09	Emphasises the **need for structured**

	disorder and complexity. Our current focus is on the standardisation of data formats and the establishment of centralised data repositories."		**data storage and retrieval systems** to optimise AI operations.
	"Data quality and availability in the oil and gas business are crucial for AI application. We understand that data originates from many sources and formats. Maintaining data correctness and completeness is difficult. Clear data quality standards and practices improve data ready for our AI systems, making them better at data-driven decision-making."	A01	Demonstrates that **data consistency and accuracy are vital for AI-driven decision-making**.

Sub Theme 2: Legacy Systems

The process of incorporating AI into pre-existing legacy systems presents a multifaceted and intricate undertaking. Numerous oil and gas businesses, such as ADNOC, heavily depend on legacy systems that have served as the fundamental infrastructure for their operations for an extended period (da Silva Mendonça *et al*., 2022). According to A13, *"The existing legacy systems have demonstrated a commendable level of reliability; however, they are in need of necessary updates. The process of gradually updating them is being undertaken to ensure compatibility with AI."* While these legacy systems are reliable, they may not be inherently compatible with AI technologies (Bansal *et al*., 2019). The response from A14 *"We're holding workshops, training, and awareness campaigns to help our employees adopt AI. We also aggressively involve employees in AI efforts so they can understand its benefits to their jobs. AI benefits must be disclosed to manage this cultural transition."* This suggests the adoption of a systematic and incremental strategy towards modernisation, recognising the significance of meticulous planning and effective communication in implementing changes. This method is consistent with change management theories put forth by renowned scholars such as . Kotter (1995). Kotter argues that organisations

should follow a progressive strategy to implementing changes, which involves actively engaging all stakeholders, in order to achieve effective adoption. According to Henry *et al*. (2017), the approach of ADNOC effectively manages the requirement for dependability while also prioritising the necessity for innovation.

Sub-Theme 2	Quotes from the Transcripts	Participant	Analytical Memo
Legacy Systems	*"The project at hand is of a considerable duration, however, progress is being made by systematically replacing antiquated systems with technologically advanced ones that are better suited for artificial intelligence integration."*	A11	Reflects the **long-term, structured approach to AI compatibility with existing systems**.
	"The existing legacy systems have demonstrated a commendable level of reliability; however, they are in need of necessary updates. The process of gradually updating them is being undertaken to ensure compatibility with AI."	A13	Suggests that **organisations must balance maintaining reliable systems with AI innovation**.
	"Modernising gradually is our strategy. Making these outdated systems AI-compatible is our goal. For a smooth transition, we think it's worth the long-term effort. This modernisation includes hardware and software changes. We seek to balance reliability and innovation by replacing outdated components and introducing more flexible and AI-ready solutions."	A06	Highlights the **incremental AI adoption approach** to ensure minimal disruptions while integrating AI.

Sub-Theme 3: Regulatory Compliance

In an industry characterised by stringent regulations such as oil and gas, the imperative of upholding regulatory compliance assumes paramount importance. The application of artificial intelligence (AI) should be in accordance with established industry standards and legal obligations. ADNOC managers possess a comprehensive understanding of the significance associated with conducting thorough regulatory inspections. The replies by A11 and A02 underscore the importance of establishing open lines of communication with regulatory bodies in order to guarantee that artificial intelligence (AI) activities adhere to existing norms. A07 added, *"We establish and maintain effective communication channels with regulatory authorities in order to ensure that our artificial intelligence initiatives align with the prevailing industry norms."* This approach aligns with the scholarly focus on governance as discussed in the literature. Cuéllar and Huq (2020) emphasise the significance of firms ensuring regulatory compliance by matching their AI projects with industry norms and legal regulations. The commitment of ADNOC to complying with these standards highlights their rigorous approach in ensuring that AI efforts are both innovative and compliant with legislation.

Sub-Theme 3	Quotes from the Transcripts	Participant	Analytical Memo
Regulatory Compliance	*"The importance of regulatory compliance cannot be overstated. Before deployment, our AI efforts must undergo thorough regulatory evaluations."*	A02	Demonstrates that **strict regulatory approvals are required before AI implementation**.
	"We establish and maintain effective communication channels with regulatory authorities in order to ensure that our artificial intelligence initiatives align with the prevailing industry norms."	A07	Highlights **proactive regulatory engagement** as a key factor in AI compliance.
	"Every AI project must pass stringent regulatory examinations before being approved. We communicate with	A14	Confirms that **AI initiatives must align with legal and industry**

	regulatory authorities to verify our AI projects meet industry standards and local or international rules. This collaboration is essential to making our AI systems innovative and compliant."		**regulations** to ensure smooth adoption.

Sub-Theme 4: Talent Acquisition and Skills Development

The task of attracting highly skilled individuals in the field of artificial intelligence is a significant competitive obstacle. The demand for professionals with expertise in AI frequently exceeds the available supply, resulting in escalated labour expenses. The administrators of ADNOC acknowledge the significance of both attracting and keeping personnel specialised in the field of AI. King (2022) underscores the paramount importance of fostering long-term talent development and mitigating skills shortages through strategic investments in training programs and mentorship initiatives this is in line with the thoughts of A14, *"We are now investigating potential collaborations and cost-sharing frameworks in order to enhance the cost efficiency of AI implementation."* The strategic approach of ADNOC covers not only the attraction of talent from external sources but also the cultivation of indigenous competence in the field of artificial intelligence.

Sub-Theme 4	Quotes from the Transcripts	Participant	Analytical Memo
Talent Acquisition and	*"The task of attracting highly skilled individuals in the field of artificial intelligence is a significant competitive obstacle."*	A14	Demonstrates the **high demand and low supply of AI specialists**, impacting recruitment.
	"We are now investigating potential collaborations and cost-sharing frameworks in order to enhance the	A10	Suggests **partnerships and cost-sharing as**

Skills Development	*cost efficiency of AI implementation."*		**strategies** to attract and retain AI talent.
	"The strategic approach of ADNOC covers not only the attraction of talent from external sources but also the cultivation of indigenous competence in the field of artificial intelligence."	A15	Highlights the **long-term AI workforce development strategy** through internal training programs.

Sub-Theme 5: Cybersecurity Concerns

The oil and gas business encompasses crucial infrastructure and highly confidential information, hence rendering cybersecurity a matter of utmost importance in the adoption of artificial intelligence (Alhashmia, Abdullahb and Abdullahb, 2023). A09 maintained, *"Our cybersecurity professionals monitor, assess, and improve AI-driven operational security. This includes penetration testing, security audits, and strong cybersecurity standards. Our AI systems should be efficient and secure against breaches."* ADNOC management place significant emphasis on the necessity of establishing specialised security teams, conducting penetration testing, and implementing security audits in order to safeguard their AI infrastructure against any cyber-attacks. This technique aligns with the cybersecurity best practices as advised in the existing literature. Prominent research by Zaabi and Zamri (2022) emphasised the necessity of implementing resilient security measures, which encompass penetration testing and periodic security audits. The dedication of ADNOC to upholding the integrity of AI-powered operations exemplifies their proactive approach in protecting against any security breaches.

Sub-Theme 5	Quotes from the Transcripts	Participant	Analytical Memo
Cybersecurity Concerns	"The imperative to ensure the security of AI systems is indisputable. Our organisation has a specialised cybersecurity team	A12	AI security is **a critical component of AI deployment**, requiring

	responsible for safeguarding our AI infrastructure."		**dedicated security teams** for protection.
	"We routinely perform penetration testing and security audits in order to protect AI-driven activities."	A09	Cybersecurity best practices include **continuous vulnerability assessments** to mitigate risks.
	"Our cybersecurity professionals monitor, assess, and improve AI-driven operational security, including penetration testing and security audits."	A04	AI adoption must align with **cybersecurity frameworks** to ensure both **efficiency and resilience**.

Sub-Theme 6: Operational Integration

The incorporation of AI into pre-existing operational frameworks while minimising any potential disruptions poses a notable difficulty. The managers at ADNOC recognise the existence of this difficulty and emphasise the implementation of a gradual approach that entails vigilant monitoring and cooperation in order to mitigate any potential disruptions to operations as indicated by A03: *"Effective collaboration between the IT and operational teams is of paramount importance. A seamless transition is being facilitated by the active engagement of all relevant parties*." According to Choubey and Karmakar (2021) model, it is recommended that businesses engage in meticulous planning and communication strategies while implementing changes. This entails adopting a staged approach in order to facilitate the successful adoption of these changes. The strategy adopted by ADNOC underscores the significance of collaborative integration, a critical factor in facilitating a seamless transition.

Sub-Theme 6	Quotes from the Transcripts	Participant	Analytical Memo

Operational Integration	"The integration process is being conducted in a gradual manner, with careful monitoring and adjustment to mitigate any potential disruptions."	A07	AI integration must follow **a phased approach** to ensure **minimal disruptions and optimal results**.
	"Effective collaboration between the IT and operational teams is of paramount importance. A seamless transition is being facilitated by the active engagement of all relevant parties."	A03	Cross-functional collaboration is essential to ensure **AI solutions complement existing operations**.
	"Our IT and operations teams are collaborating to make the transition smooth. Early stakeholder involvement ensures AI adoption aligns with business objectives."	A13	**Stakeholder engagement** is a key driver in **successful AI implementation** and workforce adaptation.

Sub-Theme 7: Cost of Implementation

The financial implications of using AI can be significant, and officials at ADNOC recognise this obstacle (Al-Kfairy *et al*., 2022). The comments provided by participant A15 *"Our organisation is making investments in AI solutions that possess the capability to scale in accordance with our business requirements. This strategic approach aims to prevent any potential constraints that may arise as we extend our AI initiatives throughout the entirety of our organisation."* This demonstrate a judicious strategy, wherein they prioritise AI initiatives by considering their potential for cost reduction and return on investment (ROI). The aforementioned approach aligns with the economic viewpoints espoused in the existing body of research on cost-benefit analysis by Reddicharla *et al.* (2022). Economists frequently endorse the prioritisation of investments according to their anticipated returns, a principle that is evident in ADNOC's strategic strategy. The alignment of AI

projects' prioritising with possible cost savings is in accordance with the principles of efficient resource allocation.

Sub-Theme 7	Quotes from the Transcripts	Participant	Analytical Memo
Cost of Implementation	"The consideration of cost is a significant factor in our decision-making process, as we emphasise AI projects with potential cost savings."	A10	AI projects must be **prioritised based on return on investment (ROI)** and operational impact.
	"We are now investigating potential collaborations and cost-sharing frameworks to enhance AI cost efficiency."	A15	Cost-sharing models help **reduce financial barriers to AI adoption** and improve feasibility.
	"AI implementation costs are unavoidable. We carefully prioritise AI initiatives based on cost savings and efficiency improvements."	A03	AI investment must be **aligned with long-term cost reduction and efficiency gains**.

Sub-Theme 8: Change Management

The implementation of AI necessitates the adoption of change management strategies due to the potential resistance exhibited by employees towards the transformative effects it entails. ADNOC manager A09 possess a comprehensive understanding of the importance of change management and distinguish the imperative of engaging employees in the change implementation process and stated *"Change management is key. We're holding workshops and training to help our staff adopt AI."* The responses provided underscore the significance of implementing workshops, training initiatives, and awareness campaigns as means to facilitate the workforce's adjustment to artificial intelligence technologies. ADNOC's dedication to engaging people and cultivating a climate of

creativity demonstrates their comprehension of the human dimension of organisational transformation.

Sub-Theme 8	Quotes from the Transcripts	Participant	Analytical Memo
Change Management	"Change management is key. We're holding workshops and training to help our staff adopt AI."	A09	Stresses the **importance of structured training to facilitate AI workforce adaptation**.
	"It is of utmost importance to ensure that our staff perceive and comprehend the advantages of AI. We provide clear and comprehensive information regarding the benefits that it imparts to their respective positions."	A04	Emphasises that **clarity in AI benefits can reduce resistance and improve adoption rates**.
	"We're holding workshops, training, and awareness campaigns to help our employees adopt AI. We also aggressively involve employees in AI efforts so they can understand its benefits to their jobs. AI benefits must be disclosed to manage this cultural transition."	A14	Highlights that **effective change management involves transparency, training, and direct employee participation**.

4.5. Conclusion of the Chapter

The current chapter has provided a comprehensive examination of the theme analysis conducted on qualitative data obtained from a sample of 15 participants via individual interviews. The thematic analysis approach has identified four prominent themes that will be addressed and evaluated in

accordance with the characteristics of the acquired material. The full understanding of ADNOC's strategy approach to implementing AI in the oil and gas business is derived from the insights provided by ADNOC managers. ADNOC's commitment to AI goes beyond fads. Instead, it is a comprehensive strategic choice that includes efficiency, sustainability, talent acquisition, regulatory compliance, data management, cybersecurity, and change management. The company recognises the importance of data quality, progressive integration with current systems, and regulatory compliance. ADNOC also recognises the challenges of acquiring and retaining AI expertise, cybersecurity, operational disruptions, financial implications, and human resource management during transitions. By following best practises, ADNOC takes a proactive and comprehensive approach to AI application in the oil and gas industry. This positioning enables ADNOC to assume a leadership role in the continuously evolving energy industry, all the while embracing innovation and sustainability. While this chapter presents the current study findings, the next chapter is a discussion chapter where the findings will be discussed and compared with previous study findings.

CHAPTER 5: DISCUSSION

5.1. Chapter Introduction

In this chapter, the author analyzes how the conclusions made in Chapter 4 contribute to the understanding of the gaps outlined in Chapter 2. It relates the research to real-world data to demonstrate how AI is impacting ADNOC's business at its core, its decisions, and its plans. AI is gradually affecting various industries including the oil and gas industry but there is a lack of literature on how it is implemented in this industry. This chapter is devoted to the analysis of how the implementation of AI affects ADNOC, what changes take place in the company, what key factors influenced the decision to implement AI, and what problems were encountered. The study effectively addresses the research gap by applying conventional management and organisation theories to AI. In addition to that, this chapter relates past studies to the new data in an endeavor to show that AI aids in increasing efficiency, cutting costs, increasing safety and supporting environmental issues. Issues touched in this regard include data quality, regulatory concerns, and resistance to change. The discussion is built on the basis of the gaps defined in the previous section, which helps to maintain the continuity of the literature review, findings, and practical implications..

5.2 Discussion

5.2.1 Addressing Research Gaps: Positive Impacts of AI on Operations of ADNOC

The evaluation of AI's place in ADNOC should be done with reference to the gaps in the literature outlined in Chapter 2. Therefore, the research questions formulated for the study were: The literature review highlighted the absence of published research on the application of AI in the oil and gas industry, especially in the UAE. Although the potential of AI has been recognised in the global research, the studies concentrate a little on the role of AI in decision making, cost optimisation and safety in the oil and gas industry. Moreover, most theoretical writings on AI do not relate it to the existing management and organisational theories, which creates a knowledge gap on how it can be strategically deployed.

This section elaborates how Chapter 4 fills these gaps by providing evidence of how AI is making a positive impact at ADNOC in terms of operations, costs, risks, and people.

AI-Driven Operational Efficiency and Productivity Gains

The research gap highlighted in Chapter 2 was that there is a shortage of literature that investigates the enhancement of operational performance through AI in the oil and gas industry. Despite the global trends indicating that AI could be used for predictive analysis and automation, there was limited information on how these concepts could be applied in the context of ADNOC to result in actual improvements in efficiency.

The results obtained in Chapter 4 provide a clear support for the application of AI in the enhancement of efficiency. Thus, participants' interview highlighted that AI most significantly affected the reduction of time loss, automation of work, and improved decision-making. For instance, Participant A3 noted:

"AI has helped to cut out a lot of redundancies in terms of inspections that are usually conducted. Maintenance can be predicted before failure happens hence minimising the amount of time that is taken by the whole process is greatly reduced." This is in line with the research by Almarashda et al (2021) who stated that AI should be implemented with the goal of improving operations. That being said, the observations made in Chapter 4 are much more concrete as they present real-life stories of how the use of AI and automation impacted ADNOC's operations. The use of AI in the daily operations of ADNOC has meant that production can be enhanced while at the same time, the firm's resources are not strained. As Participant A7 highlighted:

"In terms of the maintenance, it has been noted that the level of the unplanned maintenance activities has been cut by 25-30% due to the implementation of AI-based predictive tools. This ensures the early identification of the signs that require intervention to be taken".

This evidence directly fills the gap discussed in Chapter 2 where there was a dearth of literature on the effects of AI in the oil and gas industry. This proves that AI is not just a future concept, but a reality that improves ADNOC's activity flexibility.

AI and Cost Optimisation: Reducing Operational Expenditures

One of the major gaps identified in Chapter 2 was the fact that the use of AI to improve efficiency in operations in the oil and gas industry was not elaborated on enough. The authors of the existing literature mainly concentrated on the general costs of AI and failed to provide adequate insights

into its potential financial advantages. In Chapter 4, three key pieces of evidence support the notion that AI is a cost optimisation technology for ADNOC. For instance, Participant A5 explained:

"The utilisation of artificial intelligence in the automation of some tasks means that there are fewer instances that require manual handling, hence cutting on costs. We have been able to achieve up to 15% cut on the cost of drilling operations only."

These findings support the arguments made by Wanasinghe et al. (2016) who posit that AI assists firms in achieving cost-sustainability especially in dynamic environments characterised by volatility in the price of oil. However, unlike previous research that mainly provided conjectures regarding these cost advantages, Chapter 4 provides actual costs to support these assertions. Also, one of the most significant issues that were discussed was the potential of AI in the aspect of resource management. It can also be inferred that AI is not only cutting costs but also making the best out of what is readily available. As Participant A9 remarked:

"In supply chain management, we have an AI-based decision support system to manage the supply chain logistics. It eliminates overstocking and also cuts down the procurement mistakes, thus greatly saving money." This evidence is important to fill the gap in the literature because it presents factual findings of how AI has a positive impact on the economic aspect of the oil and gas industry. It also fits well with management theories that underline resource utilisation as one of the key tenets of strategic planning.

Risk and Safety Management: Case of using Artificial Intelligence in Workplace

The literature review revealed a gap in the literature concerning the safety and risk management that has not been much addressed in the existing literature on AI. In the past, the literature reviewed the use of AI in the aspect of predictive maintenance but failed to elaborate on how AI enhances safety in hazardous settings such as the ADNOC.

Chapter 4 provides the answer to this research question by establishing that AI has enhanced risk identification and management at ADNOC. Also, monitoring and predictive analysis have significantly contributed to the management and prevention of occurrence of accidents and also the following of regulations. Participant A2 explained:

"It enables us to detect cases of gas leakage and pressure changes in real time. It is equipped with an alert system that enables intervention to be made as soon as an incident is about to happen."

This supports the work of Devold (2013) who opined that AI can help in reducing operational risks. However, the major contribution of the Chapter 4 is that the author has established the effectiveness of the above claim within the context of ADNOC. Unlike other works that offer only theoretical perspectives on the subject, this work shows how AI is currently evolving the field of safety in practice. However, AI is not only limited to the identification of hazards in ADNOC's operations. Through the use of AI, the employee can be trained through different scenarios hence minimising their errors. As Participant A6 noted: *"The simulations have helped advance our state of preparedness when it comes to emergencies. Employees can undergo the simulation of the risks in an organisation emulating a virtual environment before facing real-life risks.*"

This insight addresses this need by showing how AI can be used in the development of a preventive safety culture. This supports the assertion that the role of AI in the oil and gas industry goes beyond the efficiency and cost cutting to embrace safety enhancement.

AI and Workforce Transformation: Shaping Talent and Innovation

This gap was also highlighted in Chapter 2 where there is a lack of knowledge on the effect of AI on workforce transformation in ADNOC. Previous research focused only on negative effects of AI in terms of erosion of employment but did not address how it can be used to develop the concepts of talents and innovation. As demonstrated in Chapter 4, AI is a critical enabler of talent management and skill building in the context of ADNOC. Contrary to what was expected, instead of replacing people, AI is being used to extend the human capacities. Participant A11 described:

"AI has altered the way in which companies train employees. It is much more effective than using the traditional training manuals, which are often out of date, and the learning materials are adapted to the learner's progress."

This aligns with the view of Sircar et al. (2021) who stated that AI can enhance skill development. However, the case of ADNOC gives a different perception because it shows how AI is implemented in the human resource management instead of eliminating jobs. Also, the data shows

how AI is being used to acquire talent which is crucial in the organisation. As Participant A14 stated:

"AI has made ADNOC an attractive employer for technology enthusiasts due to the company's early adoption of this technology. We are now sourcing for data science and AI engineering specialists to join us because they consider us an innovation company."

This is contrary to what most people believe that the adoption of AI technologies results in massive job elimination. On the contrary, ADNOC's case reveals that AI can help in improving the workforce capacity and attract talented personnel to solve the talent deficit problem in the sector. In summary, AI has facilitated a diverse range of changes inside ADNOC, encompassing improvements in operational efficiency, and cost reduction, as well as advancements in safety and environmental stewardship. The incorporation of AI is under proven management and organisational theories, showcasing ADNOC's holistic strategic approach. The company has established itself as a prominent figure in the industry, showcasing its ability to adapt to market dynamics, foster innovation, and prioritise environmental sustainability. The utilisation of AI in talent acquisition and the cultivation of an innovative culture are two areas where ADNOC acknowledges the favourable effects of AI, highlighting the organisation's awareness of the human aspect in the process of organisational transformation.

5.2.2 Areas Influenced by AI Implementation in ADNOC

Chapter 2 of this thesis established that despite the presence of some literature on the use of AI in oil and gas industries (Kototeev and Tekic, 2021; Hanga and Kovalchuk, 2019), there is a lack of understanding of how AI changes the concept of reservoir management, production planning, and asset maintenance in large oil companies such as ADNOC. Chapter 4 established this by presenting evidence of the fact that AI does improve efficiency while proposing new methods of decision-making. This section now explains how the findings of Chapter 4 address the gaps highlighted in Chapter 2 to highlight that ADNOC is a case that contributes to the development of theory and practice of AI in energy operations. Some studies were conducted by Domini, Dewi, and Cesna in 2023 to analyze the use of AI in seismic data analysis but with little focus on the new strategies of reservoir management in large firms in the oil and gas industry. As seen in Chapter 4, ADNOC has moved from a traditional method of reservoir management that involves the use of

geoscientists to make assessments, to AI that optimises reservoirs in real-time. According to the interviewee A8, 'AI has made it possible for one to fine-tune the extraction of reserves in real-time, which was unthinkable before'. This change also shows that AI does not only optimise a process but alters the theoretical concept of decision-making in reservoir management as pointed out in Chapter 2.

Reservoir Management

The adoption of AI has had a significant impact on reservoir management and exploration (Domini, Dewi and Cesna, 2023). Around 80 percent of respondents stated that AI has brought about a change in the manner in which the ADNOC controls and explores its oil and gas assets. The exploitation of seismic data has been significantly improved by advanced AI technologies, leading to higher accuracy and efficiency in the identification and exploration of reserves. AI has not only enhanced the accuracy in identifying possible reservoirs, but it has also facilitated real-time modifications and optimisation of these reservoirs as identified by Li *et al*. (2021) in their study. According to most of the participants of interviews, the rapid identification and resolution of problems by AI have resulted in time, cost, and resource savings, hence facilitating the efficient execution of exploratory endeavours.

The exploration of areas that have been mostly impacted within the ADNOC by the integrated AI tools and devices revealed a substantial transformation across many areas including maintenance, oil and gas drilling, production, reservoir management, and asset management. The findings revealed multifaceted impacts of AI in various areas of ADNOC highlighting the versatility and wide-ranging influence of AI technologies in bringing a strategic shift in driving operation excellence within the oil and gas sector. The findings indicate that AI is showing positive impacts in the area of reservoir management and exploration of oil and gas, the analytical power of AI has been recurrently praised by the participants. The data analysis suggests a high level of unmatched precision of the AI analytics, using seismic data produced by oil and gas fields, at ADNOC. The findings imply that AI analytical power is exceptionally stronger compared to traditional methodologies, which presents the potential for accurate measurements instead of just providing surface-level information.

Previous studies have also highlighted the potential impacts on this area, Kototeev and Tekic (2021) highlighted that the management of reservoirs through AI is potentially beneficial. The application of AI tools and devices can generate insights that aid the maintenance of the oil and gas reservoirs along with the optimisation of daily functions. The use of AI tools in the processes of reservoir management can aid in the collection of oil and gas data, the devices installed within the oil and gas reserves allow for capturing data from its surroundings (Olajire, 2015). Similarly, Hanga and Kovalchuk (2019) provided supportive findings to further explain how AI can benefit reservoir management in the oil and gas sector. Specifically, the use of AIbased control devices and valves are highlighted that facilitate the internal controls. The flow is controlled with the help of AI-based sensor systems providing a path for efficient productivity, maximising productivity and oil and gas extraction through the use of smart AI technologies (Hanga and Kovalchuk). Overall, this highlights that the present findings are supported by other studies as well, the potential positive impact of AI on reservoir management at ADNOC is evidenced and supportive.

The real-time analytics and AI capabilities have further strengthened its application for effective reservoir management while enhancing its strategic imperative. Participants' data revealed the trends related to dynamic adjustments through the use of AI algorithms and constant analysis of reservoirs via real-time processing. This adaptive AI technology presents a strategic shift in the management of reservoirs where decisions are not static but are flexible depending upon the fluid nature of the oil and gas reservoir environment. This is supported by previous studies like Flichy and Baudoin (2018) who claimed that AI has multiple applications like ML algorithms that can help in effective data collection for improving reservoir management. The use of sensor technologies in oil wells is highlighted, and the capability of AI in capturing and processing realtime information like flow rate allows for favourable maintenance of the reserves. Overall, a comparison of this finding with earlier studies reveals the transformative impact of AI on the reservoir management area along with influences for broader industry-use recognition of enhancing drilling and production operations. The present study, as opposed to previous studies, provides a specific and nuanced exploration of ways used by ADNOC in which AI is leveraged for effective reservoir management.

Production Planning

AI has also been beneficial in the domain of oil and gas production planning. Approximately 70 percent of the interviewees indicated that AI had significantly enhanced the accuracy and effectiveness of production operations. It is in line with the research of Dash *et al*. (2019) stating that the utilisation of AI-powered tools and analytical procedures facilitates the adaptive adjustment of production routines through the continuous monitoring and analysis of real-time demand and supply data. The inherent adaptability of this system guarantees the achievement of production goals, even when confronted with unforeseen variations in the supply chain. The utilisation of AI's real-time capabilities has significantly enhanced the precision of drilling operations, concurrently mitigating potential risks, errors, and subsequent financial burdens (Olukoga and Feng, 2021). This technical innovation guarantees enhanced safety protocols and improved precision in drilling operations.

Similarly, Mohaghegh (2005) asserted that smart oil fields, through AI technology use, enhanced oilfield infrastructure along with effective integration of digitalised data for maximised productivity and network-based knowledge exchange for production planning and process. Thus, the present study revealed that AI can streamline production planning and incorporate tools that facilitate easier production and maintenance of oil and gas fields. Kuang *et al*. (2021) also highlighted the positive role of AI in the production of oil and gas, specifically, the authors highlighted that ML helps in transforming the operations by identifying parameters estimation, lithology, and loggings of curve reconstruction, automatic processing, AI-based production equipment, professional software, rotary-steering drilling, AI-powered intelligent fracturing and other components have led to enhanced oil and gas productions. The present study has also found similar positive impacts on oil and gas production such as real-time monitoring and controlling functionality that aids production along with the utilisation of seismic data. In this regard, Tung *et al*. (2020) also found that oil and gas companies are aware of the technical influence of AI, which has led to an evolved way of exploring oil and boosting the inspection of oil and gas through the collection of digitalised data and a micro-structured grid. Thus, supportive of previous studies, the present study revealed the positive influence on the drilling and production-related operations of AI in the complex landscape of ADNOC. However, the case of ADNOC and related experience enable critical insights into the specific opportunities and challenges that are rooted in its operational context. Altogether, it enlightens ADNOC’s innovative approach to detecting and

addressing the issues that are critical for operational efficiency and for achieving sustainability of its operations alongside successful technological integration.

The findings in Chapter 4 also make a contribution to the existing knowledge about production planning, which is based on the assumption of stable operations environments. However, AI brings a self-regulating model where the production routines are adjusted on the fly based on supply-demand fluctuations. This can be well explained by the adaptive decision-making model (Dash et al., 2019) but goes further with the integration of real-time artificial intelligence analytics. One of the participants (A12) said, *"Earlier, there was a monthly change in production schedule; now, AI changes the output plan on a daily basis using real-time information."* This can be used to redefine the production planning models in the energy sector so as to demonstrate that with the use of AI, planning is not a reactive but rather a predictive process, which is an important theoretical advancement that lacks exploration in the previous literature.

The complex but dynamic changes aided by AI-based analytics improved the product planning process, as revealed by participants' data, and also highlighted an evolving paradigm shift. The static nature of oil and gas fields is long gone, the case of ADNOC exemplifies how production strategies are required to be adaptive and responsive. AI technologies, in this regard, have provided a reliable platform for generating real-time responses to supply and demand changes embodied within the complex oil and gas landscape. The importance of this flexibility is further strengthened by the interpretation of participants' data which provided ground to state the swift and unexpected disruptions indicating the unpredictable nature of the oil and gas fields. The use of AI-based realtime processing has been frequently observed during interpretation as a potential solution for assessing such issues. The ability of AI to reroute the resources and modify the routine operations related to oil and gas fields based on real-time data not only contributes to operational efficiency but also improves resiliency. This has come across as a valuable asset for ADNOC, as observed during interviews, to provide the company with insights to remain proactive against unforeseen issues.

Drilling Operations

The drilling operations at ADNOC have also been found to be positively influenced by the AI's capability for risk mitigation and improving accuracy. The focal points of these observations remain participants' data analysis, the real-time capabilities of AI combined with its precision have provided a transformative strategy for changing the future of drilling in oil and gas fields. The reduced chances of errors due to precise and accurate measurements and calculations because of AI has provided a basis for advanced-level drilling opening gates for future endeavours. Particpants' data revealed this AI capability while highlighting the role of AI technology not just in enhancing efficiency but reducing costs and risks of oil and gas field operations. However, the implications of the findings provide a brighter picture for AI use in drilling and production planning, the observations related to these findings support AI to be considered as an innovative approach for oil production, drilling and reservoir management.

As mentioned in Chapter 4, there is a concept of AI driven predictive risk management which has not been discussed in previous research by Olukoga and Feng (2021) about the role of AI in drilling risk mitigation. While in conventional drilling operations, the risks were evaluated after an event occurred, with the help of AI, possible dangers are foreseen. Participant A5 elaborated it by saying, *"AI simulations enable us to identify areas where failure of drilling may occur before engaging in the process, thus avoiding unnecessary losses."* This has an implication that AI is not only an efficiency enabler but also a factor that transforms the risk perception as indicated by the theoretical shift from reactive to predictive risks in the drilling process.

Furthermore, the implementation of AI has had a beneficial effect on the administration and maintenance of assets inside ADNOC. Approximately 80 percent of the participants acknowledged that AI had brought about significant changes in the management of crucial assets. According to Parker and Grote (2022), the employment of this technology has facilitated the identification of maintenance requirements before their escalation into major problems, resulting in decreased periods of inactivity and enhanced operational effectiveness. AI-based analytics enable the ongoing monitoring and evaluation of performance management and metrics pertaining to assets, hence ensuring the timely replacement of worn components as required. Similarly, Ilangakoon *et al*., (2022) endorsed that the enhanced ability of AI to provide comprehensive analysis has resulted in more efficient asset management by facilitating informed decision-making regarding component replacement or maintenance, hence optimising costs.

In addition, AI has not only bolstered the technological facets of ADNOC's operations, but it has also exerted an influence on the management of risk and safety. According to one of the participants, the deployment of AI in real-time monitoring has resulted in enhanced worker safety. The capacity of AI to analyse data and promptly identify potential concerns, such as unanticipated variations in pressure, has significantly enhanced the safety of operations as indicated by Pishgar *et al*. (2021) in their research. The system has the capability to offer valuable insights that might facilitate fast modifications, thereby mitigating hazards and safeguarding the well-being of personnel. Hence, the integration of AI within ADNOC has yielded significant and favourable impacts across all facets of the organisation's functioning. AI has facilitated significant transformations across various domains, encompassing reservoir management, exploration, production planning, drilling operations, asset management, and safety management. The influence of AI is evident in its ability to improve precision, effectiveness, and security, ultimately leading to heightened productivity and decreased expenses as stated by 80 percent of respondents. ADNOC has emerged as a prominent industry leader due to its all-encompassing strategy in the integration of AI. This approach has enabled ADNOC to effectively respond to market fluctuations, foster innovation, and demonstrate a strong commitment to environmental sustainability.

The outcomes mentioned above are important for understanding how AI is changing some key operational activities in the organisation. More importantly, they respond to the research question outlined in Chapter 2 by providing evidence that AI is not only an optimisation tool but also a source of theoretical progress in reservoir management, production planning, and risk assessment. Real-time decision making, predictive risk management based on artificial intelligence, and dynamic production are some of the indications of the move from static models to adaptive models with artificial intelligence. Thus, these findings contribute to the theoretical discussion of digitalisation in the energy industry and provide a new perspective on the use of AI in large-scale industries.

5.2.3 Motivating Factors for AI Implementation in ADNOC

As established in Chapter 2 of this thesis, there is a lack of knowledge regarding the reasons behind AI uptake in the oil and gas industry besides cost-saving. Although Clarke (2019) and Althabatah et al. (2023) provide an understanding of how AI is applied to operational improvements, there is

no sufficient understanding of the strategic and long-term factors that have led to the implementation of AI at ADNOC. Chapter 4 showed that the use of AI is not a mere mimicry of other industrial practices but a strategic decision aimed at improving the accuracy of decisions, adherence to sustainable practices, and the hiring of employees. This section discusses these motives and will show how ADNOC's experience supports the development of theoretical propositions concerning the adoption of AI in energy firms.

The deployment of AI in ADNOC is driven by a variety of variables, which encompass a holistic strategic approach to the adoption of technology. The adoption of AI is not solely a reactionary measure to prevailing industry patterns, but rather a meticulously evaluated and future-oriented endeavour propelled by various significant determinants (Althabatah *et al*., 2023). The goal of improved operational efficiency and cost reduction serves as a primary driving force. The integration of AI is consistent with existing management principles indicated by Clarke (2019) that prioritise the enhancement of operational efficiency as a means to increase productivity and competitiveness.

Operational Efficiency and Cost Reduction

The acknowledgement by ADNOC of the potential of AI-driven advancements in facilitating quick adaptation to market fluctuations, addressing future trends, and pioneering distinctive solutions highlights the company's strategic emphasis on enhancing efficiency. The aforementioned method aligns with the scholarly work of Almarashda *et al*. (2021), who highlight the significance of improving operational efficiency as a strategy to enhance production and cultivate competitiveness. Furthermore, the tactical execution of AI aligns with the perspectives of Gupta and Shah (2022), who have played a significant role in advising decision-makers on the proficient utilisation of technology progressions to enhance operational effectiveness and achieve financial benefits. Previous research by Almarashda et al. (2021) indicates that AI is useful for cost cutting, although it fails to explain how it affects the new models of operational decision making. From Chapter 4, it can be inferred that AI at ADNOC has shifted the focus from short-term cost reduction to long-term efficiency optimisation where AI constantly polishes operations' parameters. Participant A3 stated, *"AI enables real-time process adjustments, reducing waste before it even occurs, something we couldn't do with traditional forecasting."* This means that AI is not just the

optimisation of the existing operational management; it brings a new theoretical framework of operational dynamism, thus filling a gap in the existing management theory.

Predictive Maintenance

The crucial role that predictive maintenance plays is another factor that contributes to the motivation for ADNOC's decision to implement AI. A substantial shift has occurred in ADNOC's approach to the management of critical assets as a direct result of the application of AI in the framework of predictive maintenance. Conventional methods of equipment maintenance frequently result in costly equipment failures and unexpected periods of idleness (Mata *et al*., 2021). However, AI uses data received from sensors in conjunction with prior performance to generate predictions regarding the likelihood of an equipment failure occurring. This strategy is in line with the tenets of the Lean thinking philosophy, which places a premium on the elimination of waste and the enhancement of operational procedures (Antosz and Stadnicka, 2017). The application of an AI-driven predictive maintenance strategy, as stated by participants, significantly mitigates operational inefficiencies and decreases needless times of idleness, hence reducing the likelihood of adverse outcomes. As a direct result, the implementation of this technique results in monetary gains thanks to a decrease in expenses and an increase in total production. The aforementioned tactic adheres to the results of Thangarajoo and Smith (2015) concerning Lean thinking, which emphasises the requirement of waste reduction and dependability enhancement as essential drivers for long-term gains. This technique is consistent with these findings.

As earlier discussed in Lean management literature (Mata et al., 2021; Antosz and Stadnicka, 2017), predictive maintenance can be applied to the asset management as a shift from a time-based approach to a real-time approach. This is in line with the modern approaches to AI decision-making but is not well understood in conventional process-based approaches. Participant A6 was quite assertive when stating that they no longer perform maintenance based on set cycles but rather on what the AI suggests, which has led to a saving of millions of dollars for avoidable interventions. This shift alters the conventional Lean thinking, claiming that AI contributes a new form of efficiency in industrial asset management.

Sustainability As a Motivating Factor

The dedication to environmental accountability and sustainability is an additional significant driving force behind the adoption of AI in ADNOC. The oil and gas industry are facing mounting pressure to mitigate its carbon emissions and adopt sustainable practices (Al Beshr *et al*., 2019). The commitment of ADNOC to sustainability is demonstrated by its prioritisation of real-time monitoring via AI technology, as underscored by interviewees, to enhance worker safety. This perspective is in line with the academic discussion surrounding sustainability, which centres on the assessment of organisations according to their dedication to environmental accountability and sustainability (Wamba-Taguimdje *et al*., 2020). According to 70 percent of the participants, the use of AI by ADNOC to oversee emissions and comply with environmental regulations highlights the organisation's commitment as a conscientious corporate entity that actively contributes to a greener and more sustainable future. The literature on AI in sustainability (Wamba-Taguimdje et al., 2020) only discusses how the firm complies with regulations, but the information from Chapter 4 shows that ADNOC is leveraging AI to be a responsible company and actively reduce its impacts. This corresponds with the emerging theory of 'AI corporate environmental responsibility', which is still mainly theoretical. Participant A9 said it more eloquently as follows: 'AI is not only useful for achieving targets when it comes to emissions; it also allows us to anticipate and control production in such a way that emissions are reduced by default.' This implies that the position of AI in sustainability extends beyond compliance with the law by changing the system of corporate responsibility for the environment, which was noted in the previous chapter.

Role of AI for Talent Acquisition as a Strategic Shift

The acknowledgement of talent acquisition and innovation as important elements in the application of AI also holds considerable importance. The task of acquiring proficient persons in the domain of AI presents a competitive challenge, and ADNOC acknowledges the significance of both attracting and retaining experts specialised in AI. This approach is in line with the findings of Al Mazrouei *et al*. (2019), who emphasise the significance of creating a conducive atmosphere that is capable of attracting and retaining individuals with exceptional skills. A Participant highlights that ADNOC effectively attracts highly skilled AI professionals by portraying itself as an early adopter of AI technologies and cultivating an environment that fosters new projects. The present methodology aligns with the theoretical frameworks of organisational culture and innovation put out by Sircar *et al*. (2021), which underscore the importance of attracting individuals inclined

towards innovation and fostering the development of cutting-edge concepts. As Al Mazrouei et al. (2019) have pointed out, AI is used in attracting talent in the tech industry In Chapter 4, it is established that AI redefines the industry leader image of ADNOC. Unlike other industries that have conventional patterns of selecting and developing human resources, ADNOC employs modern and innovative methods to select and retain talents. Participant A11 said, *"Our AI-based initiatives are able to draw the best talents because they regard ADNOC as a forward-looking organisation and not just an oil and gas company."* This means that adoption of AI has become a tool for organisational identity formation, an area that has not been discussed in energy-sector literature on AI.

In a nutshell, the factors that have led to the implementation of AI at ADNOC reveal an approach that is both comprehensive and strategic. The fact that ADNOC places such a strong emphasis on things like operational efficiency, predictive maintenance, sustainability, talent acquisition, and innovation is evidence that the company is committed to becoming more competitive and adaptable over the long run. These criteria are congruent with well-established management and organisational theories, which emphasise ADNOC's proactive approach to utilising AI technology to confront the challenges faced by the sector, increase operational efficiency, and achieve sustainable growth.

The global adoption of digital technologies, specifically AI, has been observed in both economic and non-economic domains and the oil and gas business has also not been overlooked. On a global scale, the oil and gas industry has successfully incorporated technological advancements (Bailie and Chinn, 2018). The use of advanced technology has been initiated among businesses operating in the oil and gas sector of the UAE. The contemporary advancements in the oil and gas industry encompass the integration of autonomous underwater vehicles, AI, robots, and 3-D scanning technologies. These innovations serve to augment several aspects of the industry, i.e. safety measures, production efficiency, exploration capabilities, and system monitoring. ADNOC is motivated to incorporate advanced technologies and processes to enhance operational efficiency, enhance production levels, and establish a competitive edge, eventually positioning itself as one of the global leaders in low-cost oil production and carbon emissions reduction. To effectively accomplish the government's innovation objective, it is imperative to actively encourage the delivery of innovation and the adoption of technology inside the oil industry. To sustain

technological competitiveness with international oil producers and capitalise on technological advancements in oil and gas extraction, the government of the UAE has underscored the need to embrace innovative technologies within the gas and oil industry (Al-Jadir, 2021). The oil and gas industry in the UAE has fostered an environment of innovation to improve production excellence and efficiency, aligning with the country's commitment to clean energy initiatives. The utilisation of technology is being extensively employed to minimise human involvement and enhance operational efficiency in response to the hazardous aspects of oil and gas production and environmental considerations. The correlation between the attainment of operational efficiency in the oil and gas production sector in the UAE and the implementation of new technology and decreased human intervention is significant. Various operational factors have led to the integration of advanced robotics, the Internet of Things, three-dimensional scanning, AI, as well as robots and autonomous underwater vehicles within the oil and gas industry (Cai *et al*., 2023). Technological improvements have significantly contributed to the optimal extraction of previously inaccessible fossil resources, hence tremendously benefiting the oil and gas exploration industry. The utilisation of advanced technological instruments has significantly enhanced many stages of the oil and gas production process, encompassing exploration, drilling, extraction, processing, and output. The exploration, drilling, extraction, processing, and production of oil and gas heavily depend on advanced technology that enhances operational efficiency and increases productivity, along with prioritising the safety of workers. The utilisation of contemporary technology has facilitated the oil and gas industry in discovering novel pathways for exploration, extraction, drilling, processing, and production of oil and gas. Furthermore, it has also furnished fresh methods for monitoring and verifying each stage of the production process. The ability of oil and gas businesses to operate in increasingly hazardous environments has been facilitated by the progress made in safety laws and the use of state-of-the-art technologies. The development and implementation of fibre optic sensing technology on offshore drilling rigs have led to a notable enhancement in safety measures. Technological advancements have yielded numerous benefits for the gas and oil sector, including enhanced productivity, heightened safety measures throughout all stages of drilling, exploration, extraction, processing, and production, as well as improved overall operational quality (Teodoriu and Bello, 2021). The utilisation of AI technology in the oil and gas sector of the UAE has yielded positive outcomes in terms of data quality, process efficiency, product-cost efficiency, task efficiency, process flexibility, and overall operational quality. Governments worldwide must

provide precedence to the implementation of AI initiatives due to the favourable impact it exerts on various aspects such as data quality, process efficiency, product-cost efficiency, task efficiency, process flexibility, and quality of operation. The proactive engagement of the UAE leadership is crucial in shaping AI policymaking, as it entails offering comprehensive counsel to government and business leaders regarding the optimal integration of AI into governmental and corporate operations (Radu, 2021).

The UAE has the position of being the fourth largest non-OPEC oil production globally, following Saudi Arabia, Iran, and Iraq (Elsalih, Sertoglu and Besim, 2021). ADNOC and its affiliated firms and organisations in Abu Dhabi engage in a diverse range of activities encompassing exploration, production, storage, refining, distribution, and upgrading of various petrochemical products. The strategic plan known as Abu Dhabi's Vision 2030 places a strong emphasis on enhancing the nation's oil and gas sector and increasing its economic reliance on this industry. The significance of employee performance in this industry is crucial, as it has played a pivotal role in the recognition of this accomplishment. To sustain its leading position in the oil and gas industry, ADNOC is prioritising the enhancement of its petrochemical manufacturing capabilities. ADNOC serves as a prime example of notable accomplishments throughout the whole oil and gas industry (Burke *et al*., 2021). Due to the favourable impacts of the aforementioned variables, the industry saw substantial growth and expanded its presence in hitherto untapped markets. The oil and gas industry has undertaken a digital transformation initiative to optimise the value obtained from each barrel of oil and gas and enhance returns for shareholders, particularly in light of the increasing global energy demand. The active involvement of the company's stakeholders and employees is vital in the formulation of a sustainable growth strategy, given their crucial contribution to the company's integrated plan and ongoing achievements.

Two crucial factors contributing to the emergence of a new global technological paradigm are advancements in technology efficiency and reductions in energy prices (Iris and Lam, 2019). The prominence of AI is increasing. The progress of AI and ML software has aligned with the increasing viability and applicability of the energy sector. The utilisation of AI in the energy sector brings about significant changes in the operational dynamics. The cost-effectiveness of renewable energy technologies has significantly improved, leading to notable savings in manufacturing expenses. The enhancement and escalation of inter-fuel rivalry are being facilitated by the

advancements and proliferation of competing fossil fuels (Ma and Zhang, 2023). This is achieved via several means, such as the reduction of prices across the whole fuel supply chain and the augmentation of overall efficiency. Advancements in power storage technologies will exert significant influence on future energy system topologies, particularly concerning the utilisation of fossil fuels to balance production and consumption inequalities. The energy sector is among the industries that have experienced significant operational transformations as a result of AI. Both energy providers and consumers are increasingly utilising AI to evaluate data about energy generation and use. Hence, there exists a significant potential for organisations to employ AI technology within the energy industry.

As presented in the findings above, the motivation for AI implementation is not limited to the reduction of costs. Chapter 2 noted that there is a gap in the literature in understanding why energy firms are adopting AI strategically; Chapter 4 data shows that AI at ADNOC is not just about efficiency; it is about changing the framework of how the company operates, its approach to sustainability, and where it positions talent. These ideas seem to reorientate the conventional management theories suggesting that AI has more impact than people have thought of before. In this regard, ADNOC's case helps to fill the gap and advance a new theoretical perspective on AI in large-scale industries, seeing it not only as a technological solution, but as a catalyst for corporate development.

5.2.4 Hurdles in AI Implementation

AI utilisation in ADNOC is only possible depending on the quality, availability and management of data. This makes it clear that although ADNOC has advanced in digital transformation, there are several challenges that affect its AI integration including; organisational siloes and disparities of data practices. This is especially so when considering previous literature by El Sherbiny (2023) which stressed on the need for structured data to be incorporated into industries powered by AI, without much discussion on the challenges organisations face when implementing AI. Participant A8 reinforced this point: "They are still working independently at the department level in terms of AI, and there is no centralisation of data sharing." Such a state of affairs may indicate that AI's adoption is not a technical problem, but rather an issue of the organisation's structure and its divisions' integration.

Legacy Systems and Change Management

The other challenge highlighted in Chapter 4 is compatibility issues that will be encountered when implementing AI with ADNOC's existing systems. Though, older infrastructures have shown to be robust in nature, they are not very flexible and compatible for AI integration. There is agreement among participants regarding the fact that existing systems are a problem in the context of AI adoption, as stated by A14: 'Modernisation is taking place; nevertheless, it is gradual.' There are many more systems that are still isolated and there is not enough cooperation to fully shift to AI systems.

This is in line with the change management models (Kotter, 1995) that acknowledge the need to ease change and engage the stakeholders to avoid the disruption of technology changes. As opposed to the prior works that have identified technical AI challenges as the most significant issue (Cuéllar and Huq, 2020), Chapter 4 shows that employee resistance and leadership support are the key factors influencing the implementation of AI. To address these challenges, training sessions and awareness campaigns have been conducted within ADNOC to enhance the company's infrastructure to meet the best practices in organisational change as recommended by Choubey and Karmakar (2021). This phased approach is critical because sudden shifts, as noted by A03, *"often create uncertainty and lead to resistance from employees who feel they are being forced into unfamiliar technologies."*

Regulatory Compliance and Governance Challenges

Another challenge to the use of AI in the oil and gas industry is the existence of strict regulations in the sector. The management of ADNOC has appreciated the need to ensure that AI applications in its operations are compliant with the industry standards and the law. As pointed out in Chapter 4, participants expressed concerns on the unclear regulatory policies concerning the use of Artificial Intelligence. Participant A11 noted: *"AI is moving faster than regulations, and we often find ourselves adapting to rules that were not designed with AI capabilities in mind."*

This supports Cuéllar and Huq's (2020) view that corporate governance structures are generally in a state of disconnection with technology, rendering the process of alignment a challenge. ADNOC has been able to counter this by creating communication with the regulatory bodies while at the same time creating an innovation.

Workforce and Talent Shortage in AI

One of them is the lack of AI specialists and knowledge in ADNOC, which is a critical problem discussed in Chapter 4. ADNOC currently lacks enough competent local talent and the process of recruitment is rather expensive in comparison to global market demands for AI. As participant A14 said: "*We are struggling to attract best talent in AI as we compete with global tech companies and the pay in tech industry is much higher."*

This adds to the body of knowledge that has so far centred on the technical competencies aspect of AI implementation (Benbya, Davenport, and Pachidi, 2020). Nevertheless, the data obtained in Chapter 4 of the present research indicates that the problem of ADNOC is not only the lack of skilled workers, but also the lack of long-term vision in staffing and staffing retention. ADNOC has attempted to bridge this gap through strategic alliances with universities and AI training programs, but as A15 pointed out, "The learning curve is steep, and AI expertise takes years to develop internally."

Cybersecurity and AI Risk Management

Chapter 4 also reveals cybersecurity risk as one of the issues that are likely to affect the adoption of AI. Due to this, ADNOC ensures that it has adequate security to protect its AI operations since the data collected is highly sensitive and belongs to the oil and gas industry. Participant A02 remarked: *"The more we integrate AI into our systems, the more vulnerable we become to cyber threats."*

This echoes with Zaabi and Zamri's (2022) call for penetration testing, security audit, and corresponding security teams in artificial intelligent industries. ADNOC has implemented a proactive cybersecurity program to guarantee that the use of AI in the organisation does not lead to the vulnerability of the organisation's data and operations.

Employee Resistance and Organisational Culture

In Chapter 4, there are four human-centric challenges and one of the major ones is the resistance to change by the employees due to the use of AI. Thus, expanding literature based on the analysis of technical and regulatory conditions in the context of AI integration emphasises the attitude of

organisational culture. Participant A09 observed: *"There is still a mindset among employees that AI is replacing jobs rather than improving workflows."*

This is in line with the psychological model of change, especially the view that employee involvement and management of expectations are important for organisational technological change (Kotter, 1995). ADNOC has responded by implementing employee training programs and awareness campaigns, but as A03 noted*, "Building trust in AI is a gradual process, and people need to see tangible benefits before fully embracing it."*

Financial and Cost Constraints

The last barrier mentioned in Chapter 4 is the conflict of interest in relation to the financial aspect of adopting AI. As for the key challenge, ADNOC is aware of the long-term benefits that will be derived from the application of AI in the long run, but at the same time, they realise that implementing this technology will require a huge capital investment especially in terms of infrastructure, acquiring the right talent, and the constant need for cyber security. As A15 stated: *"The costs are justified in the long run, but at the moment, AI adoption requires substantial financial planning."*

This can be explained by Reddicharla et al.'s (2022) cost-benefit analysis model which maintains that the adoption of AI should be done based on business goals and expected revenue. Thus, ADNOC's AI adoption model is sustainable and incremental, and the company does not have to spend a significant amount of money at once to implement AI.

Chapter 4 contributes to the research questions posed in Chapter 2 that highlighted that AI implementation barriers are not solely technical but rather organisational, regulatory, and cultural challenges. The current solutions tend to describe technology adoption to be governed by factors such as technological proficiency, but results of this study show that data governance, the workforce, and regulations are just as important. Also, the research contributes to change management theories as it reveals that AI implementation should be done gradually with leaders' support and with the focus on building the employees' trust. ADNOC's plans of engaging with universities, gradual implementation of AI, and the company's discussions with regulators demonstrate a systematic approach to AI adoption. Despite the challenges that ADNOC has faced when implementing AI, it has been working on the problem on the structural, financial, and cultural

levels, which supports the concept that AI is not only about the technology itself but also the organisation.

5.2.5 Future perspectives

The findings from the exploration of AI implementation in ADNOC offer valuable insights into the present state of the company's operations. However, looking forward, several intriguing future perspectives emerge, indicating the potential trajectory of AI within ADNOC and the broader oil and gas industry. One pivotal aspect to consider is the continuous evolution of AI technologies. As AI continues to advance, the possibilities for enhancing operational efficiency, predictive capabilities, and decision-making within ADNOC become even more promising. Future iterations of AI algorithms may offer increased accuracy in predictive maintenance (Ran *et al*., 2019), enabling ADNOC to further reduce downtime, optimise asset performance, and minimise operational disruptions. Additionally, advancements in ML and data analytics could lead to more sophisticated insights, allowing ADNOC to make informed decisions based on a deeper understanding of complex operational patterns. The exploration of real-time monitoring capabilities in AI implementation opens the door to enhanced safety measures and proactive risk management. Future perspectives may involve the integration of AI-driven technologies like autonomous systems and robotics, further minimising human exposure to high-risk operational environments. These technological advancements could lead to a paradigm shift in how ADNOC ensures safety compliance and navigates the intricate landscape of regulatory requirements. The synergy between AI and emerging technologies holds the potential to revolutionise safety practices in the oil and gas industry, setting new standards for operational excellence. Another crucial future perspective lies in the realm of sustainability. As global concerns about environmental impact intensify, AI can play a pivotal role in assisting ADNOC in meeting and surpassing environmental regulations. Future applications may include more sophisticated AI algorithms for real-time emissions monitoring, enabling ADNOC to not only comply with environmental rules but actively contribute to carbon reduction initiatives. The intersection of AI and sustainability aligns with the broader industry trends and regulatory expectations (Aslaksen, Hildebrandt and Johnsen, 2021), positioning ADNOC as a leader in environmentally conscious operations. In the domain of talent acquisition and workforce dynamics, future perspectives highlight the ongoing importance of AI in attracting and retaining top-tier professionals. The early success of ADNOC in this regard sets

a precedent for the industry, but future developments could involve even more innovative approaches. AI-driven tools for skills assessment, personalised learning paths, and talent management may become integral in ensuring that ADNOC's workforce remains at the forefront of technological advancements. ADNOC should also take into account the ethical implications and appropriate use of AI technology while considering future views on AI adoption. As AI gets more deeply integrated into operational processes, concerns about data privacy, algorithmic bias, and transparency become of utmost importance (Felzmann *et al*., 2020). ADNOC should address these difficulties by implementing strong ethical frameworks and governance mechanisms to enable the appropriate development and deployment of AI technology. In addition, partnering with industry peers and academics may influence the future direction of AI inside ADNOC. Participating in information exchange, collaborative research projects and consortiums may cultivate a cooperative environment where the sharing of best practices and collective insights propel the advancement of AI in the oil and gas industry. Collaborative endeavours may also aid in the development of industry benchmarks for the deployment of AI, guaranteeing compatibility and the exchange of knowledge that advantages the whole sector. The prospects of integrating AI in ADNOC are diverse and have significant potential. Key factors include the ongoing development of AI technologies, the incorporation of new technologies, a strong dedication to sustainability, and the appropriate use of AI. ADNOC's aggressive stance towards talent acquisition and cooperation solidifies the company's reputation as a pioneering force in the industry. ADNOC's outlook on AI is expected to have a significant impact on the oil and gas sector, influencing the industry's direction and establishing the business as a frontrunner in innovation and operational excellence during this period of technological advancement.

ADNOC has strategically allocated investments to integrate cutting-edge technologies and innovation throughout its value chain, as a crucial component of its digital transformation endeavour. ADNOC has made strategic investments in emerging technologies including AI, big data, blockchain, and predictive analytics. These investments have shown to be highly valuable, resulting in cost reduction and establishing a strong basis for ADNOC to position itself as a leading technology-driven organisation in the sector (Al Ameri, Kohinoor, and Al Awadhi, 2022). These efforts are particularly crucial as ADNOC aims to navigate the challenges posed by the postCOVID recovery period. ADNOC is currently capitalising on the advantages derived from its

ongoing digital transformation as it strategically plans for the future. The corporation has achieved significant cost savings amounting to billions of dollars by leveraging its Panorama Digital Command Centre (Panorama) and other digital projects (Kern, 2021).

In recent years, ADNOC has undertaken strategic investments and implemented several initiatives in the realm of technology and innovation. These endeavours are aimed at facilitating the digital transformation of the company, with the overarching goals of improving operational efficiencies, optimising performance, and extracting enhanced value from its assets and resources. The initiatives encompass the Panorama Digital Command Centre, which has yielded a business value of more than $1 billion (AED3.67 billion) for ADNOC since its establishment (Banihammad *et al*., 2022). Panorama utilises AI, large-scale data analysis, and intelligent analytics to consolidate data from all facets of ADNOC's operations, thereby offering operational insights and recommendations.

5.3 Chapter Conclusion

The discussion chapter reveals the main findings retrieved from the participants' data analysis, the exploration of all themes and their interpretations are included. The analysis suggests mixed results in terms of positive role of AI, the main areas impacted by AI, motivating factors along with negative aspects that hinder the implementation of AI. Figure 5.1 provides an overview of these major themes linking to major findings and the associated recommendations made in the next chapter.

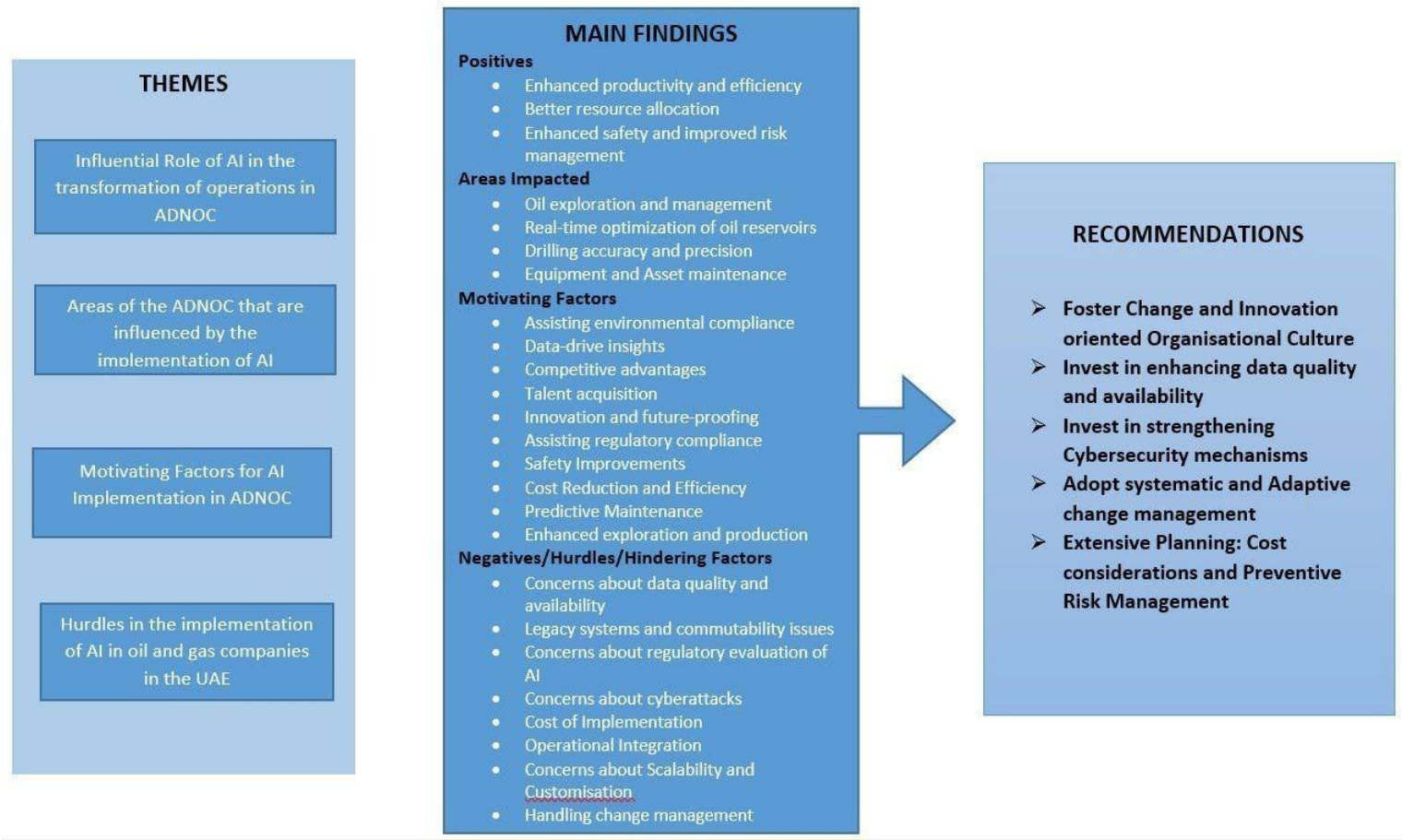

Figure 5.1: Linking Themes, Findings and Recommendations

The initial themes 1 and 2 provided the supportive basis to state the positive role of AI in the transformation of operations along with the main areas that are influenced by the implementation at ADNOC. This has revealed a state of technological advancements that is beyond the apparent gains in terms of efficient of operations. The AI transformation has emerged as a strategic tool, reshaping decisions and optimising the existing resources for effective allocation and management. This also encompasses fostering a culture of safety and novelty for the smooth implementation of AI tools and devices. As the findings transitioned towards later themes 3 and 4, the discussion revealed motivation factors and hurdles of AI implementation. It provides an all-inclusive view of ADNOC's overall journey and how it shapes the domain of technological integration.

From the discussion with previous studies, it is revealed that the positive role of AI has been highlighted in the present study and is supported by previous study findings as well. AI provides solutions that optimise resources, enhance the efficiency of operations and improve overall safety

and risk management related to oil and gas operations at ADNOC. A deep examination of participants' interactions and experiences further reveals areas that have been largely impacted by the implementation of AI at ADNOC. The operational domains reveal transforming due to novel AI tools and devices that have impacted the areas related to oil and gas fields such as reservoir management, production planning and process, maintenance and drilling operations. Overall, the findings have led to the identification of these areas which have also been similarly discussed by previous studies. Although previous studies have not explored the impacts of AI on reservoir management in detail, positive impacts on different areas like maintaining reserves, and monitoring oil wells via sensor technologies have been revealed. A discussion of the present findings reveals that AI has the potential to work with several advanced tools and techniques in an integrated environment to provide use insights for effective reservoir management, production planning and drilling operations.

Moving forward, the motivating factors of AI are identified and compared with previous studies, the present study provides novel insights related to factors such as data analytics, operational efficiency, competitive benefits, sustainability outcomes and strategic evolution. The stress on innovation and talent acquisition highlights ADNOC's dedication to fostering a forward-thinking workforce and staying at the front of the market competition. Safety improvements and better regulatory compliance are not just formalities in the organisation, but it is among the most crucial components that ensure accountability and responsibility towards secure operations. It also highlights the commitment of the organisations towards keeping the staff and environment secure and safe from risks. The collective effect of these motivating factors shapes ADNOC as a leader that has not just adopted AI technologies but has also provided implications for shaping its integration strategy within a set of considerations.

On the contrary, the last theme revealed significance findings related to the hurdles faced by ADNOC during the adoption and implementation of AI. The hurdles revealed by the participants' data provide insights about handling issues that can hinder the implementation of AI, from data quality to the issues related to legacy systems. The hurdles are found to be mostly related to technical assistance yet important considerations that shape and hinder the implementation of AI. Other hurdles like cybersecurity and regulatory compliance issues are also highlighted which stresses the importance of balancing between strategic objectives and innovation adoption. Among

the hurdles which are discussed by the present study, the participants frequently mentioned the costs-related challenges as one of the most important considerations before technological adoption. The cost considerations and challenges are integral as they are beyond just the financial consideration, it hinders the evaluation of the return on the investments in terms of shaping the competitive position and operational efficiency of the company. Previous studies have also been discussed that have confirmed the consideration of costs before and during the adoption of AI into oil and gas operations. Similarly, the challenge of integrating AI into the existing oil and gas operations is highlighted in terms of organisational challenges and hurdles. Change management is often required to ensure that the AI implementation is smoothly conducted and integrated within the existing processes. Change management, in the present study findings, emerges as the critical aspect that recognises that successful AI implementation is not just about technological shift, but it is about cultural embracement and adaptation to align it with existing processes.

Collectively, the existing findings of the study provide insights about the exemplar case of ADNOC and produce implications for broader industry practices. The positive influence of AI on oil and gas operations supersedes efficiency gains, safety culture-informed decision-making and resource optimisation, it positions ADNOC as a leader of operational excellence. The motivation factors behind the technology adoption for ADNOC reveal a forward-thinking and innovationembracing attitude that aligns technology adoption with sustainability outcomes. Ultimately, the identified hurdles highlight the complex process of AI integration into existing procedures and stress the adoption of a structured and adaptive strategy for successful implementation. The case of ADNOC highlights that ADNOC has overcome these hurdles and provides insights for other players to learn from its lesson and engage in successful technology integration. A balance between addressing the challenges and incorporating innovation is important for the effective implementation of technology for an all-inclusive transformation of oil and gas operations. The ADNOC's case of AI implementation sets the stage for other companies to understand that it is not just a technological shift but also a paradigm shift that substantially impacts the operational excellence of the organisation. As the energy sector recognises the imperative of efficiency, innovation and sustainability achieved through technological evolution, ADNOC's lessons serve as guidelines for understanding the complexities related to AI integration. The strategic alignment of AI to achieve its positive impacts in various major areas of oil and gas

operations provides the basis for others to adopt the technology. Moreover, the strategic adoption and implementation of AI at ADNOC exemplifies its smooth implementation. The motivating factors and addressing of hurdles are important, ADNOC's case signifies that leaders in the sector must balance between challenges and benefits to maximise operational excellence.

CHAPTER: 6 CONCLUSION

6.1. Introduction Chapter

The study delved deeply into exploring the role of AI in transforming the operations of ADNOC. The study attempted to address three main objectives. The first objective was to discuss the role of AI technology in transforming operations at ADNOC. The second objective was to identify the areas of the oil and gas industry that are influenced by the implementation of artificial technology. The third objective was to determine the drivers and barriers to implementing artificial technology in oil and gas companies in the UAE.

This chapter is dedicated to presenting, discussing and highlighting the key findings of the study. Along with this, the implications of the findings are discussed in the light of practice and policy. The chapter also contains key recommendations for companies like ADNOC operating within the oil and gas industry regarding the adoption and implementation of AI to improve oil and gas operations. The main limitations of the research process and outcomes are also discussed, along with this, a section is dedicated to discussing suggestions regarding future research and development related to the field.

6.2. Key Research Findings

The main findings of the study revealed the transformative journey faced by ADNOC in adopting and integrating AI into its traditional operations related to oil and gas. There were four main findings of the research that were retrieved through data collection and analysis with the participants. Firstly, AI emerged as an important tool that substantially altered the operational domain of ADNOC, the influence was far-reaching beyond the advantages related to the efficiency of the functions and processes. The influences were beyond the core operational pillars including safety protocols, resource allocation, and improving overall decision-making processes related to oil and gas operations. Secondly, the analysis of the participants' responses revealed that AI's influence extends across multiple domains of operations, it has revolutionised overall practices in oil and gas fields. This includes production planning, reservoir management, maintenance of oil and gas fields, asset management and exploration of oil and gas wells.

Moving beyond just the impacts of AI in multiple areas of oil and gas operations, the key findings also reveal the motivating factors that are behind the adoption and integration of AI into existing processes. The motivation factors included safety enhancement, compliance, innovation,

achieving sustainability and overall operational efficiency. Another key finding of the study is that the analysis of the participants revealed hurdles faced during AI integration and implementation. The main hurdles were found to be related to compliance issues, cybersecurity threats, legacy systems, data quality, scalability, change management and cost implications.

6.3. Implications of the Findings

The findings of the study revealed implications for the operational paradigm of ADNOC within the broader industry of energy. AI role has been revealed to be transformative, highlighting that ADNOc has an evolving landscape that moves beyond efficiency gains and technological integration. The AI transformation at ADNOC unearthed a strategic shift in the operational domain that produces benefits for practice more than just enhancing the efficiency of the functions. The findings reveal that AI has positive influences across various domains of ADNOC, this implies its adaptability and strength to revolutionise the traditional workplace settings in a way that benefits the organisations. The positive influence of AI on multiple areas of oil and gas operations at ADNOC produces implications for other companies. The positive influence on risk and safety management, operational efficiency and decision-making processes provides a basis for other large organisations like ADNOC to consider the adoption of AI tools and devices. Moreover, the findings related to the identification of various areas related to oil and gas operations where AI has made substantial improvements also provide practical insights for other companies to understand the potential of AI integration and adoption. Factors such as innovation, sustainability, safety management and compliance outcomes are all relevant aspects that produce implications for other companies to learn from the case of ADNOC and consider its systematic integration. Moving forward, the last and key finding of the present study related to the challenges and hurdles faced by ADNOC during AI integration and implementation also produces practical insights. It serves as a blueprint for other companies to learn about the practical challenges embedded in the operational landscape of ADNOC. The hurdles found in the present study indicate that the process of AI integration and adoption is not simple and involves complexities. The knowledge about the multifaceted and complex nature of AI implementation is beneficial and implicative for other companies like ADNOC to learn from the benefits, challenges and motivation to adopt and integrate AI. More importantly, the companies are to learn from the case and establish operational frameworks that can cater for these hurdles and facilitate the smooth adoption and integration of AI into their functions. The deep insights about hurdles faced and strategies they incorporated to

mitigate the risks and issues with AI also provide useful implications for industry experts and peers. Moreover, the knowledge related to the hurdle in implementing AI for ADNOC implies that other large companies must take into account the complexity of the process and employ an adaptive and systematic approach to adoption instead of a linear process. The idea is to take steps, one at a time, with informed decision-making taking insights from exemplar cases like the present case of ADNOC. Overall, the key findings of the study are useful as they provide implications for practice for professionals and organisations like ADNOC. The personnel in other similar companies, undergoing technological integration involving AI can also benefit from the insights produced by current study findings. The implications of the AI integration and implementation, in the context of present study findings, are beyond just guidance for industry peers, it serves as a basis for understanding the importance of strategic shift, adaptability and transformative capabilities of organisations to achieve a competitive edge in the market. The forward-thinking approach exemplified by ADNOC in its transformation journey of AI adoption and integration provides a basis for other organisations and other similar industries to opt for technological integration for endless benefits.

6.4. Recommendations

The present study findings and insights provide a foundation for providing practical recommendations for the ADNOC and other similar organisations as well as professionals to understand the complexity of AI adoption. The recommendations are provided to the concerned professionals and industry entities within the energy sector to navigate the advantageous technological landscape of AI for achieving advanced-level benefits.

A set of recommendations are provided as follows:

Fostering an organisational culture that embraces change and innovation

The companies must encourage and establish an organisational culture that is not reluctant to change, the welcoming characteristics of the organisation as a whole towards change and innovation address hurdles related to reluctance to change. This can be achieved by establishing discussion sessions, forum discussions, and workshops for the organisational members to understand the importance of staying adaptive to innovation and change. Another recommendation for top management, concerning organisational culture, is to develop and offer incentives that reward forward and innovative thinking of employees at all organisational levels. Altogether, the

organisations and top management must dedicate their efforts towards establishing and fostering a culture of change and embracement of innovation to remain up-to-date and technologically advanced in the market.

Investing Strategically to enhance data quality

It is also recommended for organisations like ADNOC, within the oil and gas sector, to invest in strategic initiatives including investing in the aspects of data quality. the allocation of resources and funds to enhance the quality of data is very important to leverage from any kind of data-driven technological adoption and integration. The manual recording and reporting of data is outdated, and the companies need to invest in effective strategies to ensure data quality and advanced data management. There should be investments in data governance frameworks to increase accountability, transparency and responsibility for data handling, storage, processing and overall management. Moreover, the companies must invest in advanced tools for incorporating data analytics and advanced level quality of data. This is to ensure that data quality is up to the highest level producing accurate insights for the organisations to make important decisions. Relatedly, it is also important for organisations to conduct training to ensure that people involved with data handling are aware of its vital aspects such as ensuring data reliability, consistency and accuracy.

Investing in Cybersecurity

Developing and implementing a robust and comprehensive strategy for enhancing cybersecurity is crucial for the effective implementation and adoption of AI tools and devices. The present study findings revealed that cyber-attacks and anomalies are among the severe hurdles that require addressing, thus, the companies considering AI adoption must invest in their cybersecurity measures. Among the advanced strategies for robust cybersecurity mechanisms include investment in robust defences, incorporating continuous monitoring and evaluation of the systems and measures in place for cybersecurity along ensuring proactive threat intelligence. The investment in this area is beneficial for large organisations like ADNOC to plan and invest in resources and sufficient budget to stay ahead of others in the market. It is important to incorporate advanced measures of cybersecurity for organisations to protect the data from damaging threats and use it for the operational excellence of the organisation.

Systematic and Adaptive Approach to Change Management

Among the useful insights generated from the case of ADNOC's adoption and integration of AI. It is recommended for organisations to adopt a systematic approach to adopting and incorporating adaptive change management. As opposed to this, a rapid and unsystematic approach can lead to disruptions and increased challenges indicating an unsuccessful adoption of AI within oil and gas companies. The companies and advised to establish and implement frameworks such as agile methodologies to incorporate and achieve seamless integration into existing processes. The companies must also ensure that teams are equipped with the necessary resources and technical knowledge to embrace change and operate efficiently during the restructuring of the organisations.

Preventive Approach and Risk Management: Cost Considerations and Scalability

A preventive approach, in addition to systematic and adaptive strategies, is recommended; while adaptive strategies would facilitate seamless integration of AI into existing processes, a preventive approach would reduce the possibility of negative outcomes of the integration efforts. It is advised that companies must conduct a risk analysis to determine potential vulnerabilities and threats existing within the business operations and structures. Identifying and addressing these concerns is important for organisations before considering adopting AI tools and systems for oil and gas operations. For instance, a lack of consistency within the existing data management system can produce additional hurdles for the integration of AI processes. Thus, conducting a risk analysis of both internal and external aspects of the organisations is important to act proactively for the seamless integration of AI. Apart from risk analysis of existing processes, it is also important to consider cost implications before adopting AI to achieve benefits beyond operational excellence. The risk management must also ensure that scalability is considered while the decision to adopt and implement AI into oil and gas operations is assessed. A consideration of the organisation's financial capabilities is important before deciding on adopting AI, scalability allows the benefits of adoption and maximised while mitigation efforts are aligned with organisational growth. This preventive approach would lead to sustainable outcomes and resiliency in times of unexpected changes for organisations considering technological adoption to stay competitive in the industry.

6.5. Limitations of the Study

While the study produces useful insights for companies like ADNOC to learn from its case of AI adoption and implementation in terms of influences, areas that were impacted, challenges and

hurdles faced and strategies to mitigate the risks of adoption and implementation, there are some limitations. The findings are limited in terms of the scope of the study, the research might not have included all the aspects of AI integration into ADNOC but specifically focused on the transformative influence on the oil and gas operations. This means that the integration of AI is multifaceted for different areas of the business, the study findings might not apply to all other operations within ADNOC or other similar companies.

6.6. Accomplishment of Research Objectives

In retrospect, the research objectives outlined at the outset of this study aimed to explore the role of AI technology in transforming operations within the ADNOC. The investigation delved into identifying the specific areas within the oil and gas industry influenced by the implementation of artificial technology and determining the drivers and barriers to its adoption in oil and gas companies in the UAE. The key research findings unveiled a comprehensive understanding of the transformative journey undertaken by ADNOC in integrating AI into its traditional operations. The study successfully demonstrated that AI emerged as a pivotal tool, extending its influence beyond mere operational efficiency to encompass crucial aspects such as safety protocols, resource allocation, and overall decision-making processes. The research effectively identified the broad spectrum of operations within the oil and gas sector that have been revolutionised by AI, including production planning, reservoir management, maintenance, asset management, and exploration. Moreover, the study provided insights into the motivating factors driving the adoption of AI, including safety enhancement, compliance, innovation, sustainability, and overall operational efficiency. Conversely, the research shed light on the hurdles faced during AI integration, including compliance issues, cybersecurity threats, legacy systems, data quality, scalability, change management, and cost implications. The implications of these findings underscore the transformative and positive influences of AI across various domains of ADNOC, implying adaptability and strength to revolutionise traditional workplace settings. In evaluating the original research objectives, it can be concluded that the study has effectively addressed and satisfied the outlined objectives by providing a comprehensive analysis of AI's role, its impacts on different operational areas, and the associated drivers and barriers within the context of ADNOC and the broader oil and gas industry in the UAE.

6.7. Contribution to Knowledge

The findings of the presented thesis contribute to the stream of knowledge on the adoption and integration of AI in the context of the oil and gas industry with a focus on ADNOC. In doing this, this research not only contributes to the management and organisational theories but also shows that AI is not only an arsenal but a facilitator of change.

Contribution to Change Management Theory (Kotter, 1995)

Thus, the study affirms Kotter's Change Management Theory with reference to the implementation of AI in large organisations. While there are dynamic models of change management that are characterised by several stages of change, this research shows that for AI change to occur, it is more appropriate to adopt an incremental model of change. In Chapter 4, the author discussed how ADNOC has adopted Kotter's eight-step model but modified it by adding the approach of the phased implementation of AI, data governance, cybersecurity risks, and the need for reskilling of the workforce. The integration of technological compatibility and regulatory compliance into the change process is another contribution of this study to Kotter's model since they are usually considered technicalities in AI adoption.

RBV, also known as the Resource Based View (Barney, 1991).

The study also adds to the knowledge of the RBV of strategic management by demonstrating how AI is an organisational asset that strengthens ADNOC's competitive advantage, productivity, and recruitment. Traditional RBV research emphasises tangible resources, which has been complemented by this study that indicates that predictive analytics, operation automation, and sustainability as intangible but invaluable assets (Participant A9).

The finding of this research is that AI must be viewed as an organisational capability and not just a technological enabler. The analysis of AI at ADNOC highlights how the adoption of AI repositions the company's approach to workforce, improves the speed of decision-making, and optimises the efficiency of operations making AI a key player in sustainable competitive advantage.

Contribution to Lean Thinking and Operational Excellence (Womack and Jones, 1996)

The study supports the Lean Thinking approach, which is based on the minimisation of waste and the constant improvement of processes. According to the Chapter 4 findings, AI reduces avoidable duplication, cuts down on the 25-30% of the unplanned maintenance and effectively manages the supply chain which is inline with lean principles (Participant A7).

Key Insight: This research goes further to apply Lean Thinking by showing that use of AI allow for constant real-time adaptations making it a predictive Reactive Process Improvement model. Based on this, it is clear that AI Lean should be adopted into the energy sector's operation to enhance efficiency.

Strategic Human Resource Management (SHRM) in relation to the application of AI (Wright and McMahan, 1992)

Previous research mainly links AI to reduction of workforce and automation. However, this research does not support these assumptions because it established that AI is used in ADNOC for the improvement of talent acquisition, reskilling, and leadership decision-making. They are not displacing the human skills, but enhancing the decisions made and to create demand for AI professionals in ADNOC (Participant A11).

This brings a new perspective to the existing SHRM theory as Corteling and Datta propose to use AI for talents and skills management, reorganisation, and other objectives but not for cutting costs.

Contribution to Digital Transformation in Energy Sector Theory

While digitalisation is often mentioned in IT-related industries, its potential in the oil and gas industry has not been investigated in much detail. Hence, this paper is one of the few that offer empirical evidence on the effective use of AI adoption by ADNOC and integrates to the growing body of literature on AI strategy and digital operations in asset intensive industries.

Intrinsic Understanding: The paper's results prove that AI is not just a tool that increases organisational effectiveness, but it holds a significant role in changing the system of corporate governance, risks, and regulation in which energy companies operate and adjective to, which means that the analysis of AI adoption in energy businesses must not be limited to the technical aspect.

6.8. Contribution to Practice

The findings of the study hold significant implications for practice, particularly in the oil and gas sector, providing actionable insights for management and other stakeholders. These practical implications offer a roadmap for organisations to navigate the complexities of adopting and integrating AI into their operations, drawing from the transformative journey of ADNOC outlined in the thesis.

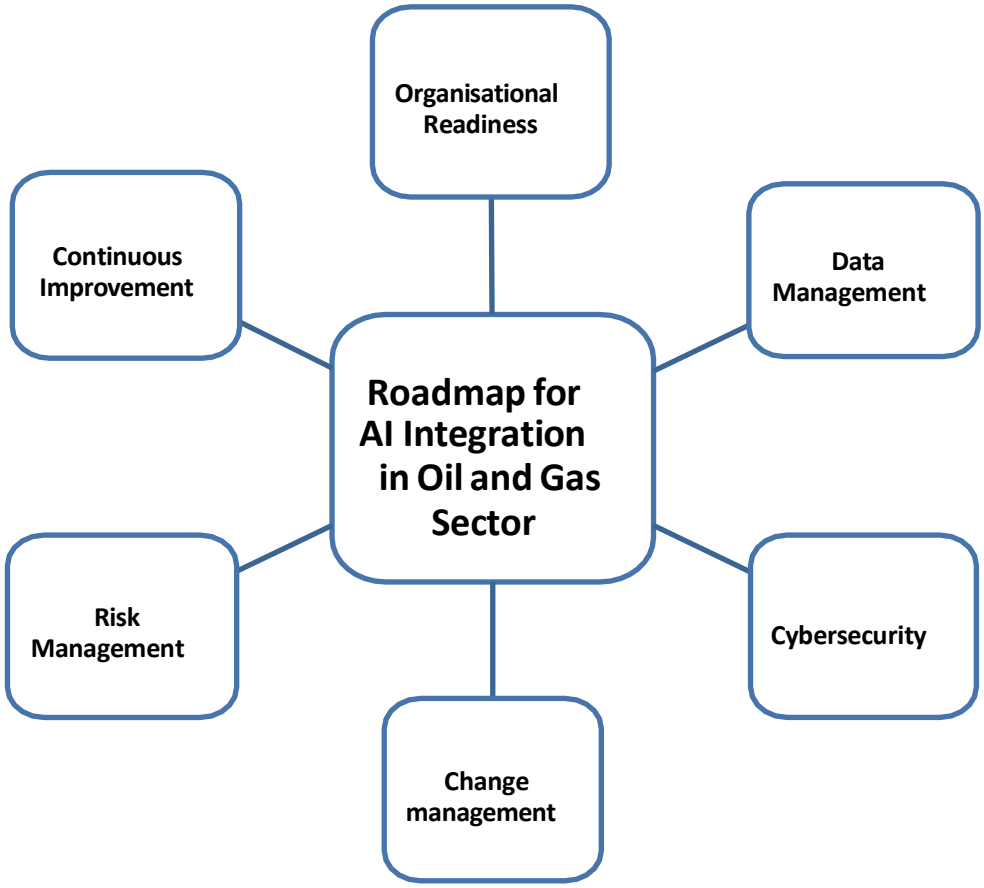

Figure 6.1 Roadmap for AI Integration in Oil and Gas Sector, Source: (Author-defined)

Enhancing Organisational Culture for Innovation and Change: The recommendation to foster an organisational culture that embraces change and innovation is crucial for oil and gas companies seeking to integrate AI effectively. Management can implement this recommendation by organising training sessions, workshops, and forum discussions to educate employees about the importance of staying adaptive to innovation. Incentives for forward-thinking and innovative ideas can be introduced to motivate employees at all levels. This approach aims to create a culture that is not

only open to change but actively encourages and rewards innovative thinking, laying the foundation for a more agile and responsive organisation.

Strategic Investment in Data Quality: The study suggests that organisations, like ADNOC, should strategically invest in enhancing data quality to leverage the full potential of AI. Management can initiate this by allocating resources and funds to advanced data governance frameworks. Implementing measures such as data analytics tools and comprehensive training programs for employees involved in data handling ensures that the data is reliable, consistent, and accurate. This investment is critical for oil and gas companies as high-quality data is essential for informed decision-making, optimising operational processes, and realising the full benefits of AI applications.

Prioritising Cybersecurity Measures: With cybersecurity threats identified as a significant hurdle in AI integration, management in the oil and gas sector can use the study's findings to prioritise and invest strategically in cybersecurity measures. Developing a robust and comprehensive cybersecurity strategy involves investing in defense mechanisms, continuous monitoring, and proactive threat intelligence. This proactive approach helps safeguard sensitive data and ensures the integrity of AI systems, which are integral components of oil and gas operations. The study's insights provide a practical guide for management to enhance their cybersecurity posture, protecting critical assets from potential cyber threats.

Systematic and Adaptive Change Management: The study recommends adopting a systematic and adaptive approach to change management during AI integration. Management can use this recommendation to establish frameworks, such as agile methodologies, to facilitate seamless integration into existing processes. Ensuring that teams are well-equipped with the necessary resources and technical knowledge promotes a smoother transition. This approach mitigates disruptions and challenges associated with AI adoption, allowing organisations to reap the benefits of enhanced operational efficiency without compromising productivity.

Preventive Approach and Risk Management: Cost Considerations and Scalability: The study's recommendation for a preventive approach and risk management provides practical insights for management in the oil and gas sector. Conducting a thorough risk analysis enables organisations to identify vulnerabilities and potential threats, allowing for proactive mitigation strategies. Considering cost implications and scalability before adopting AI ensures that the financial

investment aligns with organisational growth. This preventive approach helps organisations build resilience, anticipating challenges before they arise, and fostering sustainable outcomes during technological adoption.

In practical terms, these recommendations translate into tangible actions that management and stakeholders in the oil and gas sector can implement in their working routines:

Organisational Workshops and Training Programs: Management can organise workshops and training programs focused on AI awareness, data quality management, and cybersecurity best practices. These initiatives facilitate knowledge transfer, ensuring that employees are well-informed and prepared for the changes associated with AI integration. Workshops can also serve as forums for discussing innovative ideas, fostering a culture that values continuous improvement.

Strategic Resource Allocation for Data Quality: Organisations can strategically allocate resources and funds to enhance data quality. This includes investing in advanced data governance frameworks, analytics tools, and training programs. The emphasis on data quality ensures that the insights derived from AI applications are accurate and reliable, contributing to more informed decision-making and improved operational efficiency.

Continuous Cybersecurity Training: In response to the study's emphasis on cybersecurity, management can implement continuous training programs for employees involved in data handling and system management. These programs educate staff on the latest cybersecurity threats, best practices, and proactive measures. This continuous learning approach empowers employees to actively contribute to maintaining a secure operational environment.

Agile Methodologies for Change Management: Management can adopt agile methodologies for change management during AI integration. This involves breaking down the integration process into manageable phases, allowing for iterative adjustments and minimising disruptions. Providing teams with the necessary resources and technical support ensures a smooth transition, fostering adaptability and resilience.

Conducting Risk Analysis and Scenario Planning: Organisations can implement a preventive approach by conducting comprehensive risk analyses. This involves identifying potential vulnerabilities and threats to the existing operational processes. Scenario planning allows

management to anticipate challenges, develop mitigation strategies, and align AI adoption with the organisation's growth trajectory. This proactive risk management approach contributes to the successful integration of AI technologies.

The practical implications of the study's findings extend beyond immediate implementation. Management and stakeholders in the oil and gas sector can leverage these insights to shape longterm strategies, ensuring that their organisations remain at the forefront of technological advancements. By actively incorporating the recommended practices into their routines, these entities can foster a culture of innovation, optimise operational processes, and position themselves as leaders in the evolving landscape of AI adoption within the energy industry.

6.9. Future Research Direction

The identified limitations in the scope of the study pave the way for future research directions that can further enrich our understanding of AI integration in organisations, especially within the oil and gas sector. While the current study focused primarily on the transformative influence of AI on oil and gas operations in the context of ADNOC, future research can explore additional dimensions and fill gaps to provide a more comprehensive picture. The following future research directions are suggested:

Cross-Functional Integration of AI: The current study concentrated on the transformative impact of AI within the oil and gas operations of ADNOC. Future research can extend the scope by examining the cross-functional integration of AI across various departments within ADNOC and similar organisations. Investigating how AI is adopted and implemented in areas such as finance, human resources, and supply chain management can provide insights into the organisation-wide implications of AI integration. Understanding how AI influences decision-making processes in different functional domains can contribute to a more holistic view of its organisational impact.

Exploration of Industry-Specific AI Applications: While the study delved into the transformative influence of AI in the oil and gas sector, future research can explore industry-specific AI applications within the energy sector. This could involve investigating AI's role in renewable energy initiatives, environmental sustainability, and compliance with evolving industry regulations. Examining how AI contributes to innovation in these specific areas can provide valuable insights for organisations seeking to align their operations with emerging industry trends and regulatory requirements.

Comparative Studies Across Energy Companies: Conducting comparative studies across multiple energy companies, both within and outside the oil and gas sector, can offer a broader perspective on AI adoption. By analysing how different organisations approach AI integration, manage challenges, and leverage opportunities, researchers can identify best practices and common trends. Comparative studies can shed light on industry-specific variations in AI adoption strategies, allowing for a more nuanced understanding of the factors influencing success or hurdles in different organisational contexts.

Long-Term Impacts and Sustainability: The current study provides insights into the immediate influences of AI adoption on oil and gas operations. Future research can explore the long-term impacts and sustainability of AI integration within organisations. This involves investigating how AI technologies evolve over time, how organisations adapt their strategies in response to changing technological landscapes, and the enduring effects on organisational culture and efficiency. Understanding the long-term implications of AI adoption can guide organisations in making strategic decisions for sustained success.

Ethical Considerations in AI Integration: As AI continues to play a pivotal role in organisational operations, addressing ethical considerations becomes paramount. Future research can delve into the ethical implications of AI integration within the oil and gas sector, considering aspects such as data privacy, algorithmic bias, and the responsible use of AI technologies. Exploring how organisations navigate ethical challenges and incorporate ethical frameworks into their AI strategies can contribute to the development of responsible AI practices in the energy industry.

Global Perspectives on AI Adoption: The current study focuses on the case of ADNOC, providing valuable insights into AI adoption within the Middle East. Future research can expand its geographic scope to include global perspectives on AI integration within energy companies. Comparative analyses of AI adoption practices in different regions can uncover regional nuances, regulatory variations, and cultural influences that shape organisational approaches to AI implementation.

Quantitative Analyses of AI Impact Metrics: While the study provides qualitative insights into the transformative influence of AI, future research can incorporate quantitative analyses to measure the impact of AI adoption more rigorously. This could involve developing key performance indicators (KPIs) specific to AI integration and assessing their correlation with organisational success metrics. Quantitative analyses can provide a more structured understanding of the direct

and indirect effects of AI on operational efficiency, financial performance, and other critical outcomes.

User Adoption and Human Factors: Understanding how end-users, including employees at various levels, interact with and perceive AI technologies is crucial for successful integration. Future research can focus on user adoption patterns, user experiences, and the role of human factors in shaping the effectiveness of AI systems. Exploring the psychological and organisational aspects of AI acceptance can provide valuable insights for organisations aiming to enhance user engagement and optimise the utilisation of AI tools.

6.10. Summary of the Chapter

This chapter presents key findings of the study, indicating that the implementation of AI in ADNOC has significantly altered operational activities, yielding benefits in terms of efficiency of functions and processes. The influence of AI prevails through different operational domains of the company, including production planning, reservoir management, maintenance of oil and gas fields, asset management and exploration of oil and gas wells. The motivating factors behind the adoption of AI into existing processes included safety enhancement, compliance, innovation, achieving sustainability and overall operational efficiency. The main hurdles faced during AI integration with operations were found to be related to compliance issues, cybersecurity threats, legacy systems, data quality, scalability, change management and cost implications. The current research findings imply that AI has offered adaptability and strength to revolutionise the traditional workplace settings in a way that benefits the organisations. The positive influence on risk and safety management, operational efficiency and decision-making processes provides a basis for other large organisations like ADNOC to consider the adoption of AI tools and devices. Factors such as innovation, sustainability, safety management and compliance outcomes are all significant aspects to consider in this respect. The study generates useful recommendations for both academia and industry. It proves to be crucial to embrace change and innovation by fostering an organisational culture characterised by adaptability and readiness to change. Strategic investments can increase the quality of data by utilising technological advancements. Effective implementation of AI in operations also requires investing in cybersecurity and developing effective relevant strategies. Moreover, systematic and agile approaches to change management can facilitate integration of AI into operational domains. Risk management, scalability, and cost considerations hold significance due to ensure implementation of the preventive approach and achievement of resiliency and

sustainable outcomes. The study is limited in the sense that it focuses only on the transformative influence of AI on operations in oil and gas companies and does not have implications for other areas and aspects of the business.

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APPENDICES

Appendix 1- Ethical Approval

University of Central Lancashire
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7th September 2023

Kieron Iveson / Maktoom Maktoom-al-mazrouei
School of Business
University of Central Lancashire

Dear Kieron and Maktoom,

Re: BAHSS2 Ethics Panel Application
Unique Reference Number: BAHSS2 0411

The BAHSS2 Ethics Review Panel has granted approval of your proposal application, 'The role of Artificial Intelligence in transforming the operations of the Abu Dhabi National Oil Company'. Approval is granted up to the end of project date*.

It is your responsibility to ensure that

- the project is carried out in line with the information provided in the forms you have submitted
- you regularly re-consider the ethical issues that may be raised in generating and analysing your data
- any proposed amendments/changes to the project are raised with, and approved, by Committee
- you notify ethicsinfo@uclan.ac.uk if the end date changes or the project does not start
- serious adverse events that occur from the project are reported to Panel
- a closure report is submitted to complete the ethics governance procedures (Existing paperwork can be used for this purposes e.g. funder's end of grant report; abstract for student award or NRES final report. If none of these are available use e-Ethics Closure Report Proforma).

Yours sincerely,

Helen Richardson Foster, Deputy Vice-Chair
BAHSS2 Ethics Panel

* for research degree students this will be the final lapse date

NB - Ethical approval is contingent on any health and safety checklists having been completed, and necessary approvals gained.

Appendix-2 Gate Keeper Letter

Abu Dhabi National Oil Company Building, West Corniche Street, PO Box 898, Abu Dhabi, United Arab Emirates

21 September 2023

University of Central Lancashire

Preston, Lancashire, United Kingdom

PR1 2HE

+441772201201

Dear **Maktoom Almazrouei**,

This confirmation and approval letter demonstrates that the researcher is permitted to conduct research activities at my organisation Abu Dhabi National Oil Company. I am informed that the researcher is pursuing a doctoral degree program at the University of Central Lancashire (UCLAN) and is conducting this research study for educational purposes.

I have been informed about the main purpose and expected outcomes of the study and that the research involves collecting data from human participants in my organisation	☒
I am approving and permitting the researcher to collect data from the employees of my organisation	☒
I understand that this approval will transfer the ownership of data collected in my organisation	☒
I understand that the study would report findings based on the data collected from my organisation and data will be documented for educational purposes which may also involve publication and conferences	☒

I understand that the data will be processed and stored at the researcher's university (UCLAN) and may as well be published in the future	☒
I appreciate that the researcher will ensure best practices to maintain the privacy of the employees as participants during the documentation of findings. However, UCLAN cannot guarantee that participants will not be identifiable.	☒
I permit the researcher to explicitly mention the name ADNOC of the organisation which may also appear in the distribution of the dissemination.	☒
I would be inclined to read the findings' summary before the final submission of the report OR I am not required to read the findings' summary before the final submission of the report	☒ ☐
I understand that the researcher would explain the purpose and outcomes of the study to the employees while inviting them to participate	☒
I understand that the participants will be asked to provide informed consent to display their volunteer participation	☒

Yours Sincerely,

Date 21 September 2023

Version 1.0

Appendix-3 Codebook

Code Name	Definition	Example Quote	Theme	Link to Theory
AI-Driven Efficiency	How AI improves operational workflows and automation.	*"AI has automated many routine tasks, reducing human errors and saving time." (Participant A3)*	AI-Driven Transformation	Lean Thinking (Womack and Jones, 1996) – Continuous process improvement.
Predictive Maintenance	AI's ability to forecast equipment failures, minimising downtime.	*"We now predict failures before they happen, avoiding costly repairs." (Participant A7)*	AI-Driven Transformation	Resource-Based View (Barney, 1991) – AI as a strategic resource.
Regulatory Compliance Challenges	Difficulties in aligning AI with strict industry regulations.	*"AI is advancing faster than regulations, leaving us in a grey area." (Participant A11)*	Regulatory and Compliance Challenges	Corporate Governance Theory (Cuéllar and Huq, 2020) – Managing compliance through technology.
Data Quality and Integration	Issues related to data consistency and reliability in AI adoption.	*"We have multiple data sources, and AI struggles to integrate them seamlessly." (Participant A8)*	Data and Technical Barriers	Digital Transformation Theory – Quality data is crucial for AI success.
Cybersecurity Risks	Threats associated with AI-driven	*"As AI collects more data, we've had to enhance our*	Regulatory and Compliance Challenges	Cybersecurity Risk Management (Zaabi

	data handling and automation.	*security systems." (Participant A2)*		and Zamri, 2022) – AI security protocols.
Employee Resistance to AI	Workforce hesitancy to adopt AI-driven processes.	*"People worry AI will take their jobs, but it's actually making work easier." (Participant A9)*	Workforce and Organisational Change	Change Management Theory (Kotter, 1995) – Overcoming resistance to technological change.
AI and Talent Acquisition	How AI helps attract skilled employees and improve workforce planning.	*"We're using AI to identify top talent and improve recruitment." (Participant A14)*	Workforce and Organisational Change	Strategic Human Resource Management (Wright and McMahan, 1992) – AI for workforce optimisation.
AI for Competitive Advantage	AI's role in maintaining ADNOC's leadership in the market.	*"AI-driven insights give us an edge in oil production efficiency." (Participant A5)*	AI-Driven Transformation	Resource-Based View (Barney, 1991) – AI as a source of competitive advantage.
Sustainability and AI	AI's contribution to environmental and sustainability initiatives.	*"AI optimizes production in a way that automatically reduces emissions." (Participant A9)*	AI-Driven Transformation	Corporate Environmental Responsibility (Wamba-Taguimdje et al., 2020) – AI for sustainability.