Business Model Transformation in Oil and Gas Industry in UAE: the Influence of AI

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Abstract

This study has investigated the experiences of implementing AI in the UAE oil and gas sector. Academic studies have ranged from those conducted in North America and Europe, which have provided a rich source of information, but have neglected the experiences of the challenges associated with implementing AI from an operational, project management and executive level. There has also been an acknowledgement that there have been only a few studies conducted in the region, and to date, there has been limited research focused on informing future AI implementation projects. Initially informed by the researcher's professional experience, then drawing on existing academic knowledge, the study involved conducting a qualitative study over three-phases.

The main study used an interpretivist methodology in the form of semi-structured interviews, which investigated initially the experiences and perceptions of eleven operational engineers, then four project managers and finally three executive or senior managers working in the UAE oil and gas sector. The findings of the study were gathered until saturation was reached and then interpreted using a thematic approach.

The study's first key finding is the importance associated with using a lesson learned methodology. As this technology is new and still in its infancy, this methodology of learning from the past is essential. Linked to this, this study found that there was a specific need for a recognised and systematic change management methodology to be adopted and followed, which addresses the recognised gap that this theme had been neglected or omitted from previous studies as to digital transformational AI solutions in the oil and gas sector. The second finding is associated with the need to seek collaborative involvement to address potential skill gaps and expertise. Although this can be challenging as the industry is known for its silo culture and not sharing business data, there is a need for closer collaboration but also needs senior management support. Finally, the model has been applied through using an existing AI project, then presented in the form of a preliminary evaluation.

In conclusion, this thesis provides a deep and rich conceptual insight, knowledge and understanding on how to implement an AI solution in the UAE oil and gas sector. The first contribution of the study includes the development of a new framework to represent the various stages of implementing AI in the oil and gas sector. The second contribution relates to the need for greater collaboration and for the existing engineers to possess the necessary skills and talents. Like all studies there are limitations. With only eighteen participants involved, eleven operational staff, four project managers and three executive or senior managers, the study

cannot provide a generalised outcome, but instead has provided a rich insight from those working for the main provider in the UAE oil and gas sector. Secondly, this study has accessed participants who are often unavailable or inaccessible to provide a critical insight which could not be effectively achieved if a quantitative project were adopted.

Keywords: AI and oil and gas sector, project management, collaboration, lessons learned, change management.

Declaration

I declare that the work in this thesis was conducted in accordance with the regulations of the University of Gloucestershire and is original except were indicated by a specific reference in the text. No part of this thesis has been submitted as part of any other academic award. The thesis has not been presented to any other educational institution in the United Kingdom or overseas.

Any views expressed in this thesis are those of the author and in no way represent those of the University of Gloucestershire.

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Table of Contents

Figure List

Table List

Chapter One– Introduction

1.1 Introduction

Artificial intelligence (AI) has become an important component of the Digital Transformation initiatives in various industries and sectors. This has included the oil and gas industry, where applications have been reported producing significant benefits, including delivering value-added services and improve operational efficiencies (Agbaji, 2021). As a result of the introduction of digital transformational solutions such as AI, the oil and gas industry has seen a fundamental change of focus as to how it operates. These digital transformational solutions, apart from AI, has included the usage of robotics and machine learning which has potentially transformed the sector, in terms of handling and processing the high volumes of data which are generated, the reliance on subjective decision-making processes based on past experience, but their adoption has been slow due the required high levels of investment and the high risk of limited returns, while the industry is trying to fight an increasing poor perception as un-environmentally and unsustainable industry.

The sector has the reputation of being a closed and siloed industry, which has not embraced technology like AI until very recently, but remains very competitive, and involves complex technological industry solutions and high-risk management strategies, while relying on employing specialised individuals to make critical decisions (Wamba-Taguimdje et al., 2020). This study has found that the effective implementation and usage of AI remains challenging in the UAE. This is despite it align experiences and Government's 2031 artificial intelligent strategy which has enabled the improvement of existing business and operational processes through providing real-time information, optimising existing activities, including improving end-user and stakeholder experiences, and offering greater financial returns to the business (Almarashda et al., 2022).

In the oil and gas industry, and in the UAE, there have been increasing business activity and investment associated with the undertaking and adoption of different digital transformational solutions. Part of this shift to digital solutions, which includes AI and machine learning can potentially assist companies to innovate, provide efficiencies along with the optimisation of business processes, which has led to Ferreira, Segua and Fucs (2019) to conclude that AI and machine learning have changed the oil and gas industry through the enhancement the operational efficiency by automatically identifying data patterns and interpreting them.

However, AI and associated digital transformational business solutions also present certain challenges, such as the expertise and specialism needed to programme, develop, and maintain this form of technology, having adequate and sufficient resources for the future, including processing power, the readiness of the data, and adequate storage facilities.

1.2 Problem Statement

The introduction of artificial intelligence (AI) can provide the means to optimise operational activities, provide predictive maintenance and forecasting as to the exploration and extraction within the oil and gas sector, whereby acting as a means to reduce costs, improve profitability and shareholder value (Lu et al., 2019). The technology can also leverage high volumes of data to provide real-time information and insights to make informed decisions, but there are potential problems.

Digital transformation solutions like AI have the expectation of potentially removing human intervention and being less reliant on expert experience and expertise, which are key aspects of the sector (Lu et al., 2019). There are now increasing reports that using AI related technologies such as robots to improve productivity have resulted in job losses and a deskilling of the workplace. At the same time there are now reports that have documented instances where the use of AI in the UAE has generated multi-billion-dollar payments by oil companies to employees, due to poorly programmed AI solutions (Ranaldo et al., 2021). At the same time, there is the challenge of providing the correct technical infrastructure, such as data storage, and expertise to implement these solutions, which also needs to comply with the regulatory requirements and industry standards. Through the effected literature review, it was found that, there has been little research conducted on how to best address these challenges in the field of oil and gas from an AI implementation perspective, less from an UAE, and even fewer from a project management viewpoint. This presents a problem as to current understanding but also an opportunity to expand the current knowledge.

Despite the identified benefits associated with digital transformational solution, like artificial intelligence, they are still not fully adopted in the UAE oil and gas industry and the technology is only now being introduced into the country. As this technology is rapidly being implemented, themes such as data availability and quality, lack of oilfield instrumentation or metrics, external factors such as data storage and accessibility and employee perception are emerging as important challenges to capture the benefits of those projects and consequently as an important topic to study.

To address the above-mentioned challenges this research intends to focus on developing a business transformational model to represent these aspects related to AI, but from a project management perspective, a contribution which has not been done and should be valuable to the country and the industry.

Underpinning the entire study is the lack of any research focused on the implementation of AI from a project management and end-user viewpoint, as noted by one of the earlier researchers Munns and Bjeirmi (1996). For Munns and Bjeirmi (1996) the tendency has been to focus on the application as opposed to the project management challenges and this is no different to the oil and gas sector when managing AI and digital transformational solutions. More recently, and from an oil and gas perspective, Choubey and Karmakar (2021) and Waqar et al. (2023) both noted that the project management experiences of the end users and the practitioner's perspective have been missing. This is particularly relevant as the usage of AI is now being used increasingly in most organisational setting including the oil and gas sector (Choubey & Karmakar, 2021).

To address this, and drawing on the professional background of the researcher, this doctorate study will investigate core themes which have been neglected, like for example, the importance of managing change which often occurs with AI. The study will focus on the need to learn from previous projects as AI can be uniquely challenging particularly around resource allocation. Finally, the study will also investigate the challenges associated with the need for expertise beyond the traditional specialisms like geoscience and engineering, to include a level of AI competency. Additionally, the study will explore the technological infrastructure requirements needed to manage AI from a hardware and storage perspectives, together with the need for data accessibility and readiness.

1.3 Mini Review and the Significance of the Study

While the world's commercial businesses have become increasingly dependent on petroleum-based products over the past 50 to 100 years, making them an indispensable part of the world's economy, there are also challenges for the future, particularly in the exploration, extraction, and production of these commodities (Lu et al., 2019). These challenges have included the need to find solutions to increase efficiencies, reduce costs, improve production, while also maximizing profits. To assist in providing solutions to meet these challenges the sector has invested in Industry 4.0 technological solutions. This technology has included the emergence of cloud computing, big data, and the Internet of Things (IoT), which includes the

replacement of the traditional industrial production technologies with artificial intelligence solutions. The question which emerges is whether this replacement has been effectively implement, and why?

But the digitalisation process in the oil and gas sector has been slow and can be problematic as these technological solutions can be complex and have their own challenges. These challenges can include needing to have the necessary expertise and knowledge to operate and maintain the technology, or the need for additional data storage facilities. This has led to the researcher to observe as noted by Close (2006) and Lu et al. (2019) that for this technological solution to be effective, the sector and senior management teams need to understand the functional experts and project managers experiences, as this technology is potentially transformational, but also presents unique challenges which to date have yet to be investigated, such as the how the UAE government's restrictive regulations on data storage on remote technology can be addressed, as remote services outside the country's boundaries are restricted, or whether the traditional roles of geoscientists, reservoir and drilling engineers need to be updated, changed or even required, and what new knowledge and expertise is needed and why, when using digital and AI solutions by these experts?

Reflecting this, this study to understand the importance of artificial intelligence within the context of its implementation in the oil and gas sector is important for several reasons. First, the technology deployment and lessons learned have yet to be extensively researched and documented. Second, although AI solutions seem to provide several benefits to the sector, its deployment lacks the tools and methodology needed to be managed and supported effectively, particularly as to its complexities and infrastructure requirements. Thirdly, as the oil and gas sector begin to adopt this technology, there is a need for senior management, project managers and operational staff to be aware of the challenges ahead and to have some form of framework and roadmap. Reflecting this, the study's aim is presented below.

1.4 Aim, Objectives, and Research Questions

1.4.1 Aim

The aim of this study is critically investigating the experiences of implementing a digital transformation solution of artificial intelligence (AI) in an UAE operational working environment in the oil and gas sector.

1.4.2 Objectives

To achieve the aim of the study, the following research objectives were asked:

1. To critically identify and evaluate the effectiveness of operational management approaches towards implementing AI in the UAE oil and gas industry.
2. To critically determine the benefits and efficiency gained from implementing AI in the exploration and production in the UAE oil and gas sector from an operational management perspective.
3. To critically analyse and evaluate the operational managerial challenges of adopting AI in the UAE oil and gas sector.
4. Based on the findings, to develop a transformational model as to how AI can be effectively implemented in the future, in the UAE oil and gas sector.

1.4.3 Research question

To address the aim of the study and research objectives, the following research question were asked.

- How and why have artificial intelligence projects been implemented in the operational activities of the UAE oil and gas sector?
- What aspects have needed to be considered and implemented when introducing a digital transformation solution in the UAE oil and gas industry, why?
- To what extent and why has artificial intelligence transformed the current business practices in the UAE oil and gas industry, and how will this transformation inform future projects?

1.5 Thesis Structure

This research thesis is made up of six chapters: the Introduction, the Literature review, Methodology, Findings and Analysis, the Discussion and finally the Conclusion. This chapter, Introduction, introduces the background to the study, the problem statement, the aim and objectives, and purpose of the research.

In the second chapter, Literature Review, the current literature of AI and the oil and gas sector is presented and critically reviewed. This includes the current debate related to project management and the implementing of AI in different sectors and industries including the oil and gas sector. The chapter draws on key studies by contributors to the field including Lu et al.

(2019), who conducted a deskbound project in the global oil and gas sector in using AI, and Toufaily et al. (2021), as to the UAE implementation of this solution. But while these researchers have collected important insights, they have yet to study the implementation experiences from a project management, operational, and executive viewpoint. From this chapter a conceptual framework of the existing knowledge is presented together with emerging themes and gaps. This includes the importance of implementing and using a lesson learned methodology, the monetary value, external factors, level of acquired knowledge, and change management.

The third chapter, Methodology, will set out the methodology adopted as to the research techniques used, the design of the study using a qualitative approach, the philosophical perspective of being an inductive researcher, the data analysis strategy including the coding process, and finally ethical considerations.

In the fourth chapter, Findings and Analysis, the results of the interviews over three phases will be set out with the presentation of the interview data from the three phases involving operational expertise and technicians, then the project managers and finally the executive team, from which a framework will be presented as to how the implementation process can be effectively managed. In creating the framework five emerging themes were identified and presented to the project managers: the importance of strategic leadership and senior management commitment, data readiness and usage, people and skills, process and optimisation, and the implementation of technology and integration.

Chapter five, Discussion, is dedicated to the critical review of the implementation framework in relation to addressing the gaps of knowledge identified in the literature review. This will include how certain techniques of project management are essential like lessons learned and change management but have been neglected in existing AI implementation studies focused on the oil and gas sector, but also the experiences of implementing the solution including the challenges of external factors like remote cloud storage and ensuring that there is a collaborative environment created and supported by senior management.

In the sixth chapter, Conclusions, the contribution is set out, which includes the professional contribution of developing an AI business transformational model for the oil and gas sector, and the creation of an MS Excel spreadsheet which requires the project managers to rank and rate five identified themes to enable them to focus on providing an effective AI solution in the operational workplace, but then act as a reflective methodology. The academic contribution was that although missing from academic literature in the field of study, lessons learned and change management are essential techniques, but also updated academic understanding as to

how AI can be effectively implemented by providing a new unique qualitative insight beyond the current often deskbound studies like Lu et al. (2019). In Appendix A, a preliminary evaluation of the Conceptual Model in one of the company's significant projects is presented.

1.6 Conclusion

This chapter has presented the current background of the study which will be focused on the next chapter, the literature review. The chapter has also set out the central aim of the study, as to critically investigating the experiences of implementing a digital transformation solution of artificial intelligence (AI) in an UAE operational working environment in the oil and gas sector, which has informed the research objectives.

Chapter Two - Literature Review

2.1 Introduction

In order to focus on the experiences and perceptions of integrating AI-driven business transformation projects in the UAE oil and gas sector, from both a professional and academic perspective, this chapter will present the current debate. The chapter will firstly focus on the discipline of project management as to its application of introducing a digital transformational project from a theoretical perspective. The chapter will then introduce the theme of project management and its methodological connection specifically to the oil and gas sector.

As this study is focused on the digital transformation in the oil and gas sector, the chapter will critically review the industry's background and usage of technological-based solutions, by firstly contextualising the industry's profile. This profile will include the challenges faced currently in the extraction and production of oil and gas. The chapter will then focus on the emergence of digitalisation including the internet of things (IOT) together with how big data and data readiness has become critical. This chapter also examines the importance of blockchain technology in the sector, the application of algorithms along with machine learning. As with any solution, there are challenges and barriers, which will be critically presented, including how AI has potentially changed the upstream exploration activity, together with a focus on the usage of algorithms in the sector. In presenting these challenges associated with AI, the review will consider the need for experts and specialists possessing both the technological skills and the specific industry expertise.

Finally, a conceptual model will be used to summarise the central themes of the chapter and emerging debate. For this purpose, the six emerging themes will be used to inform the study's research questions, as set out in section 2.9. These research outcomes will then inform the first stage of the study. The research questions consider topics such as the importance of lessons learned, together with the challenges associated with external factors, including the potential reliance on third-party expertise and remote cloud storage.

2.2 Background Debate to Project Management

For any businesses, whether that is in the oil and gas sector, or other industries, projects are essential for sustainability, survival, and success. Reflecting the Projects in Controlled Environments (PRINCE2) definition, a project is a combination of activities that leads to a new

product, service, or activities being created, evolved, and delivered, used to potentially improve existing procedures (PMI, 2001). The delivery and implementation of successful projects will lead to increase sales activity, reduce costs, improve quality, customer satisfaction and modify the working environment. In the oil and gas industry, as result of artificial intelligent projects process and activities related to exploration and extraction of the hydrocarbons may improve, which is the focus of this study. The concept of project management has become recognised as an important methodology to achieve business and operational outcomes (Lewis, 2000). According to the Project Management Institute (PMI, 2001), project management is the methodology used to inform knowledge, skills, tools, and techniques needed to conduct project activities. The challenge for any organisation is which guidelines are the most suitable to follow and use when managing the various project activities. This also includes which procedural framework should be followed, both for the current project and for the future. Where projects have been successfully implemented, this is often due to various specialists and experts working together to achieve the overall project goal. This is particularly important for complex, high-risk projects, such as with oil and gas exploration and production. Projects in the oil and gas sector are complex. These complexities are due to the uncertainty in the geology and reservoir structure of the drilling site, next the unknown cap rock characteristics, and finally the volume of hydrocarbons being produced. The risks associated need to be carefully managed and monitored, often through the evaluation of the risk by conducting risk analysis meetings to assess and anticipate the potential outcome (Jahn et al., 2008; Motta et al., 2000; Suslick & Schiozer, 2004; UNEP, 2015; Weijermars, 2009).

There are also associated economic risks as to the uncertain amount of budget needed in the business. This activity includes projecting future costs and expenses, therefore indicating the need for assessing and predicting the potential likelihood of finding and producing sufficient volumes of oil and gas, whereby providing a suitable monetary value return (Motta et al., 2000; Suslick & Schiozer, 2004; Wagner & Armstrong, 2010; Weijermars, 2009). Then there is the unpredictability of natural disasters occurring, which requires an awareness of the associated risks (Negash et al., 2018). In presenting the need for an awareness of unpredictable risks, Negash et al. (2018) argued that one way to minimise its impact is to develop different scenarios in the production forecasting models. To achieve this, Negash et al. (2018) found that for the modelling structure to be effective, the model ought to be based on artificial neural networks. These networks are created from algorithms which are trained, validated, and then evaluated with historical data. The outcomes of the scenarios are then used to predict potential production rates based on different risk outcomes. In concluding, Negash et al. (2018) in this

Malaysian theoretical study, noted an essential part of project management planning in oil and gas exploration is the need to establish clear workflow modelling and structures, together with the usage of risk scenario tools.

A project, whether that is oil and gas related or not, is a complex concept which involves interconnected activities, with the purpose of achieving an objective which has been agreed by senior management and aligned to the business vision, being of a temporary nature, and of a non-repetitive process (Dinsmore & Cabanis-Brewin, 2006; Khatib, 2003; Lewis, 2000; Nicholas, 2004; PMI, 2021). To manage a project, to achieve the intended outcome implies careful planning and monitoring to be conducted through the execution stage, whereby the intended and agreed objectives are achieved, based on three agreed criteria: time, cost, and quality. In the past project management had a specific focus on managing a project, but today it is recognised the project delivery is often a composite of various organisational skills, which involves and permeates all levels of the organisation and business processes (Kerzner, 2010; Kerzner & Saladis, 2009; Lewis, 2000; Nicholas, 2004; PMI, 2021; Westland, 2006). While the debate as to the necessity of project management is no longer valid, the question which does emerge is what form of project methodology should be used. This includes what methods, tools, and human resources are most suitable for the project (IPMA, 2006). Writers including Dinsmore and Cabanis-Brewin (2006), Kerzner (2010), Kerzner and Saladis (2009), and Nicholas (2004) have argued that analysing the institutional or organisation structure is essential to achieve strong project governance. This debate is centred on ensuring that the project management efforts adhere to the corporate procedures.

To achieve this, there is a need for strong and robust project governance, which Bekker and Steyn (2007, p.5) see as ‘a set of management systems, rules, protocols, relationships and structures that provide the framework within which decisions are made for project development and implementation to achieve the intended business or strategic motivation’. However, as noted by Derakhshan, Turner, and Mancini (2019), each organisation will have its own model of project governance, and of course will differ based on the sector and project type. Bekker and Steyn (2008) in studying the importance of governance from an information technology perspective concluded that it is not possible to generalize a project governance model, since different projects might require different approaches, but do indicate the importance of senior and executive management involvement and commitment. Both Yilin et al. (2008) and later Salazar-Aramayo et al. (2013) in a Brazil oil-based project management study highlighted that project governance tends to work indirectly on project management performance, but again needs the support of senior leadership and management. The importance of executive team

involvement led to Bekker and Steyn (2008) and Salazar-Aramayo et al. (2013) to concur that formal project governance, tends to achieve better project outcomes. For the project to be successful the deliverables need to be based on agreed deadlines, budgets, and quality levels, whereby meeting the expectations of the stakeholders (Cooke-Davies, 2002).

For the outcome of the project to be successful, it is important to follow the right processes throughout the project lifecycle. Burke (2013) and other writers in project management, such as Meredith et al. (2016) agree that the project lifecycle consists of a series of stages. It should be noted that this study will draw on Burke's (2013) prescriptive project lifecycle, rather than other implied models, like from the Project Management Body of Knowledge (PMBOK). Burke (2013) proposed the following diagram or presentation of a generalised project management methodology and associated techniques, which involved 10 stages: the strategic vision and values, the project requirements to meet the business vision, the business case, the feasibility study, the project definition, then the project execution, the commissioning and handover stage, the operational start-up, then the half-life of the project and the need for updating or upgrades, and finally the disposal stage of the project. But this comprehensive lifecycle of Burke (2013) is not an accepted industry standard. To show this, Burke (2013) said that the British Standard for Project Management BS6079 involves only five stages: the idea, feasibility, design, execution, handover, benefits, and disposal, while the Project Management Body of Knowledge (PMBOK), the UK professional organisation advocated 4 stages: start the project, organize, and prepare, carry out the work, and then finish project. The North American Association of Project Management (APM) sees the cycle as starting with the concept, providing a definition, the implementation stage, then the handover, operational stage and then termination of the project and disposal of the concept. To support the argument of providing a more detailed generalised methodology, Burke (2013) stressed the need to split each stage into separate components, also the importance of the vision and values of the organisation being at the beginning of any project, before defining the requirements, then preparing the business case and feasibility study. Throughout these stages which is lacking or absent in the BS6079, APM and PMBOK methods is the importance of the close out report which includes a reflection and documentation of the whole project which is then used to inform future projects. This process of lessons learned is important especially for transformational projects, such as the AI introduction as digital solution. In reviewing the literature there are few studies addressing the theme of lessons learned in the oil and gas sector. One of those few studies, Zuofa and Ocheing (2017), focused on offshore operations, conducted semi-structured interviews of senior safety managers and leadership. The study of Zuofa and Ocheing (2017) found that a deep

understanding of lessons learned is essential for the success of any new project. However, Zuofa and Ocheing (2017) study focused on Nigerian offshore extraction activity not addressing the implementation of a digital solution, an aspect of this study focuses on. another fundamental pillar in project management is change management (Burke, 2013; Taboada et al., 2023), have extensively discuss about change management, is seen as an essential process to follow, particularly when implementing a digital transformation solution, such as an AI infrastructure.

2.2.1 Project Management in the oil and gas sector

Project management in the oil and gas sector can be seen as being unique, as noted by Postali and Picchetti (2006) who emphasised that the exploration and extraction activities of the industry is often irreversible. This irreversibility is due to the costs of these activities, therefore making project success critical. For Postali and Picchetti (2006) a key aspect of any project in oil and gas exploration is to ensure that all activities provide value for money, which is constantly being reviewed then evaluated, which is seen as a vital mechanism to determine success. Therefore, the success of the project often involves the establishment of various key performance indicators (KPIs) and associated measurements, which is then used constantly to inform management from an operational, project management and senior management perspectives, for the entire duration of the project, and specifically related to the resources needed. In presenting this perspective, Salazar-Aramayo et al. (2023) conducted a study based in Brazil to understand the implications of project management when delivering an exploration solution as to determining whether a project was successful. In presenting findings, the authors advocated a map which captures part of the process.

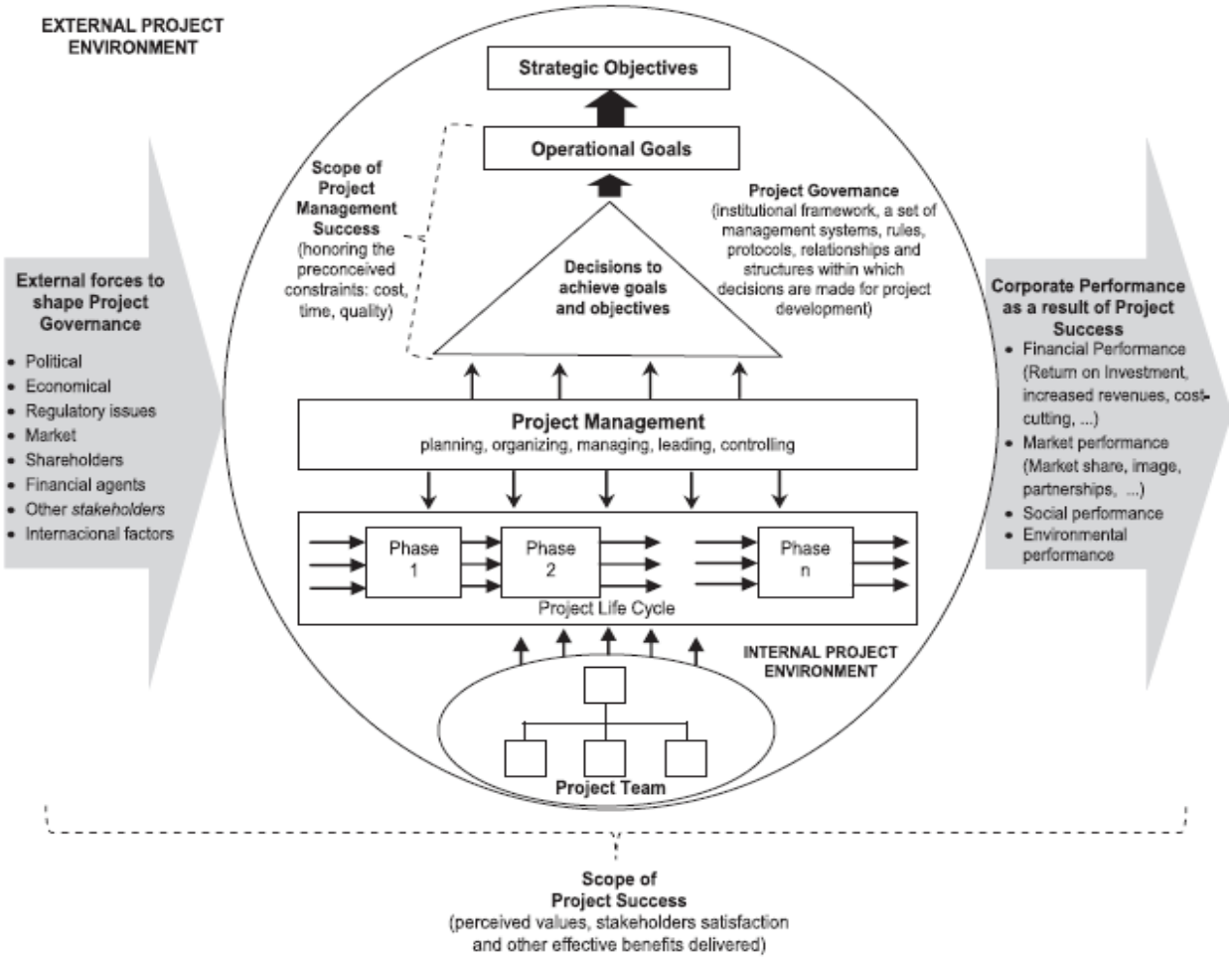

Figure 2-1. The Project Environment in the Oil and Gas (Salazar-Aramayo et al., 2023)

As can be seen from the diagram, the model does present many of the important aspects of a project lifecycle including the strategic objectives which are linked to the operational goals, which are then aligned to the project management methodology of planning, organizing, managing, leading, and controlling. The model of Salazar-Aramayo et al. (2023) also includes the role of the project team in meeting the perceived values of the business, those of the stakeholders and providing other benefits, such as monetary value and being environmentally sustainable. However, on closer inspection of Salazar-Aramayo et al.'s (2023) model while informative, there were several significant aspects missing. These missing aspects included drawing on past experiences through documenting lessons learned, and then using this information to inform future projects.

2.2.2 Summary of project management in the oil and gas industry

This section has presented the background to project management methodology. Burke (2013) and Taboada, et al. (2023) will be used to provide the basis to understand the core concepts, attributes and components related to implementing a transformational project. Drawing on the generalised portrayal of project management by Burke (2013) then later supported by Salazar-Aramayo et al. (2023), were two important components. The two components were the role of senior leadership and executives and the need to capture and learn from previous experiences through following a lesson learned activity. Part of the debate around the role of senior leadership and the executive team as noted by Salazar-Aramayo et al. (2023), is that the strategic vision has to be aligned to the long and short-term business and operational activities. As for lessons learned, Salazar-Aramayo et al. (2023) noted that this approach can enable the project management team to gain invaluable insights into previous projects.

2.3 Profile of the Oil and Gas Industry

Before proceeding to present the current debate related to the implementation of a digital transformational solution, it is important to understand the existing knowledge related to the oil and gas sector. In the world economy, particularly amongst industrialized countries, there is still a dependency on oil and natural gas (Postali & Picchetti, 2006; UNEP, 1997; Weijermars, 2009). Lu et al. (2019), a key author in the field of oil and gas 4.0 who conducted an extensive systematic literature review concluded that the industry has become increasingly dependent on the petroleum-based products over the past 50 to 100 years, making them an indispensable part of the world economy. Iliinskij et al. (2021) at the International Scientific

Conference, INTERAGROMASH in 2021, stated that the worldwide oil and gas industries generated in 2021 more than 5 trillion US dollars. However, in the past twenty years, the oil and gas industry has become unstable due to the fall in the global oil price, for example, from 2014 to the late 2010s, the oil price fell by as much as 70% (Depersio, 2019). The oil and gas production has decreased by 3% to 5%, which caused many petroleum companies to struggle financially. As a result, these companies had to cut costs, which led to layoffs and a 40% increase in unemployment in the sector over the past two decades (Hiller, 2019). As a result, there has been a loss of valuable expertise and experience in the industry.

These outcomes indicate the impact and significance of falling or unstable oil prices while also attempting to operate oil and gas exploration, extraction, and production in a more efficient way. These falls and rises in the oil and gas prices and production are constantly changing, due to the relationship to supply and demand, which makes the sector susceptible to cyclical changes. These cyclical activities see times which are difficult for the sector, while other periods are more beneficial. At the same time, the industry is now in a period of transition with increasing changes and challenges associated with cost, efficiency, sustainability, while also seeking reserves which are harder to reach and exploit (World Economic Forum, 2023). One of the key challenges has been associated with the disruption in exploration and exploitation of oil and gas reservoirs, for example with technical bottlenecks. Handscomb et al. (2016) in a McKinsley report, pointed out that these bottlenecks had led to the oil and gas industry being the only sector that has lost efficiency over the past one hundred years compared to other asset-intensive industries. This has resulted in the sector seeking to find solutions to provide increased efficiencies, reduce costs, improve production, while maximizing profits and providing monetary value. This has led to the rapid development of Industry 4.0 in the oil and gas sector. Industry 4.0 includes technologies such as cloud computing, big data, and the Internet of Things (IoT) being applied in business or industry, referred to as the Industrial Internet of Things or IIOT. IIOT has replaced the traditional industrial production technologies with artificial intelligence solutions being introduced through digital transformational projects. Writers, including Lu et al. (2019) and Yang et al. (2016), have indicated that the oil and gas industry has begun to increasingly rely on Industry 4.0 solutions, including artificial intelligence. At the 2018 Abu Dhabi International Petroleum Exhibition and Conference (ADIPEC), the CEO of the ADNOC Group Dr Sultan Ahmed Al Jaber, presented a blueprint for “Oil and Gas 4.0” (The National, Oil and Gas, 2019). The blueprint stated that the core goal of this century is for the usage of advanced digital technology to achieve higher value in the petroleum industry. However, the digitalisation process in most companies, including in the oil

and gas sector is slow and can be problematic as these technological solutions can be complex and have their own challenges. These challenges can include having the necessary expertise and knowledge needed to operate and maintain the technology, or the need for additional data storage facilities. Lu et al. (2019) noted that one third of oil and gas companies see their organisation as being new or exploratory in adopting and implementing digital transformational solutions, which is interesting as the oil and gas industry tends to be perceived as playing a leading role in innovative technologies. It seems however, that there are only a few organisations in the oil and gas sector which have fully accepted innovative technologies such as robots, satellites, and usage of blockchain and artificial intelligence (Lu et al., 2019). A report by Deloitte's (2015) reported that digitalisation of the oil and gas industry is still in its early stage, which was later supported by Lu et al. (2019), who noted that only a few leading enterprises have been digitally transformed.

Reflecting this lack of digital transformation, and meeting the demands associated with oil and gas production, the sector has needed to increase its number of extraction activities while finding new reservoirs. Both these activities can be grouped into two categories: upstream, which includes exploration and production, and downstream, which is related to the refining and processing crude oil and gas production, together with the distribution and commercialization of the products. In explaining these components of exploration and production which is part of the focus of this study, Jahn et al. (2008), Manzano, Monaldi and Sturzenegger (2008), Motta et al. (2000), Postali and Picchetti (2006), and Suslick and Schiozer (2004) characterize the exploration then the production processes as having certain attributes. These attributes reflect the activity of oil exploration, including the generation of significant revenue or monetary value, the need to have high levels of investment, which may often generate no return indicating a potential risk, but has a volatility of demand and prices, which can impact on the return of investment (ROI).

The oil and gas industry and its associated projects do depend on high levels of capital, which is often associated with the substantial risk of accurately predicting and finding new reserves. This decision-making process of making precise choices can be very complicated and requires vital information to be provided in real-time. However, this information must be pertinent for senior management as well as for project management and operational specialists.

To provide this information and then initiate the project, related exploration, and production projects need to be a combination of multidisciplinary teams. These teams may include a reservoir engineer who could be working with a drilling expert or a geoscientist; however, both

these specialists will need to have different information to predict accurately the project outcomes.

For this form of multidisciplinary team to work in the oil and gas sector, there are several critical factors which can be problematic if not managed correctly (Close, 2006). For Close (2006) this included functional experts who do not understand how their contribution influences and impacts on other parts of the process. There was also the issue as to team members not understanding the ramifications of tasks being unfinished, and the potential ramifications of that delay potentially postponing the entire project. To address these obstacles, Close (2006) noted the importance of formalised or automated ways to communicate in real-time the project status. Although it needs to be recognised that many of these issues raised by Close (2006) are potentially dated and addressed through the emergence of technology, there is now the need for the sector to be more environmentally sustainable while also meeting market demands while still seeking replacement reservoirs. To meet this new shift in the oil and gas sector. Weijermars (2009) conducted a research study based on existing sources and found that management skills are especially important for exploration and production in the oil and gas sector. These skills involved acting as supporters and leading change effectively. In recognising the importance, Weijermars (2009) noted that leadership needs to possess an understanding of behavioural skills, able to recognise the complexities of multidiscipline teams, while facilitating a proactive learning environment. However, Close (2006) and Weijermars (2009) studies have not fully investigated the skills and knowledge needed now in the digitalised oil and gas industry.

2.4 An Overview of the Digital Transformation in the Oil and Gas Industry

This section will review the current debate associated with the digitalisation of the oil and gas industry by presenting how 4.0 technological solutions have begun to influence and change the sector. To illustrate the sector's digital transformation, Lu et al. (2019) developed a model which broke down the oil and gas sector into three distinct activities: upstream, midstream, and downstream. With this study being focused on upstream activities, the model shows the importance associated with the need for a digital solution which provides a research and decision-making platform. This platform is seen as being fundamental, by informing the engineers with accurate exploration forecasts before the midstream extraction activities commence.

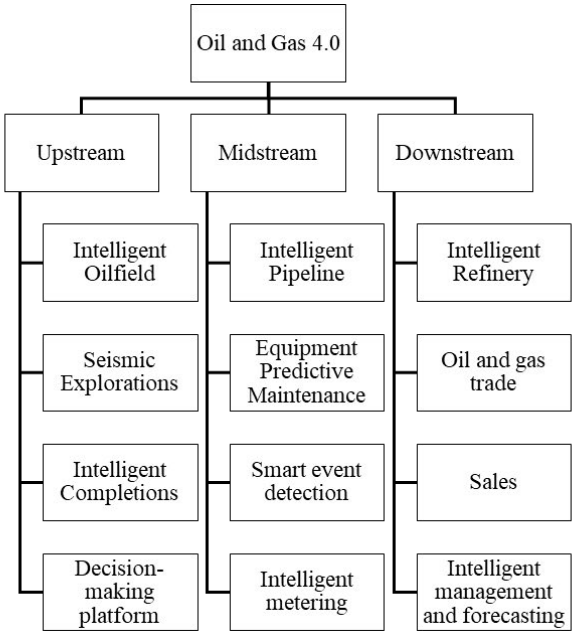

Figure 2-2. Scenarios and Applications of Oil and Gas 4.0 (Lu et al., 2019)

In the diagram above which was based on Lu et al.'s (2019) study, the interconnectedness of the three components of the oil sector is clearly represented. As to upstream activities, where the exploration and extraction occurs, for digitalisation to be effective, there is the need for intelligent oilfields to be established. These intelligent oilfields include the collection and analysis of data, but due to the amount of data generated also needs to have an AI solution to make accurate decisions. For both Lu et al. (2019) and earlier Bello et al. (2016) in a Nigerian based study, highlighted the need for the development of a strong knowledge base and expertise in the organisation, which needs to be instigated by senior management.

Leading from this, is whether the forecasting activities should be informed by previous projects, through the usage of lessons learned activities.

2.4.1. Oil and Gas Industry 4.0 and Digitalisation.

One of the gaps in existing knowledge is how digitalisation has been adopted in the oil and gas industry, therefore it is necessary to continue to draw on the work of Lu et al. (2019) to further contextualise the fundamental features of the oil and gas 4.0. As a technological solution, oil, and gas 4.0 can transform complex information and data with the usage of high-powered servers, but these require increasingly larger storage facilities, which includes cloud technology solutions. The cloud technology uses remote servers to save business critical information, such as files and business data. With the advent of digitalisation and the increased usage of cloud

technology there have been significant increases in productivity in the oil and gas sector (Lawan, Oduoza, & Buckley, 2020), whereby becoming more cost effective, while also processing information faster than a human (Negash et al., 2018).

Although the oil and gas companies have adopted digital technology since the 1980s digital technologies have failed to deliver the expected value and companies have not fully adopted them (Saputelli et al., 2013). Lu et al. (2019) noted that a single rig in an oilfield can generate trillions of bytes of data per day, however the sector has only used a small percentage of this information for decision-making. Data needs to be accessible, but also requires adequate storage, which can only be provided by an external cloud solution. But from the perspective of this study, the challenge is that the UAE government has strict regulations restricting data storage on remote technology, as to the services outside the country's boundaries.

Although key technological advances were made in the last decades, there are several reasons why upstream asset digitalisation may be slower than expected:

a. The complexity and scale of the upstream asset business processes can make it challenging to implement innovative technologies and processes.
b. Upstream is heavily regulated with engineering and safety standards, which can slow down the adoption of innovative technologies.
c. The perceived high upfront cost of implementing digital technologies may make companies hesitant to invest.
d. Cultural and organisational barriers to change, leading to a lack of understanding of the potential benefits of digitalisation.

Another theme to emerge from Lu et al. (2019) and Negash et al. (2018) studies was related to the circular collaborative ecosystem which digitalisation can provide through the usage of an integrated digital platform. The adoption of a circular collaborative ecosystem strategy can improve collaboration amongst teams. Through adopting a circular collaborative ecosystem strategy, this can potentially improve collaboration amongst teams. The concept integrates shared digital platforms therefore accelerates innovation, reduce costs, and improves operational transparency. But again, while informative, the study of Lu et al. (2019) does present more questions than answers. For example, what types of data is needed to provide accurate decision-making outcomes. Then there is the question as to whether the traditional roles of geoscientists, reservoir and drilling engineers are still needed, and what new knowledge and expertise is required when using digital and AI solutions by these experts.

Beyond the debate of skills, expertise, and lessons learned, another emerging theme which has already been identified above, is the resources needed for digital technology to operate

effectively. This included the resources required to operate in real-time, which needs sufficient processing power and adequate storage facilities. To understand these challenges, the next section will focus on the core concepts related to digitalisation, including themes such as cloud storage, big data, IIOT, and blockchain technology.

There are several key innovative technologies which are linked to artificial intelligence and business digital transformation. These themes include the increased usage of big data, which needs to be cleaned and ready for AI to be effective. To process and interpret the data, and ensure there is integrity, one of the recent solutions has been the usage of blockchain technology, which will be explored after presenting the emergence of industrial internet of things known as IIOT.

2.4.2 Industrial Internet of Things (IIOT)

The term IoT, or Internet of Things, refers to the technology of sensing and actuation that can be added to physical objects including vehicles, light switches, which can be connected to a communications network including the internet. Digital transformation relies on using IoT via a range of devices, monitors, and controllers for data collection within the physical and virtual environments (Wynn et al., 2023). The industrial internet of things (IIoT) refers to the extension and use of the internet of things (IoT) in industrial sectors and applications including the oil and gas. This technology has been used to improve efficiencies in various business practices. For the oil and gas sector, these improvements have impacted safety, whereby minimising potential system failures.

IIOT application has included the introduction of sensors, remote or mobile communication technology so that data can be collected, monitored, and analysed to enable informed and quicker decisions (Rouse, 2019). As to IIOT application in the oil and gas sector, this technology can generate real-time insights, enabling the usage of sensor technology, through to providing machine-to-machine communication solutions, and accurate data-driven analytics (Hossain & Muhammad, 2016). From the perspective of the oil and gas sector, traditionally information and data are not shared or exchanged quickly, lacking the means to be predictive, which adopting an IIOT solution can provide.

One of these enhancements for the oil and gas sector has been about safety, where they reduce the chance of system failures. IIOT is not confined to data analytics but can be used to minimise or limit the environmental impact of the sector's activity. This can include reducing energy, while monitoring activities to identify oil and gas leaks to reduce carbon emissions. However,

to implement this form of technological solution requires the commitment of senior management, key stakeholders but also the expertise to use and understand this technology.

2.4.3 Big data

As mentioned above, the oil and gas sector are renowned for the large amount of data being generated, which is referred to as big data. For writers including Rui et al. (2017) the generation and then usage of large data from various sources, requires a digital solution like artificial intelligence (Wynn et al., 2023). Rui et al. (2017) from a deskbound research project reviewed technical and project management research papers and reports to identify factors affecting offshore oil and gas projects. The study of Rui et al. (2017) noted the emergence of extensive data being generated from multiple data streams or sources in various structured or unstructured formats. These data types need extensive storage capacity, as the information can reach petabytes or even exabytes (McAfee et al., 2012). Data generated from this sector, was illustrated by Subramaniyan (2021), as cited in Lu et al., (2019) who noted that drilling data can generate 0.3 GB per well a day, seismic data can produce 100 GB per survey, while plant process data can generate 4-6 GB per day. This amount of data indicates the challenges associated with the information that needs to be processed, analysed, and managed, which can only be achieved with sufficient processing power and adequate storage facilities. To understand the extent to which big data has proliferated the sector, Feblowitz (2012) provided a model to present how big data is used in the industry, by breaking down the different components.

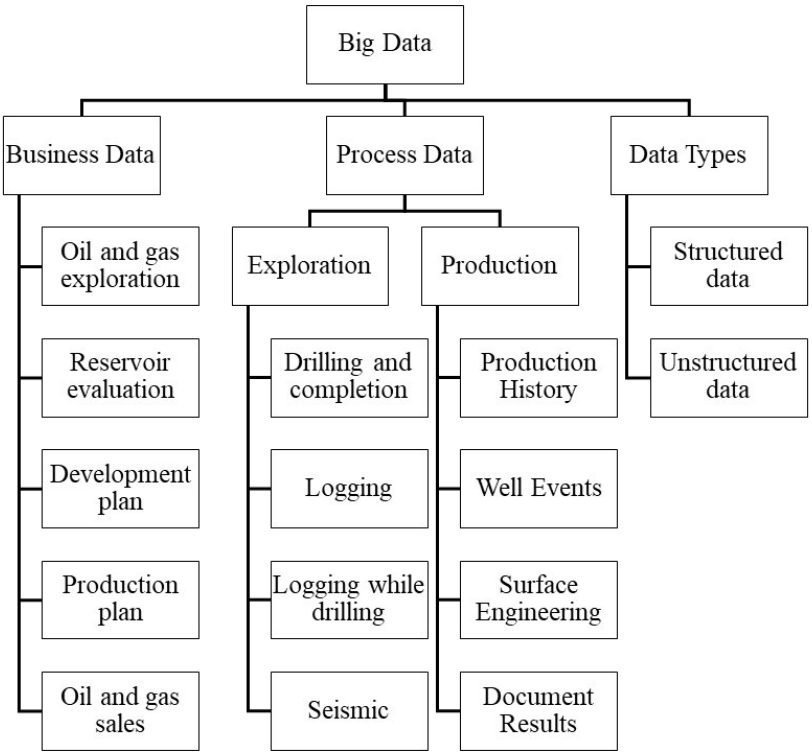

Figure 2-3. Big Data use in Oil and Gas (Feblowitz, 2012)

2.4.4 Blockchain Technology

While big data represents how enormous amounts of data is gathered and stored from various sources or streams, the processing of this information is often managed using blockchain technology. Blockchain technology is the pattern of how enormous amounts of data is transactionally processed providing an advanced database mechanism that allows transparent information sharing within a business network (Wittig & Wittig, 2023). A blockchain database stores data in blocks that are linked together in a chain. The data is chronologically consistent because the chain cannot be deleted or modified without consensus from the network. As a result, blockchain technology can be used to create an unalterable or immutable ledger for tracking orders, payments, accounts, and other transactions. The system has built-in mechanisms that prevent unauthorized transaction entries and create consistency in the shared view of these transactions (Wittig & Wittig, 2023).

From a supply chain perspective, both Gartner (2019), and more recently Chowdhury et al. (2023), noted that this technological solution remains in its infancy, and called for more research into this technology. For Gartner (2019) and Chowdhury et al. (2023) there are positive case studies related to the successful implementation and usage of blockchain solutions in various industries, including in manufacturing, logistics, finance, and the airline sectors

(Cole et al., 2019; Lohmer, 2019). However, despite these reported successes, the adoption of a blockchain solution remains unexplored, particularly in the oil and gas sector. Chowdhury et al. (2022) in their literature review, noted while blockchain technology has significant benefits, its implementation into processes and activities in an operational environment often lacked a clear organisational strategy, from both a long and short-term perspectives. For this to be addressed, Chowdhury et al. (2022) identified the need for knowledge to be shared and to establish collaboration of experts and specialists. This lack of a clear strategic and operational direction was also acknowledged as being a potential barrier to achieve a wide-scale adoption of a blockchain and AI solution (Cole et al., 2019; Hughes et al., 2019; Pournader et al., 2020; Saberi et al., 2019; Wang et al., 2019). To illustrate this, Chowdhury et al. (2022) highlighted the need to understand how to optimise business processes and practices, but also acknowledged this can be problematic as often there is a lack of understanding as to the technology's capabilities, and limitations. Earlier, Angelis and Siliva (2019) outlined that the emergence of blockchain solutions needed to be further researched into the extent to which this technology can be effectively implemented and what skills and experience are needed. For Holden and Moar (2017) this technology can be implemented successfully provided there is an understanding of the business need. Where this expertise exists, Holden and Moar (2017) identified as series of benefits including improvements in economic performance and monetary value, providing alternative solutions, and being less disruptive with reduced downtimes (Holden & Moar, 2017; Chowdhury et al., 2022). Unlike Holden and Moar (2017) and Chowdhury et al. (2022), in a recent study by Toufaily et al. (2021) conducted in the UAE, investigated how a blockchain solution can be implemented in the private and public sectors. Through the usage of semi-structured interviews, Toufaily et al. (2021) contended that theoretically a blockchain solution needs to consider a broad range of internal organisational factors.

These factors include how relatively easy the technology is to use, whether the stakeholders are prepared, does the solution met the regulatory requirements, and if the technological infrastructure was sufficiently future-proofed. The studies of Toufaily et al. (2021) and Chowdhury et al. (2022) also recognized the importance of having the necessary technological infrastructure and data readiness. However, these authors did not examine these themes from an operational perspective during the implementation of the solution, or from an operational, project management and executive perspective.

From a technical perspective, blockchain technology has enabled the usage of transparent trusted rules to be constructed inside a peer-to-peer network environment. As a technology

solution, blockchain technology is extensively used in commercial transactions, whereby ensuring that the data integrity is maintained. Each blockchain transaction is encrypted to ensure data integrity is maintained, then distributed to multiple computers in a peer-to-peer network (Andoni et al., 2019).

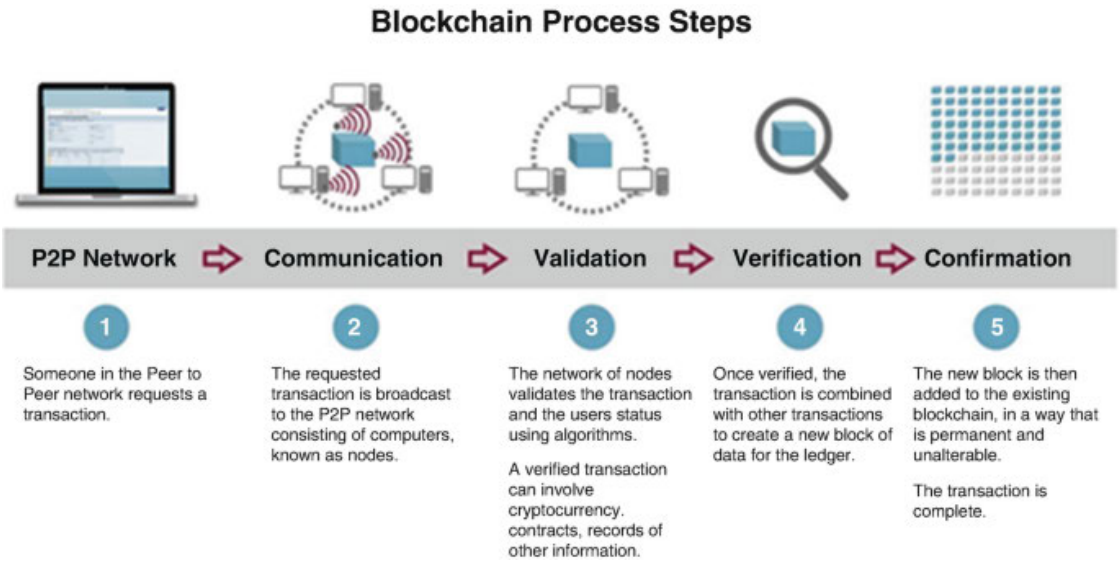

Figure 2-4. Blockchain Technology Process Steps (Bhardwaj et al., 2022)

These peer-to-peer network members then use algorithms to validate the transactions, which are finally stored on a single server. The duration of the transaction is dependent on the algorithm appending a unique hash value to each block, hence the term blockchain. Then if any transaction is tampered with or is inconsistent, then a hash value cannot be generated, and an error is reported. When a transition block is successfully verified, it will combine with the previously verified block to form a 'blockchain.' Finally, if the two parties, for example the bank and the customer's account, confirm the transaction, the process is seen to have been completed successfully, then data integrity is assured. For the oil and gas industry, blockchain technology can be used to secure data, increase transaction transparency, while providing an accurate tracking service for goods and equipment.

Since the introduction of blockchain technology, the solution has been applied effectively in four areas in the oil and gas industry. This has included firstly, around trading with smart contracts, secondly around management and decision-making processes, whereby providing accurate information in real-time for management to make informed decisions. The next, and thirdly, maintaining an accurate records, where tracking of transactions can be administrated to ensure that the data is compliant and adhering to the regulations and rules, and fourthly and

finally, around cyber-security, ensuring that the data is encrypted, with the access and storage secured. While this overview of the usage of digitisation by Lu et al. (2019), Feblowitz (2012) and Subramaniyan (2017) have been informative as to the potential of this technology's application in the oil and gas sector, these studies have yet to deep-dive into the challenges associated with themes such as how external storage and infrastructure is managed and maintained.

2.4.5 Algorithms

As mentioned above with digitalisation and the usage of blockchain, there is a reliance on computing algorithms, which has led to the emergence of AI or machine learning, used to forecast, and monitor various extraction activities (Sami & Ibrahim, 2021). Sami and Ibrahim (2021) in a study based in the Middle East oil and gas fields, studied the usage of machine-learning models. The study found that artificial intelligence can be used to compute complex parameters, then produce of data-driven models for experts to use.

In the oil and gas industries, there are several types of data collection methods used including sensors located at surface and subsurface levels to understand the hydrocarbon potential. The sensors are used to collect enormous amounts of data, which then require the information to be technically analysed before any decision or intervention is made. To achieve this and manage the data, machine learning provides the means to understand the relationship between input variables before providing forecasts and predictions. But these data collection and analysis processes generates an enormous amount of data which can be complex and difficult to interpret (Ali, 1994). To assist in the process, Sircar et al. (2021) and earlier by Sami and Ibrahim (2021), focused on different learning systems which have been adopted in the oil and gas sector. The authors found that a variety of datasets can be used to assess the accuracy and validity of the data through the usage of machine learning algorithms which would not be feasible if processed by a human (Hassanvand et al., 2018; Priyanka et al., 2021). This was supported by Chanmeka et al. (2012) who earlier noted that the use of big data and machine learning in the sector is increasingly being adopted, used, and relied on.

2.5 AI in the Oil and Gas Sector

As seen above, with the increase challenges in the sector, new technologies are being introduced to maximize performance and help fulfil the increasing demand for oil and gas. In a study conducted by Wamba-Taguimdie et al. (2020) the authors focused on the oil and gas

sector but also industries such as manufacturing, logistics, finance, and the airline with the purpose to analyse the influence of AI on a firm's performance. Wamba-Taguimdie et al. (2020) concluded that AI can improve performance both at an organisational level such as in finance, marketing, and administrative, but also operational activities whereby enhancing the organisation's value and efficiencies. This was supported by Almarashda et al. (2022), who in an UAE study, investigated the benefits and user expectations if AI is adopted in the energy sector. In using a quantitative approach, the study found that AI can increase employees' job performance, bringing about a positive impact to the organisation. However, in Almarashda et al.'s (2022) study, it was also recognized that using AI technology while increasing productivity, can also be frustrating, if the correct assistance or expertise is unavailable. Al Dhaif et al. (2022) supported this who noted that while technology could improve the performance and value outcomes of oil extraction, there was still the need to be aware of external factors, such as access to remote storage facilities which are often out of the control of the organisation. Waqar et al. (2023), agreed that this technology could automate oil and gas projects, therefore enhancing and improving the reliability of exploration activities. Interestingly for Waqar et al. (2023), the theme of sustainability was also an important consideration for the sector's future usage of AI.

The theme of sustainability was seen as a highly valuable component which AI can provide, enabling innovative solutions to be created. For example, the oil and gas industry are increasingly needing to be highly sustainable, which is made more difficult due to the increased complexities. With the increased awareness of the potential impact of the sector to the environment, there is the need to adopt more advanced methodologies, rather than rely on the more traditional methods and approaches to become more environmentally sustainable (Vaio et al., 2020). This has led to writers including Pishgar et al. (2021), to argue that AI is expected to improve every aspect of operational activities including being more environmentally friendly but does need certain expertise. Therefore, it is predicted that AI will be expected to help implement sustainable development goals in future oil and gas projects by enabling the various activities and outcomes to be more sustainable for all stakeholders (Li et al., 2021), whether they are investors, end-users, or environmentalist.

In the oil and gas, the expected benefit of digital transformation and AI is to maximize energy throughput capacity while minimizing emissions, therefore digitalisation plays a significant role in the immediate future. For example:

- By digitalizing wells and plant sites, operators can reduce the site operation footprint by up to 30%, while minimizing HSE (Health, Safety, and Environment) risk and increasing asset reliability.
- By implementing AI workflows can enable decision making that targets the highest economic value for drilling new wells and servicing existing ones, drillers are targeting to reduce by up to 20% the cost per barrel, while driving profitability up by 1% to 5%.
- By taking decisions driven by artificial intelligence, planned unnecessary maintenance on all rotating and static equipment can be reduced, therefore avoiding 30% of non-critical maintenance.
- By implementing robotic processes automation, companies plan to reduce over 50% of the time taken by human-intensive tasks.
- By implementing autonomous operation, wells and plants will self-adjust and fine-tune the production parameters and settings to achieve optimal performance and minimum emissions 24/7.

While AI has begun to proliferate into all industries and sectors, not all have become digital natives, which includes the oil and gas sector, which is seen as being a digital latecomer (Kohli & Johnson, 2011; Kane et al., 2015), but is now AI dependent. This is interesting as the first applications of AI in the oil and gas industry occurred in the 1970s (Li et al., 2020), with the sector increasingly now investing in AI solutions. This investment and acceptance of this technology coincided with the exponential growth of AI capabilities, and the industry's movement towards the Oil and Gas 4.0, to improve productivity and operational activity (Lu et al., 2019). In investigating this theme further, Koroteev and Tekic (2021) found that artificial intelligence uses algorithms to 'de-risked' processes in the sector while encouraging collaborative activities. As noted by Koroteev and Tekic (2021) with upstreaming activities, which includes the searching for potential oil and gas reservoirs, this can be particularly capital-intensive due to the associated uncertainties of locating suitable sites (Shafiee et al., 2019). But as noted by Shafiee et al. (2019), the traditional way of exploring oil and gas reservoirs tended to be primarily reliant on human expert knowledge and experience, and not based on the type of data generated by AI. This perspective is captured in the saying 'one rock, two geologists, have three opinions' which represents the high level of uncertainty and risk which oil and gas companies faced in the past. Even with the complex and uncertain nature of the oil and gas sector, management tended also to base their decision on a single-criterion approach, which

was historically centred on human expertise in the decision-making process (Strantzali et al., 2016). This decision-making process traditionally involved practitioners' using their subjective perceptions and professional experience, which means that artificial intelligence and machine learning to be effective needs to be programmed to reflect the experts experience (Sharifee et al., 2019). AI programming also needs to cover the spectrum of the various upstreaming activities including the geological assessments of the reservoirs, the optimisation of drilling activities, reservoir engineering/field development, and production optimisation, all of which requires different experts and specialists to work collaboratively to interpret the data.

2.6 The Changes to Upstream Exploration through AI

The development of new greenfield oil sites and assessing the viability of whether a brownfield location should be further exploited requires accurate information to make informed decisions. Often these decisions have been based on existing geophysical studies to assess the potential of the site. This process tended to involve modelling of geological and reservoir workflows, which may include additional geophysical surveys while following complex in-company procedures. With the emergence of AI, writers including Korotev and Tekic (2021), highlighted that the exploration of oil and gas reserves now includes the usage of 3D geological modelling. The technology can process geophysical and petrophysical data from reservoir-scale seismic surveys, which can be conducted then analysed in real-time. AI can also provide pattern recognition techniques based on deep learning, which can also be used to analyse seismic-related operational activities generated from machine learning algorithms (Cunha et al., 2019). This usage of AI was captured by Korotev and Tekic (2021) and Lu et al. (2019), who noted that the usage of AI can provide a high-level of accuracy compared to a manual approach and was seen as being one thousand times faster than the conventional method. This speed and efficiency can be applied to core analysis in the exploration and extraction stages (Erofeev et al., 2019). The results of AI can be used to refine seismic interpretation, where once geologists and petrophysicists used to conduct their own analysis based on their professional experience, whereas technology can also be faster and more accurate. However, as noted by Ranaldo et al. (2021) there is also the importance of ensuring that the technology is correctly programmed, otherwise the return on the investment will not be achieved, indicating the importance of the correct expertise and specialism needed.

2.7 AI Activities and Usage of Algorithms in The Oil and Gas in Upstream

Although the theme of algorithms has already been reviewed, it is necessary to explore this topic from an AI perspective. Machine and deep learning are now dominant approaches used in AI, particularly in upstream oil and gas activities (Li et al., 2020). This has led to these technologies being used to identify potential fields of interest (Koroteev & Tekic, 2021). As a technology, the algorithms used in the machine and deep learning are seen as being black-box solutions, as there is no obvious formula that sets out or explains why the system works or calculates / performs. These algorithms contain complex multi-dimensional algebraic expressions, where the coefficients are expressed then defined to fit the input and output data. For this to occur the system, object, or process used commences with the algorithm learning or being trained to understand the data. Once the algorithms are trained on the known data, the technology can generate new and novel insights based on this information. However, to be effective, AI needs access to enormous amounts of data to successfully build predictive and simulations models. The datasets must also contain enough recorded failures for the algorithm to effectively learn what is acceptable or not (Hajizadeh, 2018).

Therefore, clearly the utilization of AI can process and analyse data to inform conventional reservoir, drilling, and geoengineering activity through the generation of modelling data, whereby providing potentially invaluable predictions. However, as noted by Koroteev and Tekic (2021), it is essential to note that AI is not just a technological solution that enables some processes to be completed faster, cheaper or with higher quality. AI-tools can be used to exclude or replace human expertise from many traditional processes and activities. This can lead to the creation of different operational and business oil and gas modelling to occur. The outcome could result in existing activities being completed differently, including at an architectural level, but this can also be problematic, as human intervention may still be needed, however what level of expertise or intervention is required remains unclear.

2.8 Data readiness

To be effective, AI needs to have good quality data of a suitable volume to train on before it can be used in an operational setting. While using smart algorithms may help in getting better results from datasets of limited size, with poor, bad data quality, irrespective of the amount of manipulation, the required level of accuracy may not be met (Ransbotham et al., 2017). To ensure that the data is accurate, then of a suitable quality and data readiness, there is a need for training datasets to be carefully collected through well-planned responsive workflows (Ng,

2018). But this can be challenging as the oil and gas sector are not known for their agile and lean project management approaches, but tend to be more hierarchical, often following a centralised waterfall approach to processes and procedures when implementing digital transformational solution such as AI. For Ng (2018) and Koroteev and Tekic (2021), this centralised approach is also reflected in the data storage policies which are housed in one or two data warehouses, which then may have restrictions on data access (Ng, 2018). Therefore, one of the challenges will often be the need for open collaboration, as opposed to restrictive access.

2.9 Key Challenges and the Need for Experts and Specialists with Knowledge of AI

While oil and gas companies, including BP, Shell, Saudi Aramco, and Gazprom Neft have invested into AI there are several challenges which have prevented or slowed down the rapid implementation of this technology when exploring oil and gas reserves. This is not simply due to the character of the sector, but the perception of AI within the industry. As highlighted by Koroteev and Tekic (2021), one of the critical challenges has been related to the skills sets and knowledgebase needed for the exploration and extraction of oil and gas reserves. This has included the focus on the central importance of data integrity and interpretation, and the need for open collaboration. This was supported by Haroon, Viswanathan, and Shenoy (2018), at the Abu Dhabi International Petroleum Exhibition and Conference. The authors noted that in this era where digital technologies are developing at an increasingly rapid rate, these innovations have begun to transform industries, including the petroleum sector. These digital transformational innovations have included the advancement and usage of machine learning, accelerated growth in acquiring and processing data, but also the need for experts and specialists to work collaboratively. For Haroon, Viswanathan, and Shenoy (2018) these transformative technologies need to have experts embedded into the organisational and operational environment. Part of this includes the removal of data silos which have traditionally existed in the petroleum sector's data infrastructure where teams have worked independently. Instead, these writers indicate the need for collaborative approaches being adopted, including greater shared user access to the data.

The success of artificial intelligence is still critically dependent on human intervention and intelligence. It should be noted that the AI solutions is not one-size-fits-all or purchased as out-of-the-box products, rather the technology must be tailored to fit the business need and data availability (Ng, 2016). A consequence of the tailoring of the AI solution is the need of

dedicated in-house teams. These teams are made up of data and AI specialists such as geoscientists, reservoir, and drilling engineers. They need to work collaboratively to support the development of an AI infrastructure in terms of algorithms and datasets being created so that customize outputs and tools can be produced. This therefore requires oil and gas companies to become data-driven operations. AI specialists replace the traditional roles of geoscientists, reservoir, and drilling engineers.

The search and retention of AI talent is a difficult task for the organisation. To solve this issue Koroteev and Tekic (2021) suggested that data scientists, petroleum engineers, geoscientists, reservoir, and drilling engineers work with AI specialists whereby creating new partnerships. These partnerships would provide the ability to manage and process the data, finding patterns and relationships, then for the petroleum engineers, geoscientists, reservoir, and drilling engineers to share their extensive industry understanding and knowledge to interpret the findings (Ferreira, Segua & Fucs, 2019). But as AI becomes increasingly used in the oil and gas sector to augment decision-making activities, petroleum specialist and experts fear that the technology will replace them (Duan, Edwards & Dwivedi, 2019). But AI tools if not correctly understood, may lead to actions which could result in financial or production disruption losses (Koroteev & Tekic, 2021). To avoid this, AI specialists and technicians need to have a clear understanding of who is responsible for the sharing of AI algorithms, what is the role of the AI algorithm user, or that of the AI algorithm developer? With the development of AI tools, a new operational model is needed, new roles and responsibilities need to be defined, there is a need for collaborative activities to be established. Assigning roles and responsibilities related to the results of the AI algorithms is also important, as the developers may not be accountable for the data sets that are produced, but rather the operational decision-makers. Therefore, senior, and executive management need to clearly specify the roles, responsibilities and work practices of AI users and developers.

2.10 Open Collaboration

To be effective artificial intelligence needs to have an open and collaborative environment. However, while this need for collaboration is recognised in certain industries such as the financial sector, the oil and gas industry are not seen as being a collaborative environment, particularly as to sharing data between projects and even less with the competition (Hajizaheh, 2018). Although this lack of data-sharing has recently changed with the UK's oil and gas National Data Repository recognising the importance of cross-company and cross-border data

sharing, led to the announcement that their data has now become open-sourced. This release contained 130 terabytes of geophysical, infrastructure, field, and well data, covering more than 12,500 wellbores, five thousand seismic surveys, and three thousand pipelines (Oil and Gas Authority, 2019), with the intention to enable remote data technicians to assist in the analysis. The growing trend of data sharing necessitates the adoption of cutting-edge AI technology and the recruitment of specialized talent. This requirement led oil and gas companies to adopt a more open collaborative strategy, including the establishment of new partnerships with AI providers. For example, GE and Statoil have jointly invested in Ambyint (Koroteev & Tekic, 2021), in Saudi Aramco the company invested in Earth Science Analytics, to develop the next generation of petroleum geoscience AI software (Koroteev & Tekic, 2021) while BP invested in Belmont Technology, to gain AI and digital capabilities for upstream production (offshore-technology.com, 2019). Interestingly, Shell, Saudi Aramco, and Chevron have joined together with an AI startup called Maana together with a partnership with Microsoft to use its cloud computing platform Azure (Koroteev & Tekic, 2021). In addition, universities and other educational institutions can play a role in developing and recruiting AI talent. Then of course there are university and other educational institution involvement to attain new AI technological solutions while gaining important AI talent (Koroteev & Tekic, 2021). These themes indicate that for AI to be effective, data needs to be accessible, have data readiness, new technologies should be readily acquired, and have suitable available talent. These themes suggest that for AI to be effective, it requires accessible data, data readiness, readily available new technologies, and suitable talent.

2.11 Conclusion

To consolidate and summarize the above academic debate, it is necessary to investigate various themes to achieve the central purpose of the study, which is to critically investigate the experiences of implementing a digital transformation solution of artificial intelligence (AI) in an UAE operational working environment in the oil and gas sector.

The first theme was related to the importance of the lessons learned method which although advocated in various project management text, like Burke (2013) and Meredith et al. (2020), has been missed in many AI related studies (e.g., Zuofa & Ocheing, 2017), particularly those into the oil and gas sector. This is interesting as this technology is still in its infancy as to how to manage this type of project. Potentially, the usage of a methodology like lessons learned could assist in gaining the necessary insights to implement this solution effectively. This led to

the study to ask the following question which will be used to inform the main study: what is the importance of lessons learned when implementing an AI digital transformational solution? The next theme to emerge from the literature review was the value or monetary value associated with the implementation of AI, and the potential benefits it could provide. This poised the question as to how effective can this technology be assessed as to its monetary benefits? This type of technology obviously requires significant investment, but any project must evaluate the project's benefits against the costs, which is often related to the iron triangle of time, quality, and cost (Meredith et al., 2020; Burke, 2013). But the question that arose and was used in this study, was whether this technology with extensive access to real-time data can provide the necessary information correctly for the project. This led to the question: how much is monetary value considered when implementing an AI solution in the operational oil and gas setting?

Arising from the theme of real-time data usage is the identified challenge associated with having the necessary technological infrastructure (Toufaily et al., 2021), the expertise (Chowdhury et al., 2022), and adequate storage facilities (Lu et al., 2019). The issue around storage is complex, with a shift or trend towards seeking cloud solutions in the sector (Yamakawa et al., 2012; Toufaily et al., 2021). But in the UAE, this can be a potential problem due to the storage facilities being often remotely owned by external providers, therefore no longer controlled, or managed by the operation. Added to this challenge, is the need to adhere to the UAE regulations. The UAE has a number of regulations that govern the localization of data and cloud technology associated with the locality of data and cloud technology. To address this, the study questioned: what were the external factors of influence when implementing AI? Furthermore, as mentioned previously, a digital transformation AI solution requires the expertise and specializations that may not be readily available within the organisation, particularly considering that the sector is considered to be a late adopter of the technology (Kohli & Johnson, 2011; Kane et al., 2015). It has been observed that there is a growing trend towards seeking collaborative involvement to address these skills and expertise gaps. This collaboration has included initiatives such as combining oil and gas expertise with those who have AI experience. But this can be challenging as the industry is known for its silo culture and not sharing business data. This theme then led to the study questioning: what level of expertise and knowledge currently exists, and what is needed in the future when deploying an AI solution?

In light of this debate and the emerging themes, the following central research questions were posed:

• How and why have artificial intelligence projects been implemented in the operational activities of the UAE oil and gas sector?

• What aspects have needed to be considered and implemented when introducing a digital transformation solution in the UAE oil and gas industry, why?

•To what extent and why has artificial intelligence transformed the current business practices in the UAE oil and gas industry, and how will this transformation inform future projects?

Based on these questions, the initial round of interviews involved the operational technicians and engineers.

The questions above asked were focused firstly on the importance of implementing and using a lesson learned methodology. The interviews also focused on the monetary value and benefits associated with AI, then external factors, and finally the perceived level of acquired knowledge needed. Leading on from these questions, the following related sub-questions were also devised and was used in phase one and phase three of the project:

- What were the challenges encountered during the project of implementing an AI solution into the operational production environment?
- What could be changed, modified, or required in the future when implementing future AI solutions?
- What are the challenges when implementing AI into the existing workplace in relation to the current skills, talent, and knowledge base?
- What external factors need to be considered when implementing an AI solution?
- To what extent has AI enabled optimisation through the digital technological integration project?

A summary of the core questions and themes are presented below in Figure 2.5 which were generated from the literature review.

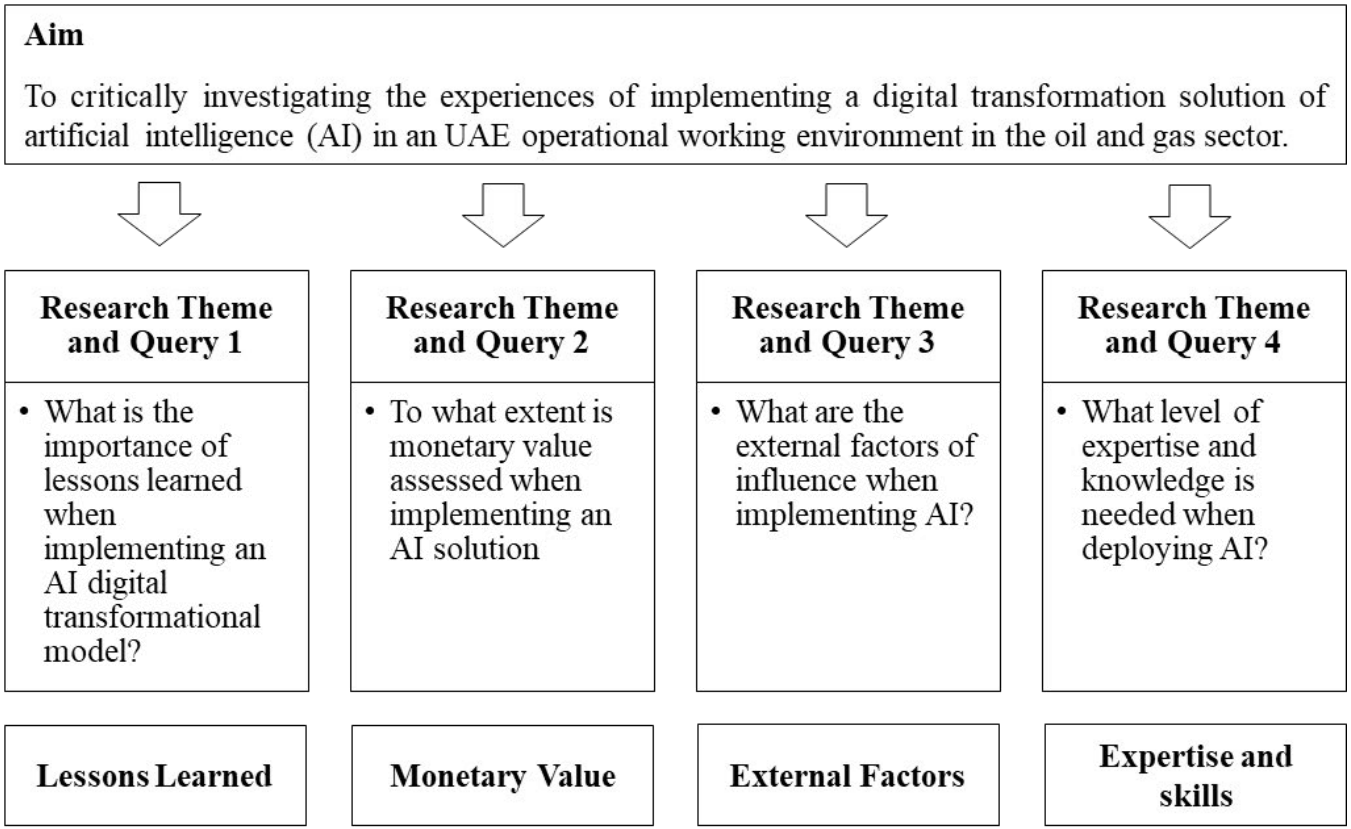

Figure 2-5. Conceptual Model

Chapter Three - Methodology

3.1 Introduction

A key question for many management researchers particularly those studying a professional doctorate like a DBA, is how to study a theme which is related to the social reality of the topic of interest, what knowledge exists and then how can a critical understanding of the subject be acquired. To achieve this, it is necessary to be fully aware of the ontological and epistemological issues surrounding the research, so that the correct methodological approach is selected to gather the data and then develop the findings, which can be used to add to the existing body of knowledge in the chosen field of enquiry. For writers like Gill and Johnson (2002, p. 491) this is critical as '…the choice is [based on] the assumption of… the nature of knowledge and the methods through which that knowledge can be obtained'.

This Chapter will outline the strategy adopted in conducting the research through adopting a qualitative approach to gather the subjective data. This strategy involved conducting a three distinct stages process to generate a new conceptual model to illustrate the experiences of implementing AI in the UAE oil and gas sector. In achieving this, the philosophical perspective and the practical methods used to conduct the study will be explored, together with the research questions, which will be present in section 3.6.2. The chapter will then set out how the pilot study would be presented, along with justifying the choice and potential limitations of the research, including how saturation was reached. As noted by writers such as Silverman (2013) and Blaikie (2007), most researchers face the dilemma of deciding on a proper research methodology, which the researcher's views and values can inform. For this research project, the worldview was informed and influenced by a particular focus on the nature of the theme being investigated, the experiences of those working in the oil and gas sector in the UAE as to how a digital transformational solution such as AI was introduced and implemented. Therefore, this study sees the world as being a series of experiences or perceptions which are the 'representations that are creations of individual minds' (Blaikie, 2007, p. 16), and not simply based on the existence of independent truths which are external to the participants being studied (Silverman, 2013).

For this study, knowledge about reality could only be reached from the viewpoint of the person, as only the individual can provide the evidence needed to construct a theoretical understanding based on their own experiences. Reflecting this, this study adopted what the social scientist

researcher Blaikie (2007, p. 8) called a 'bottom up' approach using an inductive strategy, which enables concepts and theories of social life from social actors' or interviewees to be captured, whereby enabling the researcher to understand everyday lives then conceptualise their experiences. Through this approach it is then possible to generate a correct account which can represent and reflect the participants' own accounts through using their words. The chapter will commence with the potential research approaches, by justifying the rationale for using a qualitative study as opposed to quantitative study and presentation of the research approach adopted, which was informed by the ontology and epistemology of the researcher (section 3.2). Leading from this, the research design of the qualitative project will be presented (section 3.3.5) as to the profile of the participants in the pilot study (section 3.5.1) and the main study (section 3.5.2). The chapter will then proceed to present the pilot study and the outcomes generated (section 3.6), along with the emerging themes gathered from the main study (section 3.6.1). This will also include the research questions asked during the interviews (section 3.6.2). Leading from this, the analysis of the coding of the interviews using a thematic approach will be presented in section 3.8, together with the use of NVivo and the manual coding strategies used. Finally, how the study ensured that the project was suitably robust is set out, through by ensuring that the data was authentic, dependable, and trustworthy (section 3.9), followed by the ethical considerations of the study (section 3.10).

3.2. Ontology and Epistemology

As already mentioned in the earlier section, an understanding of a researcher's world view and how knowledge or reality is gained is fundamental, therefore the next section will present the ontology and epistemology of this study.

3.2.1 Ontology

Ontology is a branch of philosophy that is concerned with the nature of what exists (Crotty, 1998), as the concept is focused on 'how you choose to define what is real,' while the epistemology is centred on 'how you form knowledge and establish criteria for evaluating it' (Hatch & Cunliffe, 2006, p. 12). Theories surrounding ontology tend to focus on the nature of social reality, which are then reduced into two opposing categories: positivism or constructivism, or in other words, the objectivist versus the subjectivist views of the world. Unlike positivists, who see that knowledge is an objective measurement and therefore is an independent external reality, this study sees reality as being more subjective. Being subjective,

the study's ontology is that if 'something exists only when you experience it and give it meaning' (Hatch & Cunliffe, 2006, p. 12). In this study, the focus is on the experiences of introducing a digital transformational AI solution into an oil and gas setting, therefore the research needs to ensure that the participant's meaning, and experiences are not ignored, and that an almost static social world which is separate from the individual's experiences could not have been created or predicted in advance.

3.2.2 Epistemology

Epistemology is the theory of how individuals gain and reach the knowledge of reality in the world (Silverman, 2013; Blaikie, 2007). Epistemology supplies a philosophical grounding for deciding and establishing what kinds of knowledge exists, what is known, and the criteria for deciding how knowledge can be judged as being both adequate and correct (Crotty, 1998). For Crotty (1998) epistemology is the knowledge which is embedded in the theoretical perspective of the person. Crotty (1998) also argues that the epistemology describes the way a researcher perceives their world based on known understanding or knowledge. Being a social constructivist, and interpretivist, the epistemological approach is that knowledge can only be created and understood from the point of view of the individual who is being interviewed and has experienced first-hand the UAE's digital transformational AI solution in the oil and gas working environment.

3.3 Potential Research Approaches

It was writers such as Blaikie (2007), a social scientist, who identified that there are two key approaches which can be used as a potential research strategy, that of positivism and social constructivism. For Blaikie (2007) and Robson and McCartan (2016) the decision as to which approach can be adopted needs to be based on and match to the intended research project outcome and the research questions that will be used. Furthermore, the decision needs also to reflect the 'worldview' of the researcher. This worldview is based on the individual's personal preferences or values, known as the axiology, together with their understanding of what is reality and how knowledge can be gained, which is referred to as the epistemology. For Blaikie (2007) this is fundamental, since this will define the research strategy, the choice of which entails 'the adoption of a particular set of ontological and epistemological assumptions' (Blaikie, 2007, p. 6). Supporting Blaikie (2007), both Easterby-Smith et al. (2012) and Alvesson and Deetz (2000) highlighted the distinction between quantitative and qualitative

worldviews or paradigms, as to their differences from an ontological, epistemological, and axiological perspectives, and noted the implication of these approaches to the outcomes and results generated.

3.3.1 The Positivist Approach

For the positivist, the research method tends to be grounded in a quantitative approach, as it has its origins in natural sciences. The positivist has characteristics which include the focus on reducing all phenomena to follow determined and defined scientific rules which are based on creating a hypothesis through which a deductive approach can be followed to either verify or disprove an original assumption (Guba & Lincoln, 1994). In the main, positivism has an objectivist conception of social reality, which is based on the collection of numerical data, with the intention to supply a generalised representation of the world which can then represent the entire population. However, for writers such as Blumer (1956), in setting out the characteristics of positivist studies, there are limitations associated with this approach, like the need to seek reliability which often cannot be achieved when studying the personal experiences and influences of the individuals being researched, particularly if the study is based on investigating the connection between the individual's perceptions and experiences which cannot be detached from their reality. Schutz (1962) supported this view of Blumer (1956) and highlighted that a quantitative or positivist research due to its scientific approach can fail or neglect to distinguish individuals and the social institutions from the 'the real world or nature' or their 'social world.' For Guba and Lincoln (1994), positivism can only generate findings that exist independently of some form of theoretical framework, therefore can become problematic when studying real-world themes such as beliefs, and attitudes (Guba & Lincoln, 1994). With positivism there is the need for the removal or exclusion of social reality, which for Sarantakos (2012, 1998), needs to be still understood when researching the social reality, otherwise the study's outcomes become almost unreal or evaluate an assumption rather than deep diving into the experiences of those being studied.

Finally, for Bryman (2012) the characteristics of positivism highlighted that the need for aim and value-free approach to be adopted, which means that the researcher needs to be removed from the research. Therefore, to adopt this approach could potentially limit the research to be able to investigate only the actual or the perceived experiences through the sample's senses (Bryman, 2012), as opposed to understanding the rich and reflexive perceptions when introducing a digital transformational solution like AI into the oil and gas sector.

3.3.2 The Interpretivist Approach

The interpretivist approach unlike positivism, is more associated with and aligned to subjective qualitative research, whereby social meaning is constructed from interpretation. An interpretivist takes the view that social research must be generated by interaction, through either the research subjects / participants or between the researcher and the subject area. This means that the interpretivist looks to study the subjective reality as opposed to objective meaning to understand social action. By adopting this inductive approach, the research process considers the interdependency of the researcher and subject (Easterby-Smith et al. 1996). Therefore, for Easterby-Smith et al. (1996) the researcher is unable to remain detached or to be removed from the research project as a positivist needs to be, but instead the researcher investigates the subject in a subjective paradigm, which is aligned to the intention and purpose of this study.

3.3.3 The Intended Research Approach

To decide which research approach to adopt, for writers including Guba (1990), these authorities argue that the researcher needs to select a single approach. Even though as noted above, there are differences between the approaches, which for writers including Sale, Lohfeld and Brazil (2002) these differences make qualitative and quantitative strategies almost incompatible, and therefore cannot be combined. However, there are other authors including Bryman (2012), Cresswell (2013), and Robson (2011) who contend that each approach does not use in isolation, and the perceived differences appear to breakdown under scrutiny (Bryman, 1988; Robson, 2011). It should be noted that even though this study adopted an interpretivist paradigm, there was an awareness of the debate as to the compatibility or incompatibility of the two approaches. To understand this debate further, Bryman (2012) suggests that these two research approaches of quantitative and qualitative, needs to be fully explored and then justified as to the intended approach adopted. Reflecting this, the next section, will present the fundamentals of adopting a quantitative approach, followed by the qualitative strategy which was finally used.

3.3.4 The Quantitative Approach

The quantitative approach is associated to positivism, as it has its origins in natural sciences. As a research approach, the positivist contends there is a single reality of truth, which can only

be explained by following fixed laws, and researched by adopting a value free deductive method to ensure that the results are valid, which are important axiology values (Bryman, 2016).With this focus on quantification and validity, the researcher must develop a functional relationship that includes interpreting the findings mathematically or statistically then present the results to prove or disprove the original knowledge or understanding. In adopting this strategy, a quantitative study will attempt often to seek to identify patterns that facilitate the prediction or control of future phenomena, which can be checked and repeated in the future based on following the same study and controlling research variables (Guba & Lincoln, 1998; Miles & Huberman, 1994). Given these assumptions and characteristics as presented by Guba and Lincoln (1998) and Miles and Huberman (1994), a quantitative approach would not be appropriate for this real-world study, as the purpose of this research project was to focus on the experiences of those in the oil and gas sector when a digital transformational solution was being introduced and what lessons can be learned for the future.

3.3.5 The Qualitative Approach

Unlike the quantitative approach, which is associated with positivism, a qualitative strategy is more linked to a social constructivist, and interpretivist paradigm. The qualitative approach sees the social world as being a human construct and that reality can only be understood from the participant's perspectives of their social interaction (Bryman, 2016). This approach is centred on developing theory through an inductive strategy, which sees and recognises the dynamic nature of the subject being studied, as opposed to the participant being a static object. A qualitative approach can enable the researcher to figure out the participant's perception to gain meaning, gaining a critical insight and understanding as to how and why a phenomenon exists. In other words, this approach can enable the interviewee to put into their own words their meaning and beliefs of their social reality, thereby generating a richness in the data (Bryman, 2012). In seeking a deeper understanding, a qualitative approach tends to study a smaller number of participants, and therefore does not aim to show generalised patterns, which is a core feature of positivism. The qualitative approach also enables the discovery of certain beliefs, attitudes, or behaviours, so enabling a unique critical insight to be generated to provide a new perspective into the complexities associated with human behaviour, which is relevant for this study into the experiences of AI being introduced into the workplace.

3.5 Research design

Designing the research involves choosing a method and then deciding on an operational framework which is suitable for conducting the study. To achieve this, the study recognised that the implementation of the digital transformational solution was experienced by three separate groups from potentially different perspectives, therefore the decision was made to divide the study into three distinct stages or phases using an interpretivist approach to capture the experiences and beliefs of these different groupings. As can be seen in Figure 3.1, there were three distinct phases, which started with the conceptual framework generated from the existing literature which were then presented to the first phase, who were the operational oil and gas experts and specialists. It should be noted that the research questions for the first phase will be presented in section 3.6.2 (3.6.2.1), and the second phase, which emerged from the first phase, set out in section 3.6.2.2.

An important part of the research design in this study was to decide whether the research project was a case study. For Robson and McCartan (2016) a case study is an approach used to study an individual, group, or an organisation, but is time and space dependent. For Bryman and Bell (2007) as a concept, the concept of a case study is extremely broad and often misunderstood. In explaining this, Bryman and Bell (2007) argued that the concept can be based on a single organisation, be conducted in a unique location, like in this study, or alternatively studying a person or single event. However, missing in this is definition of Bryman and Bell (2007) is the importance of time along with space or locality. In explaining this concept of time, a key writer in the field of case studies is Yin (2003), who stated that the concept needs to fulfil one of the following criteria: a critical case, a unique event, something which is revelatory, a project which is a representative or typical phenomenon or being longitudinal in nature. For this study and following Yin (2003) and Robson and McCartan (2016) definition, the locality in the oil and gas sector in the UAE meets the criteria as to space, and even though time is not critical, as the study was conducted after the initial AI projects had been delivered, this research can still be seen as a case study.

The next phase was informed from the outcome of the first phase and the literature review, which enabled the generation of an MS Excel spreadsheet to capture the emerging themes seen as important for an AI project delivery. This was also used as a prompt, which generated from the project managers interviews a rich insight into their beliefs and experiences. Leading from the second stage, phase three involved the senior management team being interviewed, based on the first two phases. From this a conceptual model was devised to stand for the findings,

which will be presented in Chapter Four. It should be noted the research design for all three phases included that all interviews would be conducted in English as opposed to Arabic as the main language amongst the teams was English, and that the participants were from the UAE and other countries due to the complexities and expertise of the oil and gas sector. Consideration was given to conducting the interviews in Arabic, but the researcher firstly wanted to ensure that there was consistency during the interview process, but also when the interviewees were asked for their preference, all the participants wanted to conduct the interviews in English.

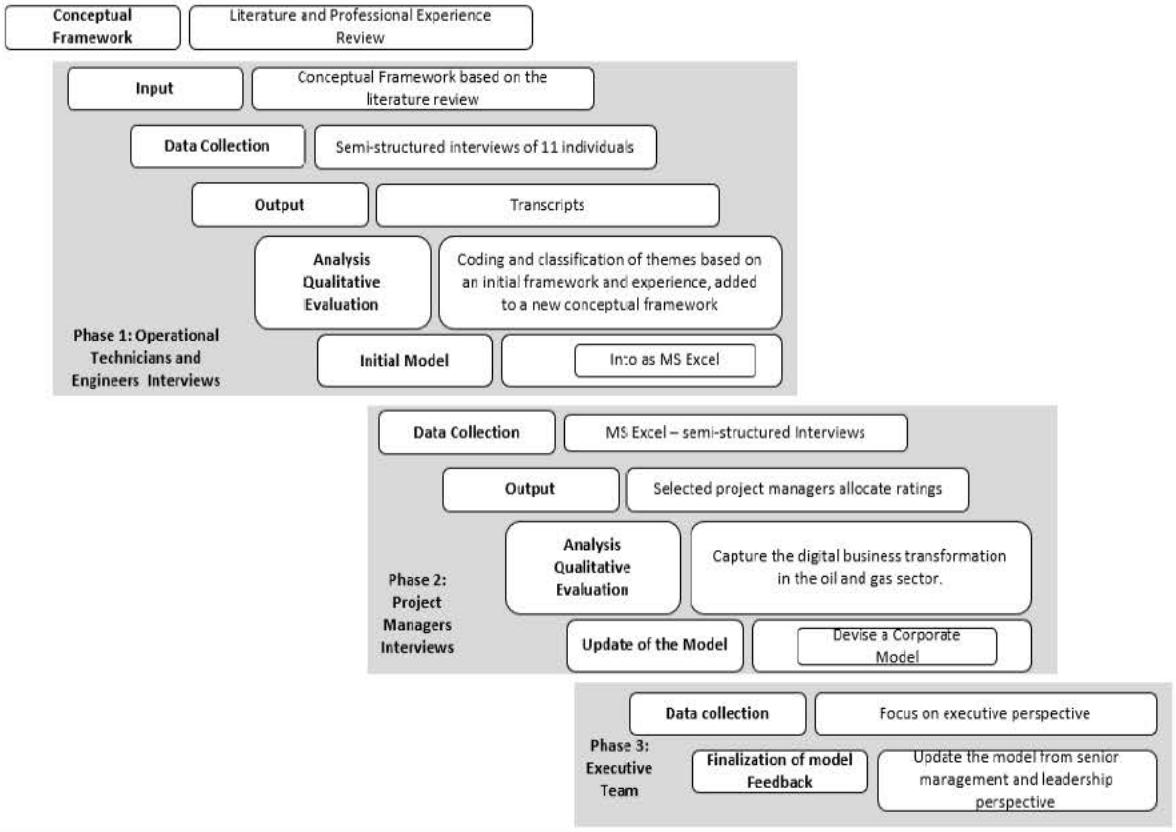

Figure 3-1. Research Methodology

3.5.1 The Sample Framing and Strategy

To contextualise the project's methodology further, it is important to present the sampling framework and strategy adopted which then informs how the selection criteria for the three stages were conducted. The decision in this study was dependent on the nature and ontological positionality of the project and the target population, which were operational experts and

project managers who were actively involved in an AI business model transformational project in the UAE oil and gas sector.

For qualitative research, the sampling framework is often based on opting for non-probability sampling technique, which is not focused on producing a statistically representative sample or to attain a statistical inference, but rather generate a new theoretical insight (Clark & Causer, 2020). Therefore, to achieve this theoretical output, a purposive sampling technique was adopted. With a purposive non-random sample, the number of participants interviewed was less important than the criteria used to select them. Therefore, the characteristics of the individuals in this study was used as the basis for the selection criteria, which was focused on recent experience and involvement in an AI business model transformational project in the UAE oil and gas sector, from an operational and project management perspectives.

There are different approaches to purposive sampling, with some focused on different aspects of the sample members, for example, the interviewees are more important or knowledgeable than others. For this study a purposive sampling approach was adopted as it offered 'theoretical sampling' strategy which was originally developed from 'grounded theory' (Creswell & Miller, 2000). The term 'grounded theory' expresses the idea that theory is generated, through an iterative process, involving the continual sampling, collection, and analysis of the interview data which then informs the next stage of the sample design, until 'theoretical saturation' is achieved; that is, no new ideas or theories emerge (Padley & Padley, 2021). While not specifically a grounded theory research project per se, this study adopted the above strategy as advocated by Creswell and Miller (2000), as the three stages of the interview design emerged as the main study progressed, while also ensuring that the project was sufficiently robust, and that saturation was achieved.

This iterative nature of the theoretical sample design was important for this study, as it provided the researcher with the opportunity to analyse the data as the interviews progressed, which enabled the researcher to then add to or change the emphasis of the sample design, whereby ensuring the robustness of the theories generated.

The study's participants as noted above were drawn from a major UAE oil and gas producer, which is a major contributor to the country's economy and energy provision, therefore can be seen as a case study (Yin, 2003). The decision to focus on this organisation was based on several reasons. The first reason was centred on the original motivation to conduct this study, based on the researcher's initial observations. The motivation was to assist and inform the senior leadership team of the experiences of implementing an AI business transformation project. The second reason was based on the researcher's immediate access to the professionals

and experts who had recently been involved in an AI business transformation project, which was seen as being paramount. However, the researcher ensured that those who participated had no direct connection to her. The third reason is that as these forms of AI business transformation projects continue, it is critical to understand the experiences, challenges, and benefits from both an academic and professional perspective. This insight could then be used by the operational and project teams to understand the implications of this new solution.

3.5.1.1 The Pilot Study Participant Profile

To review and evaluate the main study, the interview format was evaluated including whether English was the best medium. The main dilemma for the study was how to access the project managers and the Senior Management to evaluate the format of the interviews; therefore, an exact match could not be achieved. To overcome this potential challenge or limitation, senior operational managers with some executive and project management experience were approached to participate in the pilot study. The participants for the pilot study were directly approached to participate and were sourced from known individuals to the researcher who also worked in the same organisation. Part of the selection criteria was based on their availability to participate and having an interest in the outcome of the project. It should be noted that there was no line management responsibility connection between the researcher or the interviewees. These interviewees also acted as gatekeepers to access the main study participants, as their professional profile mirrored the final criteria of experience needed to investigate the central themes of the project.

Table 3-1. Participants Profile for The Pilot Study				
Participant code	**Current role**	**Years of experience**	**Experience**	**Responsible for**
Pilot Participant 1	Production and Reservoir Management Consulting Practice Manager	25	AI	Production and reservoir and the implementation of AI process in production prediction of the solution
Pilot Participant 2	AI program manager	16	AI	Development digital oilfields
Pilot Participant 3	Project Manager	30	IT and AI	Managing upstream projects

3.5.1.2 The Main Study Profile

The main study consisted of a series of one-to-one semi-structured interviews conducted through three independent stages, which comprised of the first stage involving eleven operational technical staff, four project managers in the second round, and finally three executive members/ senior managers of the organisation in the last stage. The sample composition and size were based on the desire to obtain the richest data possible (Lofland & Lofland, 1984; Creswell, 2012), but also to capture the three tiers of the organisational hierarchy. Characteristics such as gender and age were seen as not relevant, but key influences including the role of the participants was seen as being vitally important, along with their unique experience. As mentioned above, the participants for the three stages were identified and approached initially by those involved in the pilot study. Part of the criteria included the assurance that the participants were not directly connected to the researcher, whereby ensuring that the project had limited bias. Once the interviewees were identified, the researcher then formally approached the individual by either emailing them directly or approaching them in person.

Finally, the sample size also reflected the limited time and resources available, given that the interviews had to be transcribed in full, and then coded (King, 1994, 2004; King et al. 2004). The different profiles are presented below in Table 3.2, 3.3 and 3.4. Table 3.2 sets out the code of the person being interviewed, their current position in the organisation, together with the number of years in the role. The next column is based on their experience and expertise, with PE representing expertise as petroleum engineer, RM was associated with reservoir management, IT is for Information technology and finally, AI for artificial intelligence. The last column sets out the key responsibilities of the participant.

Table 3-2. Operational Participants Profile for The Main Study

Participant code	**Current Role**	**Year of experience**	**PE**	**RM**	**IT**	**AI**	**Responsible for**
Participant 1	Production and Reservoir Management Consulting Practice Manager	25	X	X			Production and reservoir and the implementation of AI process in production prediction of the solution
Participant 2	Technology Strategy and Portfolio Manager	18			X		Technology strategy planning & portfolio
Participant 3	AI Program Manager; IT/Data scientist	32	X	X	X	X	Developing digital oilfield solutions
Participant 4	AI Program Manager; IT/Data scientist	16	X	X	X	X	Developing digital oilfield solutions

Table 3-2. Operational Participants Profile for The Main Study							
Participant code	**Current Role**	**Year of experience**	**PE**	**RM**	**IT**	**AI**	**Responsible for**
Participant 5	Data Scientist	21	X	X	X		Developing programs out of algorithms. Focus on sustainability.
Participant 6	Specialist, Data Architecture	21			X		Providing digital solutions for the Upstream Oil and Gas Industry
Participant 7	Engineer, Research Experimental R & D:	40	X	X	X	X	Providing Technologies in exploration and production
Participant 8	Business User	16	X	X			Using digital solution
Participant 9	Product Manager	40	X		X	X	Head of Digital Drilling Technologies at AIQ
Participant 10	Principal Petroleum Engineering	30			X	X	Deploy digital oil Field solutions
Participant 11	Senior Specialist Cognitive Reservoir Management	30	X	X	X	X	Cognitive Reservoir Management

Table 3-3. Project managers profile for the main study				
Participant code	**Current role**	**Years of experience**	**Experience**	**Responsible for**
Project Manager 1	Project Manager	10	IT and AI	Leading digital project s and digital transformation
Project Manager 2	Technical Project Manager	20	IT	Deploy digital solutions
Project Manager 3	Project Manager	30	IT and AI	Managing downstream digital project.
Project Manager 4	Project Manager	13	IT	Managing upstream digital project

Table 3-4. Executive board profile for the main study				
Participant code	**Current role**	**Years of experience**	**Experience**	**Responsible for**
Senior Manager 1	Production and Reservoir Management Consulting Global Director	35	PE, RM and AI	Development and management of the Production and Reservoir Management business
Senior Manager 2	Software Company Chief Technology Officer	15	IT	Software applications that will help the business to achieve one business objective
Senior Manager 3	Vice President, digital project s & Innovation	20	IT	Leading the Digital transformation journey and developing Digital strategies supporting the businesses

3.5.3 The Pilot Interview

With an interpretive study, it is often not suitable or even possible to pre-determine in detail the questions which are going to be asked, but the outline themes tend to be informed or influenced by the existing literature, which provides the interview protocol. The decision was taken to use a series of open-ended questions for all three phases, but to be informed initially from the literature, but also for phase two and three, from any emerging themes derived from the first part of the study. However, it was recognised that there was a need to evaluate or pilot the interview format and questions prior to the commencement of the main study phase. The pilot interviews were conducted on October 1, 2022, and the interviews were 45 minutes to 75 minutes, which included time afterward to ask the participants for feedback on the interview protocol.

3.6 Outcome of the Pilot Study

The findings of the pilot study were analysed from two perspectives, firstly as to the extent to which the research strategy and interview protocol were dependable, and secondly as to meeting the aim of the research. The results from the pilot study were designed to ensure that the main research protocol was effective. The pilot also ensured that the power relationship between the participant and the researcher could be evaluated, and how this potential issue could be minimised, such as enabling the participant to talk freely. The pilot study revealed that the five themes were suitable but the technique in asking the questions needed to be more in an open questioning format such as asking what, how and why, as opposed to closed questions. Again, the use of English as the language to conduct the interviews was also confirmed as being suitable for all three phases.

3.6.1 Emerging Themes from the Main Study - Phases one and two

For the first phase of the study, the following themes emerged from the literature review:

The importance of lessons learned this was due to the lack of academic research into the implementation strategies of adopting a digital transformation solution within the oil and gas sector, and from the recognised importance of ITIL from the professional background of the researcher.

The monetary value – the need to ensure that the project provides value or monetary return, which is part of the three factors of the project management's determining of success, the iron triangle, time, quality, and cost.

The influence of external factors – due to the large extensive data being generated, there is the identified need for external storage including the usage of cloud technology and facilities.

Level of knowledge – linked to external factors, is the need for expertise and specialisms in technology, as this may not be available in AI and related digital transformation solutions within the existing organisation.

and *change management* - again, although under-researched from a digital transformation solution using AI in the oil and gas sector viewpoint, AI needs to be constantly monitored and then updated, but also needs to be managed correctly to ensure that business and operational activities are not affected.

From the first phase, the following themes were identified, which were then entered into MS Excel from which the project managers were asked to rate them as to importance and relevance from 1-5: 1 being the lowest and 5 being the highest.
The role of strategic leadership and senior management commitment as to the need for executive support from the outset through to the delivery in the operational environment.
Data readiness – as noted by the first phase, the access to the data was needed to be there in real-time but also the challenges associated with external provision such as data storage.
People and skills – recognised was the importance of having the correct AI and related digital transformation expertise. This also meant the introduction of both internal and external collaborative partnerships.
Process and optimisation – to be effective, the technology needs to be optimised and this requires the expertise and specialists in both AI, digital technology but sector experience, but also to have the correct technology and infrastructure.
and *implementation of technology and integration* – the final component is the need for suitable infrastructure, including processing power, storage, and expertise, which needs to have leadership and executive commitment.

3.6.2 The main study's interview questions

The following research questions devised based on the current debate, and informed from the pilot study were:

- How and why have artificial intelligence projects been implemented in the operational activities of the UAE oil and gas sector?
- What aspects have needed to be considered and implemented when introducing a digital transformation solution in the UAE oil and gas industry, why?
- To what extent and why has artificial intelligence transformed the current business practices in the UAE oil and gas industry, and how will this transformation inform future projects?

Leading from these core questions, the three stage interview questions were also focused on the three different participant groupings. For the operational technicians and engineers, the questions were informed by the current academic debate and professional practice:

3.6.2.1 Phase One

What were the challenges encountered during the project of implementing an AI solution into the operational production environment?

- What were the challenges encountered during the project of implementing an AI solution into the operational production environment?
- What could be changed, modified, or required in the future when implementing future AI solutions?
- What are the challenges when implementing AI as to the workforce's skills, talent, and knowledge base?
- What external factors need to be considered when implementing an AI solution?
- To what extent has AI enabled optimisation through the digital technological integration project?

3.6.2.2 Phase Two

For the project managers, the focus was informed by the first phase and included the following questions:

- Based on the MS Excel spreadsheet, what were the challenges associated with implementing a digital transformation AI solution?
- What external factors need to be considered when implementing an AI solution?
- What were the core requirements for implementing an AI solution?

The final stage involved three members of the management team. These individuals were then interviewed based on the first stage interview questions, but also drew on the questions and themes related to the project managers.

As this qualitative study was focused on achieving the richness of the three groups of participants perceptions and experiences, there was the need to ensure that the data generated was adequate or reached the point of saturation. In achieving saturation in this study, the first phase was achieved after the ninth participant interview, but then continued for Two additional individuals, in case any new themes emerged. The next two phases which involved firstly four project managers and then three senior leaders, this was harder to achieve 'saturation' as presented by Robson and McCartan (2016), due to the limited number of available participants. To overcome this challenge, this study saw saturation as being attained by reviewing the existing knowledge gathered from the academic understanding together with the data generated from the previous phase, which were then aligned to the new findings.

For the main study, the interviews for the first phase were conducted on November 1, 2022**,** and lasted between 50 and 90 minutes but depended on the participants' commitment. The second phase was scheduled and conducted with the project managers on December 3, 2022. Due to their work commitments, it had a shorter duration, meaning the interviews ranged between 30 and 40 minutes. Finally, the executive team access proved to be restrictive, and therefore, the interviews lasted, on average, 20 minutes and were conducted at the end of December 2022. It should be noted that the three phases were independent but did inform the next stage of the interview protocol.

3.7 Analysis and Coding the Interview Data.

Each of the interviews whether that was the pilot or the main study, including all phases, were recorded, transcribed, and analysed and then coded manually, although NVivo was used to validate the data after the initial coding exercise had been completed. The approach taken by this study as to analysing and coding the interview data was to ensure that the qualitative research from the semi-structured interviews were fully engaged with, even though there were substantial amounts of textual material generated in the form of transcripts which created enormous amounts of rich data. To code the data, this study drew on the means to organise and analyse textual data, through using a content analysis framework (Braun & Clarke, 2006). The adoption of this data analysis and coding method of Braun and Clarke (2006), is supported by Clarke (2005) and King (2004), who highlighted the benefits of using a content analysis

approach, which is not directly linked to any one specific methodology, but instead enables the researcher to gain greater flexibility in coding data compared with other methods such as grounded theory. For King (2004) the approach of content analysis provides a flexibility of the coding structure, enabling the use of priori or known themes to be set out to function as an initial structure to assist in organising emerging themes, but then for new themes or categories to be created later. Through adopting a qualitative content analysis approach in this study, the method provided a flexible means for analysing the text data (Cavanagh, 1997). Furthermore, this approach enabled the data generated from the interviews to go beyond simply counting the number of words or the occurrences to classify large amounts of text in an efficient number of categories that represent similar meanings which is a feature of NVivo, but instead enabled the richness of the meaning to emerge (Downe-Wamboldt, 1992).

3.8 The Coding Strategy of the Data

As mentioned above various coding approaches were considered, including content analysis and grounded theory. Grounded theory is the systematic generation of theory from data that requires both inductive and deductive thinking. For Glaser and Strauss (2017), when applying this approach, the authors highlighted the need for the researcher not to formulate the hypotheses or an assumption in advance or to create codes or themes, but instead review the data from an open mind. If the researcher has a perceived or known assumption, then for Glaser and Strauss (2017) grounded theory cannot be used. As this study had already some themes generated from the previous stage, whether that was from the literature review or the interview phase, the project could not adopt a grounded theory approach to the coding strategy.

With the selection of a qualitative content analysis coding and categorisation of the data strategy decided upon, the approach enabled the data to be systematically grouped and then put into a hierarchical order, which assisted the analytical process of coding and interpreting the interviewees meaning. In this study, the revision process included analysing the interview transcripts and then linking this to the existing knowledge, which resulted in changes to the theme's position and level in the hierarchical framework of the coding structure. As the process progressed, consideration was also given to the possibility of introducing new codes or altering or changing the level of existing codes in the framework. There were some changes made as the themes emerged, but the original format stayed the same.

Although the qualitative content analysis has several benefits, there are also associated limitations. These limitations included the acceleration of the process that can potentially lead to materials or interview transcript data being overlooked or neglected. The current study recognised these potential limitations; therefore, the coding process was frequently rechecked, until the key themes and relationships had been established.

3.8.1 Manual Coding of the Data

As indicated above consideration was given to using NVivo to code and analyse the data. During the initial stages of the coding and analysis of the main study's data, an attempt was made to use this qualitative software. However, NVivo was rejected as it required several months of dedicated practice, which became impractical due to time constraints. Then during the pilot study and part of the main study, it was recognised that the data had been coded manually therefore the researcher decided to keep it consistent adopting for a manual approach. Finally, the manual coding approach provided an opportunity to personally explore the interview data rather than through a software programme.

3.8.2 Coding the Pilot Studies

The coding structure for the pilot study, which did inform the main study was initially based on five core themes which emerged from the existing knowledge generated from the literature review. These themes were: the importance of lessons learned, the monetary value, the influence of external factors, level of knowledge and change management.

As the interviews progressed five new themes emerged, which were linked to new sub-categories. To achieve this, the interview data was analysed on a line-by-line basis. These themes included: the role of strategic leadership and senior management commitment, data readiness, people and skills, process, and optimisation and finally the implementation of technology and integration. During the coding process themes were initially grouped under the above five categories, together with a global 'other' grouping. Each category was then revisited to identify sub-themes which emerged from individual statements or themes which linked strongly with others.

3.8.3 Coding Strategy for The Main Study

As with the pilot study, the main study was transcribed before being manually, thematically analysed. The starting point for this analysis was the emerging themes generated from the pilot

study together with the themes generated either from the existing literature or the preceding stage. These formed the original categories for the coding framework. Each interview transcript was analysed separately to identify specific themes. When new or additional themes emerged, then either a new code was created in an existing part of the structure or combined with an existing theme.

As the coding progressed for each stage, the original framework had numerous new additions, regroupings and refinement of themes and a considerable amount of cross-referencing before the final structure was reached. Although this was time-consuming, it was beneficial in providing familiarity with the data. While the final coding structure was eventually like the original themes generated in the pilot, the process was interesting and potentially useful, to ensure that all relevant material that emerged was captured accurately.

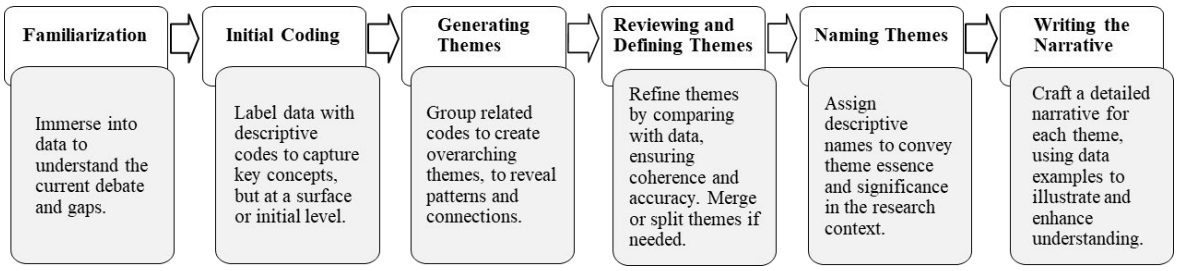

Figure 3-2. The Adopted Coding Strategy.

3.9 The Reliability and Authenticity of the study

Fundamental to the research is the need to ensure that the study is sufficiently robust. Careful consideration was given to the research design's robustness when investigating the individual's subjective perceptions of their experiences, rather than addressing a specific hypothesis. In ensuring that the data collection and analysis strategies were robust, the study's outcomes were triangulated. Triangulation is often associated with a mixed method approach of linking current academic debate, together with qualitative and quantitative findings. In this study the process involved the alignment of the current academic debate, together with the strategic and government policies in the UAE and the qualitative findings generated from the interviews. But the study also triangulated the outcomes of the current academic debate along with the three interview phases: the operational staff, the project management, and the senior leadership team.

Apart from triangulation, the study also followed Guba and Lincoln's (1994) four criteria were drawn on, namely, creditability, transferability, dependability (or bias) and confirmability, with the last criteria being trustworthiness.

Credibility

It refers to how believable or trustworthy the findings are. For research to have credibility, the researcher must represent the experience of those being interviewed so that they are understandable to the academic reader. This can be achieved through several strategies including reviewing of the interview data, also returning the narrative to the participant to check and verify the content. To assist with creditability, Guba, and Lincoln (1994) and Lincoln et al. (2011) advise researchers to ensure that the sample is authentic. In this study, all participants interviewed were associated to some extent to the oil and gas sector and have been involved in a digital transformational project using AI.

To enhance the credibility, the pilot study confirmed that the themes relating to their experiences and perception of AI and digitalisation could be explored with a purposive sample. Finally, Guba and Lincoln (1994) advocate the technique of labelling to enhance creditability, where the researcher should constantly return to specific themes and review the data.

Transferability

It enables future researchers to access the findings and use the approach adopted for later studies. However, according to Baxter and Eyles (1997), transferability is less important to the qualitative researcher than creditability.

Dependability

It is essential for qualitative research. The study should seek to provide evidence of trust in the research and the integrity of the content of the interview data. Dependability also relates to whether the findings are likely to apply to other occasions or events, and like creditability, also ensures future research can access the data for further analysis. In this study, the interviews were recorded, so that at any stage during the analysis the participant's actual words could be drawn upon and listened too again. While recording can be problematic, the process needed to be managed sensitively with the participant's consent being gained. This enabled the 'rich' content of the participant's account to be reviewed a number of times, so enhancing the dependability of the study.

Confirmability

It is the degree to which the findings are determined by the participants and not influenced by the researcher's own meaning or understanding. Researchers therefore need to give account of how their interests and motivations have affected their interpretations. Huberman (1995) considers that honesty, authenticity, and truthfulness is central to qualitative research. Honesty and truthfulness are vitally important ethical issues when presenting a genuine account of the participant's perspective. In this study, the participants were requested to review the transcripts, which assisted in the confirmability of the findings. However, although the opportunity was given, this was not requested.

3.10 Ethics

When conducting a research project with any individual always presents the researcher with important decisions and considerations. This section will set out and discuss the ethical issues surrounding this study. The research was conducted within the University's Principles and Procedures framework. This framework was informed by the British Educational Research Association (BERA) and the British Sociological Association (BSA).

The regulations set out the researcher's responsibilities including to ensure that the 'physical, social and psychological well-being of research participants should not be detrimentally affected by the research' (University of Gloucestershire Research Ethics Handbook, 2023), of the participant to provide and give freely informed consent. The researcher is required to inform the participants of the nature and aim(s) of the research, the reasons for undertaking the study and how the results will be presented. The participants' anonymity must be guaranteed, and they must be assured of the confidentiality of the data they will provide. This was achieved by naming the participants based on a perceived numbering system based on the phase, and without the use of any names.

The power relationship between the participant and the researcher was also considered, and the researcher ensured that no one from her team were interviewed or involved in the study. Throughout the interview process the power relationship between the researcher and interviewees was considered. This included informing those involved with an outline of the study, so that the participants were given greater power. The participants were also given the

right and the opportunity not to answer any questions during the interview (Brinkmann & Kvale, 2005). Few and Bell-Scott (2002) argued that during the interview process, the participant should be reminded about the nature of the study, the freedom to answer the question or to stop the interview completely. The above principles were followed throughout the study. Informed consent was obtained from all the participants, ensuring that they fully understood the nature and purpose of the research, the part they would play and what exactly they would be required to do. This was achieved by providing them with a written summary of the research purpose and structure and checking that they understood and agreed before their participation started.

Participant anonymity and confidentiality was maintained throughout the study. Assurances concerning anonymity and confidentiality were given in writing and were verbally repeated prior to the start of each interview. Anonymity was achieved using numbering the participants based on the stage or phase, and their roles, then included only minimal personal information linked to the individual to protect their identity. Permission to record and transcribe the interviews was sought on an individual basis. Finally, the recordings were managed with care and stored securely.

From the outset the interviewees were put at ease, so they felt they had control over the interview process. This included conducting the research in the place of work but in a neutral environment. Confidentiality was enhanced by requesting an interview room, so that privacy was maintained and there were no interruptions. Each participant was reminded of this right at the commencement of the interview. Participants' comfort was ensured regarding the interview environment, for example, room temperature was considered, and a glass of water provided if requested.

3.11 Methodological Limitations

Compared with a positivist approach, an interpretative methodology can create difficulties concerning ensuring that the data generated from the interviews were authentic and real. For reliability or realness, the requirement is that the research findings are repeatable (Willig, 2013; Gill & Johnson, 2010; Burr, 2003), but can only be achieved through the clarity and transparency of the research procedures, since the same outcome would not be achieved should the study be repeated again, due to different research participants holding different worldviews. For Hammersley (1990) there is an acknowledgement that to achieve reliability, can be problematic and almost impossible for qualitative research, as the study is based on individual's

perceptions and experiences within a specific time frame, therefore as the AI project is being implemented and then used, the perceptions of the individual will also change.

Another key limitation of this study was the fact this project was conducted by one individual who does not have full appreciation of all aspects of the organisation, such as at the executive level. This can be a potential limitation as the researcher may not be able to fully understand or appreciate the other person's professional experience or perceptions. To overcome this, the data from the interviews was continuously reviewed to contextualise and understand the participant's perspectives to ensure the reliability of the study.

Credibility and justification of the research depends on the identification and highlighting of clear gaps in perceptions between the participant and the researcher. To achieve creditability and to justify how the data is interpreted, the method used needs to ensure that attention to the participants' use of language is captured and understood accurately, as the interviews were conducted in English, and not in Arabic. This was achieved through again constantly reviewing and where appropriate, revisiting the literature, together with some of the participants being re-interviewed.

Finally, one of the challenges in qualitative research, particularly when using an interpretivist approach, is that the method produces an extensive amount of rich, interesting data to analyse. Separating out the data into themes can be challenging (Easterby-Smith et al., 2012). In this study, the challenge was addressed by constantly reviewing the transcripts.

3.12 Conclusion

This chapter has detailed the philosophical position of the study and the project's strategy and design. The chapter has provided an outline as to the processes involved in developing the research protocol, and how the results from a pilot study undertaken to evaluate the effectiveness and reliability of the research design were used to produce the detailed level of subjective information required on topics being researched. The research design was informed and followed the pilot study. The procedure to record, analyse and code the data was documented and brief details provided of issues identified by Guba and Lincoln (1994), namely, validity, reliability, conformability, and flexibility has been considered, addressed, and justified. An explanation of the study's findings before presenting the discussion and reflection and finally the conclusions were also presented.

Chapter Four - Findings and Analysis

4.1 Introduction

This chapter will present the findings related to the digitalisation of the UAE oil and gas sector through the introduction of AI from a business management scenario perspective. The findings will present the challenges and opportunities of how this digital solution was implemented and the experiences of operational, project management and senior management or the executive team as to the processes followed and what needs to be considered in the future. The chapter also includes how these technological solutions can potentially reduce up to 90% of employees time, providing around 10-30% costs savings and up to 100 to 1000 return on investment, through providing real-time information whereby enabling the operational teams to focus on critical activities. To achieve this, the chapter will present the findings based on the current academic debate, existing business practices and the findings generated from the interviews, to create a business transformational model to represent the outcomes of the project.

To create this conceptual model, there were five core themes which emerged from the literature review were used in the first phase of the study to interview the eleven participants who worked in the UAE's oil and gas sector as senior specialists in advanced reservoir and petroleum solutions and data science. The outcome of the interviews then enabled the creation of five new categories, which were then mapped against the original themes, then reviewed by four project managers, who then ranked the relevance of these outcomes to their project, which enabled the creation of this study's first contribution to business practice, before the findings were then re-presented to senior management or executive team. From these three phases and categories/ themes, six distinct headings or steps were combined with the existing and recognised business practices to produce the second contribution to the business practice, which will be presented in the next chapter.

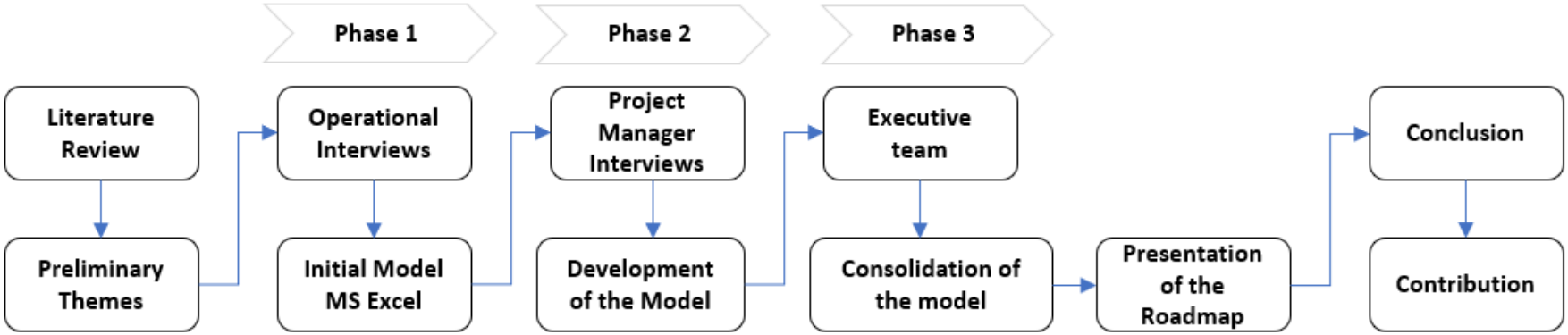

Figure 4-1. Research Framework

4.2 Phase One of the Study

The next section will commence with the five themes which emerged from the literature review, which were: the monetary value, external factors, level of acquired knowledge, and change management, but commencing with the importance of implementation of lessons learned. The section will draw on the findings of the eleven participants as to their experiences to contextualise the theme.

4.2.1 Phase 1: The Importance of Implementing Lessons Learned.

The first theme to emerge from professional practice and the current academic debate was related to the importance of lessons learned, which from a project management perspective is seen in this study as being a reflection on the events, challenges, and solutions which are used to inform future project activities based on the past. In interviewing the eleven participants as to their involvement in a recent AI project, there was a range of different perspectives as to their experiences which ranged from gathering new insights for the future, the close association with strategic leadership, the need and importance for the right skills and knowledge to exist, end-user involvement/participation, the importance of data readiness, and the added monetary value which AI can provide, but also how the project's output and the company datasets can be assessed. Although not extensively researched from oil and gas or a project management perspective, the focus of the first stage of the interviews included drawing on the theme of lessons learned. This inclusion was informed by the researcher's professional background and experience. In presenting the knowledge and background understanding of this concept, the study drew on the generalised project management methodology of Burke (2013), who provided ten phases to illustrate how a project is conceptualised, executed, and then implemented. In presenting this methodology, Burke (2013) does indicate the importance of learning from the past, through the lessons learned log, but interestingly located the concept as being a final activity as opposed to capturing it throughout the entire project.

For Participant 6, who worked in a specialist role as a data architect, the capturing of lessons learned was seen as critically important. As an example, project piloting could be used to identify the roles, responsibilities, and contribution of the end-user. These insights from an operational perspective were important to understand as to how the delivery team could accelerate the project delivery process.

> "…the pilot can lead to the commitment of the various stakeholders including end-users. The involvement of these users is needed from the project start as to their buy-in, for the roll-out to be effective, and then the adoption of the solution. With these users' involvement, the problems can be easily resolved, and AI solutions can be developed and ensure that quality, standards, planning, and the simplification of the outcome are reached, all of which although fundamental a part of the early stages of a project, which involve the lessons learned exercise being conducted, which any project depends on. You know learning from the past" (Participant 6).

Although the end-user's participation was seen as important, as highlighted by Participant 10 the lessons learned captured at the end of the project, were also essential to enforce the guidelines at the commencement of the next project. This was supported by Participant 5, the technology manager, who noted the importance of a pilot project using a small set of end-users, but also the need to learn as the testing stage commences:

> "…for me, a successful pilot can lead to the commitment by the company for financial and technical scaling, enabling me to recruit 5-10 end-users to be involved in the testing of a solution, but I also require the lessons of the past to be my reference point" (Participant 5).

This was also seen with Participant 11, who worked as a product manager and emphasized the importance of involving end users.

> "…I consider the involvement of end users from the project start as a means of buying into the work, for an effective rollout, and adoption. These end-users' input is vital in getting problems identified and resolved, as AI solutions tend to need higher data integrity and quality, which often needs the involvement of certain specialists. But also, there is the need to learn therefore drawing on past projects, particularly with AI solutions are essentials" (Participant 11).

From an AI perspective, the lessons learned, and example provided by Participant 4, who was an AI program manager and IT/data scientist, noted the importance of regular reviewing and adapting the existing processes. For this participant, he adopted a more of an agile approach which is associated with the activity called *retrospective*, but from a traditional project perspective is referred to as lessons learned. During the retrospective activity, Participant 4 recalled how the team reflected on what happened in the iteration stage, and then identified actions for improvement going forward.

> "…I am specific about regular reviewing of projects with my senior users, team and with any committees or boards. But to achieve this I prefer an agile approach to my projects and embrace the 'do more, fail fast' ethos, rather than a conventional waterfall of progress and sign-off, which can delay progress. This does not mean we are ignoring other project management methods, but we are instead adopting best practices from both approaches" (Participant 4).

However, Participant 9, who was also a data scientist, emphasized the need for this conventional traditional waterfall method of milestones and signoffs to still exist.

> "…I am totally in favour of following the conventional way of how to deliver a new project implemented with well-defined DevOps, MLOps, and DataOps processes and milestones so that the team knows what is happening. How can you learn if these approaches are less systematic or methodical?" (Participant 9).

This was partly supported by Participant 3, who was an AI program manager, whose approach was based on implementing AI based on learning from the past but also the need for clear direction and end-user involvement.

> "…for me, the importance is on diligence, clear objectives, stakeholder identification, and management along end-user buy-in" (Participant 3).

These perspectives offered an insight into the relevance of lessons learned related to the operational implementation of AI into the UAE's oil and gas sector, as to how learning about the problems and solutions, could be gained and simplified by using examples and experiences of the past. There was also the need for end-user and senior management involvement.

In summary, to emerge from the first phase of the study about the importance of implementation of lessons learned from previous projects was the theme of the need to ensure that the data readiness was created and set up accurately which could then be used to assist in the preparation, as the insights informed by previous projects by providing pre-tested and tried solutions. This is particularly important when considering the potential ramifications if the AI solution is not implemented correctly, which can include the high costs associated with rectification or the incorrect generation of datasets and decisions being made. The second observation was related to the necessity of having the correct knowledge base and skills needed. With the lessons learned and information drawn from previous projects, this could be identified earlier on in the project as to whether the team needed to have certain AI skill sets, which today are often specialised and in demand. The final theme was how the lessons learned can also inform the strategic direction of the project and how the leadership needs to get involved and to what extent, as the project methodology indicates how in the past projects have been managed, the resources used, and the AI solutions needed to be implemented.

4.2.2 Phase 1: The Monetary Value

The second theme to emerge from the literature review was related to the monetary value of the project which AI can provide. Many projects are judged on success according to the delivery of the criteria according to the agreed schedule, the standard of quality, and the cost, as measured by expenses and results (Zid, et al., 2020). The eleven participants were asked to reflect on their experiences of AI in project delivery and the monetary value of using this technological solution. The findings found a range of different perspectives, which Lu et al. (2019) noted was closely linked to the improvement for operational efficiency, which most of the interviewees agreed with and provided very different experiences, illustrations, and perspectives. For Lu et al. (2019), the main value added comes from the increase of productivity while decreasing expenses and enhancing end-

user satisfaction. Participant 1, who was a production and reservoir management and consultant/practice manager, AI and its usage was now the main enabler to generate value as it provided "…ability to achieve what the company wants to aspire to achieve". In the context of AI and its implementation in the oil and gas industries, Korotev and Tekic (2021) indicated that the technology could assist in making informed decisions in real-time which was supported by the technology strategy and portfolio manager, Participant 2, Participant 3 an AI program manager, and data scientist Participant 5. For Participant 2, it was noted that AI was a new tool for the company which could be used to:

> "…achieve production and profit objectives efficiently, enabling quick scenario creation, informed decision-making, and asset monitoring" (Participant 2).

With Participant 6, AI can provide more than informed decisions in real-time, and could be used to reduce or optimise costs, which agreed with Mihas (2019) thoughts on AI:

> "…produce and have data in a few seconds, whereby artificial intuition is the means to unlock and interpret information and find missing data to reduce cost through accurate models and modelling" (Participant 6).

As can be seen from the comments of Participant 6, as to AI and the emergence of artificial intuition, which represents how potentially artificial intelligence software will be able to function like a human consciousness, as being multifaceted, offering solutions for finding data and understanding information but also reducing the cost of generating these outcomes.

From a monetary perspective as to purchasing the hardware and associated software, and as noted by Koroteev and Tekic (2021) through their case studies, there was an associated cost of expenditure or investment, which needs to be recovered at some stage but can be hard to determine or assess when this return of investment is achieved. In explaining this paradox, Participant 5, the data scientist, stated that to store the value of the

company assets, which is often intelligence-based, "…the business needs to buy the correct hardware, which is future-proofed, then maintain a data centre, which is secure and has disaster recovery facilities" Participant 4, AI program manager IT/ data scientist, in expanding on this theme of procurement, stated that buying hardware for AI can be expensive "…so storing and maintaining data should be managed with the *cloud*".

Other participants like Participant 1 who was a production and reservoir consultant practice manager, noted the value generated while using of cloud technology solutions to handle the large amount of data that the sector generates:

> "For AI solutions to add value, they need massive processing power and data storage needed, and cloud technology provides both. I see the potential advantages of cloud technology, even though the technology is remote and here in the UAE there are certain regulations" (Participant 1).

This sentiment was shared with a data scientist, Participant 5, who developed algorithms and saw the benefits but also the potential challenges:

> "Cloud technology is an enabler of the value created by AI. Cloud servers can house large datasets and manage the increasing data we generate, and then process the computing- intensive algorithms. Added value is several orders of magnitude greater than the cloud cost. One concern is that some cloud architectures do not provide direct control to the company's IT organisation" (Participant 5).

For Participant 10, who worked as a petroleum engineer, the value and associated monetary cost were closely linked to the "…reduction in time and effort for the engineers and the timeframe needed to get assistance in remedial action if required by external bodies and specialists "… the time required to process information and make decision was reduced from 2 weeks to 1 day, which is a 90% reduction". This was shared by the product manager, Participant 9, who saw:

> "AI as being able to generate value as it can help in simplifying complex problems, save time minimizing errors and reducing the extra cost of a lot of the routine tasks that are done by humans".

The perspective of reducing engineers' intervention was identified by Wamba-Taguimdje et al. (2020) who stated that the value associated with AI could be achieved by a company if the technology is effectively implemented, resourced, and supported by senior management, but also used for its intended purpose, like in the area predictive maintenance, where the AI solution predicts its maintenance requirements. However, this perspective was challenged by the project managers along with Participants 3, 4 and 6, which will be covered later in this and the next section, as to the challenges associated with meeting the UAE's regulatory requirements while achieving the goals and aspirations set out in the country's AI Strategy for 2031.

Another perspective related to value was the associated measurement of AI based on the delivery of oil and gas projects, based on this technology's predictive ability. Participant 3, the AI program manager noted that high-value realisation is significant, and that "…the company should be able to measure value from the rollout in production". In contextualising this, Participant 3 mentioned the UAE's AI Strategy 2031, which is:

> "…focused on key sectors like energy, healthcare, etc., and of course including us here in the oil and gas sectors, with substantial investment in resources. Therefore, value creation is vital, along with adopting AI technologies for economic growth" (Participant 3).

By drawing on the UAE's AI Strategy for 2031, there was an acknowledgement of the importance of this technology in the future, and how the company was part of the UAE's drive for a technology-based economy. Beyond the commitment and alignment of the State's strategic commitment to AI, Participant 4 noted the operational importance of the need to have metrics established and agreed therefore value could be accurately and effectively measured in both business and scientific ways.

> "There is the constant need to monitor the various operational activities, but this does need to be accurate and increasingly more so in real-time. To achieve this, AI does provide real-time data, but also the means to draw on large data sets to tailor metrics which are needed and relevant for accurate decision-making" (Participant 4).

Finally, the interviews identified the importance of senior management to recognise, acknowledge and support the investment needed to provide an AI solution in the exploration of oil and gas in the UAE. In contextualising this, Participant 1, who was a production and reservoir management consultant, highlighted the need for senior leadership direction and support: "…without the support of senior leadership, change like with AI is not possible in the company" (Participant 1).

This was supported by Participant 2, a technology strategy portfolio manager who highlighted the importance of strategic leadership.

> "…For example, the typical incremental profit is in the range of 2-5% above its current business plan. In terms of costs, this could be in the range of 0.1 to 10 MM$ per application depending on the scope of the solution and this can't be achieved without management support" (Participant 2).

For these two interviewees from stage 1, the senior management team must formulate effective strategies to prepare the workforce for the changes which could emerge from the integration of AI, which is needed from the very beginning.
To emerge from the findings concerning the monetary value of AI, the interviewees identified that the value or expense needs to be acknowledged by the leadership and to be part of the strategic commitment to use this technology. This acknowledgement included the importance of investing in and then continually being committed to this technological solution. In general, the relative improvement for upstream is typical 2-3 orders of magnitude with respect to the investment required, this is a 100 to 1000 return over investment. Linked to this theme were also the skills and

knowledge needed to manage and maintain this solution, however as noted by Wamba-Taguimdje et al. (2020), AI potentially will be able to maintain and manage its maintenance in the future, being autonomous.

4.2.3 Phase 1: External Factors.

The next theme to emerge from the literature review was external factors or characteristics associated with AI. External factors include the need to meet stakeholder expectations while acknowledging that this form of technological solution is often provided and/or supported by external providers. External factors can also include the processes and procedures adopted by a business to implement an AI transformation solution, which if not managed correctly can be problematic (Al Dhaif et al., 2022). Although organisations can tolerate the influences of external factors, these are often out of the control of the business or project. It is possible to calculate potential risks and even mitigate events which could potentially impact the project. Part of this could be directly or indirectly related to the support and commitment of management and leadership encouraging the establishment of a proactive lessons-learned learning culture and strategy which is then incorporated into the AI solution to learn to predict and manage the events of the future, in conjunction with the business or project experts (Wamba-Taguimdje et al., 2020). In illustrating this, Participant 8, a business user noted that there were factors of influence not simply based on normal business activities, but also external challenges such as sustainability and environmental concerns, such as "…global warming and the potential climate problems" (Participant 8) but also how "…management and leadership commitment need to be environmentally friendly or focused, even in the oil and gas sector" (Participant 10, petroleum engineer). This was supported by Participant 7, an engineer and research experimental in research and development who noted that:

> "Sustainability and environmental protection solutions are increasingly important external factors which had now led to the emergence of an ethical dimension which AI solutions need to consider" (Participant 7).

This theme of AI and ethical behaviour is interesting as it includes the implications to job roles, how projects are delivered, the usage to predict potential oil and gas reserves through to the management and optimisation of operational activities, without potentially any real human intervention,

but also ensuring that the human environment is safe. In illustrating this, Participant 1, noted the importance of sustainability and the increasing shift to automation:

> "Externally, I think COP28, for example, has been a major influence on the focus on recent projects as to sustainability projects, like global warming. The conference looked at certain regulations that we had not considered before but may not have directly linked to the oil and gas industry but has made us look for more sustainability solutions and activities. I think to meet the COP28 initiatives will require more technological innovation, as AI and machine learning have the potential to provide a more sustainable solution" (Participant 1).

Participant 6, a specialist in data architecture also noted the need for leadership to be fully engaged and aware of potential external factors and noted the importance of the influence of the leadership, but from an IT Security perspective:

> "…I have noticed that IT Security needs to be seen as a priority. We have been talking about cloud technology, but this is externally provided, which needs risk assessment as to accessibility, reliability, and security. This can only be achieved through the support of senior leadership" (Participant 6).

Building on the view of Participant 6, Participant 2 a technical strategy and portfolio manager, highlighted the challenges associated with cyber security, by stating:

> "…one of the key roles of IT is making sure that the data secure but become more challenging as storage is now increasingly remotely provided by external providers, who are not under our direct control" (Participant 2).

This perspective of Participant 2 was also shared by Participant 4, then later by the project managers, who all highlighted the importance of cyber security standards of the UAE government and service providers to be compliant with the UAE Government cyber security laws and rules, which again needed leadership to manage this:

> "…company does follow the cyber security standards of UAE government and service providers are compliant to the UAE Government cyber security laws/rules, but some external providers may not follow those rules, which are a potential problem for us" (Participant 4).

Also, Participant 11, who is a business user, working as a reservoir and petroleum engineer emphasised the need for a cybersecurity policy.

> "…I was looking into clarity recently as to structured framework, agility, and self-generating apps, and emphasised the need for cybersecurity policy as we introduce more AI and digital transformational solutions into our business model. We need to be constantly updating these policies" (Participant 11).

An important part of AI as a tool is optimising oil and gas production, and as noted by Participant 6, the data architect, it is important the use cloud technology, either external or on-premises, which is outside the control of the company and its IT department.

> "…external factors are the cloud solution like Digital Company cloud which is outside of the company's IT domain does present us with a unique problem as the UAE government does not allow UAE data to exit the country. This has been challenging as we increasingly need to rely on more and more cloud storage solutions" (Participant 6).

In developing this theme of security, Participant 3, reported that external factors can include other threats such as malicious attacks, both from external but also internal domains, groups, or individuals, including the involvement of end-users from the beginning of the project:

> "…the implementation of robust security measures in terms of software is essential and this is the responsibility and aligned to the vision of top management, along with organisational goals. But you also need to consider external factors may also be internal, as people can be afraid that AI will replace them. Therefore, it is important to have the involvement of end users from the beginning, then have democratization of AI amongst the management, all of which can prevent or limit sabotage" (Participant 3).

For Participant 4, an IT/ data scientist; IT security is needed for "…visible support by top leadership", while Participant 5 another data scientist supported this perspective by highlighting the need for senior management engagement:

> "…there is a need for visible support from the top leadership. Senior management should create the environment for AI, for example, investing in the right infrastructure, facilitating data sharing, acquiring the right competencies and experience, and putting in place dedicated resources and external parties to help the business deliver on the AI solutions" (Participant 5).

Participant 2 again referred to the importance of IT security and the need to ensure that the data was confidential:

> "…I would say senior management need to not only be committed to deploy AI solution, but also to make sure the infrastructure and security and confidentiality of data needed are available" (Participant 2).

Finally, for Participant 2, a technology strategy and portfolio manager, the focus was on the mitigation or limiting the influence of external factors and how important it is to regulate data.

In summary, as to the external factors, the interviews revealed a connection to issues such as security threats, which can come from an external entity, but also internally. There was also the need to ensure that the technological solution was both sustainable and environmentally aware in its activities and outcomes/ solutions, as well as being secure. The findings further identified the technological solution needed to be able to meet the various UAE governmental regulations and requirements, including the use of cloud enabled solutions. In meeting this external requirement, the interviews revealed the importance of the role of senior management and their involvement.

4.2.4 Phase 1: Level of knowledge.

The literature review highlighted the importance of the organisation's level of knowledge of AI in implementing this technology in the oil and gas production environment. This became the focus of the interviews for the third theme. Unlike the previous theme described above theme lesson learned, Participants 1, 7, 8, 9, and 10 did not provide any real insight, as they were more interested in the monetary value of AI, external factors, and the last theme, change management.

Drawing on the current debate, of knowledge needed for the successful implementation of AI in a business transformation environment including in the oil and gas sector, Sharifee et al. (2019) noted the large amount of specialism knowledge and skills needed particularly in geoscience and engineering. With geoscience and engineering the AI workflows tend to generate a significant amount of data, which needs to be analysed. Participant 3, one of the AI program managers, and IT/data scientist emphasised the need to have an adequate information technology infrastructure in place, but also for the operational team to have the correct knowledge base or understanding to interpret the data.

Participant 3, one of the AI program managers and IT/data scientists emphasized the need for the end user's mindset to have the basic infrastructure and the correct knowledge base.

A large amount of specialized geoscience and engineering knowledge is needed for successful business transformation in the oil and gas sector (Sharifee et al., 2019). These niche AI workflows tend to generate a significant amount of data, which needs to be analysed. Participant 3, one of the AI program managers, and IT/data scientist emphasised the need to know the infrastructure requirement as well as the end user's mindset.

> "The basics are the development and then implementation of processes through to the training of how to use the generated models, the means to manage expectations. By having enhanced AI software there is also the need to educate the mindset of the end users to understand what the information means as the datasets and modelling can be complex" (Participant 3).

Building on the perspective of Participant 3, and Participant 4 highlighted the importance of knowledge of the AI information being generated even at the operational level of the organisation, and emphasised that:

> "The users need to understand new technologies and the way that AI can change the way the data is processed and interpreted. Even down to the recognition and awareness that different scenarios are constantly updating, and this will change the performance and outcomes of operational activity" (Participant 4).

For Lu et al. (2019) there was an emphasis on performance delivery by noting the necessity to fully understand the usage of AI-generated outcomes and scenarios. For this to occur there must be a deep and informed knowledge base which is cascaded and supported throughout the organisation, from senior management to the operational oil and gas personnel. This was captured by Participant 5, who stated that there was a minimum knowledge for any engineer in the oil and gas industry as to understanding AI:

> "Even an engineer must have a minimum knowledge of data science and understand the way the data can be used to improve performance and efficiency" (Participant 5).

However, Participant 6, who worked as a data specialist also noted that the company did not have data scientists who possessed this knowledge which could be problematic. This was supported by Participant 11, who was a senior specialist in the cognitive reservoir. For Participant 11, the level of knowledge as a theme was influential as to "…shaping of the project needed AI expertise, and therefore the basic understanding of AI was

a necessity therefore for data scientists to understand this technology" (Participant 11). With Participant 6, a knowledge base needed to exist throughout the different levels of the organisation and sector:

> "The workforce needs to have good knowledge of the new technology, including some awareness of digital transformation, machine learning, and of course a good background in the oil and gas industry" (Participant 6).

This was also supported by Participant 3 who stated that the level of knowledge needed to include a mix of expertise and be aware of areas outside their specialism.

> "The AI solution provider team must be combined and integrated within the business structure, the data scientists, the data management team, together with the IT specialists, so that a general awareness of AI and the data implications for the oil and gas sector can be shared" (Participant 3).

To achieve the required level of knowledge, the combination of engineering and data science is essential. For Participant 5, there was a need to have suitable and robust training.

> "It is about the availability of a solid training process to bring the level of AI knowledge throughout the entire operational environment" (Participant 5).

With this importance of having the correct level of knowledge, Participant 3, also noted the importance of the "…association with competencies" and "…an adequate understanding of the usage of AI in the company" (Participant 3), whilst Participant 2 saw the awareness of functionality and suitable support was essential:

> "Requirements included an awareness that AI in an oil and gas project can impose a different approach on the exploratory activities and functions but need to have adequate support in place from the outset" (Participant 2).

Although not focused directly on the skills needed, Participant 5 provided another insight from a recruitment perspective.

> "Nowadays, job descriptions need to change or reflect the new recruitment processes and the demand for AI skills. An innovative mindset is now an important characteristic, and this attribute needs to be encouraged throughout the organisation" (Participant 5).

Participant 2, who worked as a technology strategy and portfolio manager then added about the importance of training.

> "The required level of knowledge of AI should be available throughout the company therefore there is a need to have adequate training and an awareness about the usage of AI in the organisation particularly as to oil and gas exploration" (Participant 2).

From these perspectives, there is clear evidence that possessing the correct level of knowledge and awareness is important, which includes the complexities of the software, machine learning, and data interpretation. However, underlying this is the need to have senior management and leadership commitment around people and skills.

4.2.5 Phase 1: Change Management.

The final theme to emerge from the literature review was change management, which is a fundamental attribute of project management. In this context, Burke (2013), using the ITIL methodology, contended that change management needs to be closely linked to the business strategy for commercial and operational sustainability. Pishgar et al. (2021) and Li et al. (2021) referred to this as being the inclusion of knowledge to ensure

that any changes which digital technology can bring in the digitisation to business operations are made known to all those who need to know. For Lu et al. (2019) the emphasis is based on the need to concentrate on the increase of productivity while decreasing expenses and enhancing end-user satisfaction. The interviews revealed that the concept of change management was not fully understood, particularly its implementation in this company's oil and gas exploration. Only Participant 2, Participant 5, Participant 6, Participant 9, and Participant 11 had some critical insight into change management. For Participant 2, change management and the implementation of AI and its impact on oil and gas exploration needed to have the support of senior management, which was a common comment in the other themes.

> "Without the support of senior leadership, change is not possible in the company, particularly with AI as this is a major change in the organisation and processes and procedures followed" (Participant 2).

For Participant 11, the change apart from the role and importance of senior management and leadership was the impact of AI on the workforce itself.

> "Switching people to use AI and the change it brings needs to be acknowledged. Often there is a need to have AI attainment certification, to solve problems, as the quality and quantity of the data is complex and needs to be correctly interpreted" (Participant 11).

From a theoretical perspective, Wamba-Taguimdje et al. (2020) noted the relevance, significance, and importance of real-time data which AI has introduced, which Participant 6 saw as being absent in the company's original initiatives of adopting this technological strategy. Part of the reason was associated to the fact that existing or 'brown field' sites are not computerised while new or 'green field' tend to be AI automated. This absence was illustrated by Participant 9 who recalled how eight groups were originally involved in the implementation of the AI and digital transformation project, however lacked the specialist skills, due to the project being an existing site:

> "With any existing site, there was a lack of a real-time data model being created from the beginning, which was a part of the data engineering role but was missing. This meant that the AI implementation was significantly delayed" (Participant 6).

As noted above, and recalled by Participant 9, was the occasion when the change management process was delayed by the lack of expertise, which was compounded by the type of site being explored:

> "…the lack of expertise procrastinated the entire strategy for change management as the protocol needed to pass through several approval procedures or steps, which then slowed down the entire process. This was due to the exploration of an existing brown field site" (Participant 9).

To explain how Participant 6 and Participant 9 observation occurred, it was Participant 11, the senior specialist and cognitive reservoir manager who independently noted again the importance of senior leadership:

> "Executive sponsorship and support for initiating change management in the company is essential otherwise the processes of change will be ineffective, but with informed AI leadership this can be addressed" (Participant 11).

These examples related to change management indicated the difficulty for the oil and gas sector of the UAE when implementing an AI solution. There was a hindrance created by the concerns of lack of real-time data modelling, certification and knowledge of AI technology, and a perceived lack of support from the senior leadership.

4.2.6 Summary of the First Phase Themes.

The themes from Phase I of the interviews were originally informed by the literature review, the interviews were based on the importance of implementation of lessons learned monetary value, external factors, level of acquired knowledge, and change management. From the context of the importance of implementation of lessons learned, there was a need to have data readiness, so that the AI information is cleaned and free of any errors or duplicates, so enabling accurate interpretation of the results so that effective decisions can be made. But also, the importance of implementing lessons learned is related to having the correct personnel who understand and have the correct knowledge base and skills. To achieve this, there is a need to have leadership and executive management commitment and support. This also includes the need for end-user engagement and acceptance from the commencement of the project.

The interviews revealed from the theme of monetary value the need to fully understand what AI can generate in terms of benefits which includes efficiencies but also from an investment perspective, like return on investment (ROI). Again, the participants also noted the importance of senior leadership support.

The interviews revealed that the external factors included the need to have technological solutions implemented and invested in, and this included the usage and dependence of cloud technology. The use of cloud technology could potentially present the challenge if not effectively managed. These external factors include security issues which have been identified such as malicious activities from unknown sources. While ensuring that the technological solution meets the UAE governmental regulations and rules. It must be ensured the guidance around cloud certification need to be gained by the providers whereby assuring that the infrastructure is located within the country.

On a similar theme associated with AI, the interviews also revealed the potential challenge of 'employees feeling threatened that their roles will be replaced by AI.' The findings also indicated the importance of the team possessing the correct level of knowledge throughout the organisation, together with an awareness of senior management and leadership support.

Finally, the findings indicated a lack of change management knowledge could hinders the ability to transform business successfully. To illustrate these new themes and the connection to the existing literature, **Table 4-1** maps out the findings.

This mapping exercise of emerging themes generated five new categories, which were then inputted into MS Excel, together with a description of the meaning of each category. These themes were: strategic leadership and senior management commitment, data readiness and usage, people and skills, process and optimisation, and the implementation of technology and integration.

Table 4-1. Phase 1 to Phase 2 Themes Mapping activity

Themes Generated from Phase One	**Themes Generated from Phase Two**
Implementation of lessons learned	Data Readiness and Usage, People and skills, Strategic leadership, and senior management commitment
Monetary value	Strategic leadership and senior management commitment
External Factor	Implementation of technology and integration
Level of Knowledge	People and skills, Strategic leadership, and senior management commitment
Change Management	Implementation of technology and integration

4.3 Phase Two

The themes were then inputted into MS Excel, with the project managers asked to rank them in order of importance, 1 being the lowest and 5 being the highest. Amongst the four project managers, there was a lack of consensus or agreement, with some of the themes not being seen as important when applied to their recent projects or being seen as problematic and therefore ranked lower. Then as the project ended the same project managers were asked to reflect on the outcome of their project and how the AI solution had transformed the workplace. The participants were also asked to provide input on what still needed to be addressed or reviewed. The outcome of base line, AI project contribution and the remaining gap is presented below in

Figure 4-2. Initial perception and baseline (Light blue), AI contribution to working practices (Dark blue), and Gap and future (red).

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The next section will present the findings related to the second phase of the study. A summary of the findings is shown below in **Table 4-2**, **Table 4-3**, **Table 4-4** and **Table 4-5**.

With Project Manager 1, as shown in **Table 4-2** data readiness was seen as the most important aspect, as it enabled the AI business modelling to be achieved. In achieving this, the project manager noted that optimisation and processes could be automated by using the correct technology. Interestingly, the role of strategic management was seen as less important, but the summary of the project manager's perspective provided a critical insight into the lack of senior management support. This perspective of Project Manager 1 was challenged by Project Manager 2 (**Table 4-3**), who saw senior management as the most important theme. The least important were people and skills, but there was an acknowledgement of the importance of collaboration. As to technology, Project Manager 2 noted the need for some form of KPIs or metrics to be able to monitor and assess performance.

For Project Manager 3, like Project Manager 2, as presented in **Table 4-4**, strategic leadership was essential, and was then linked to the importance of having tangible benefits and the ability to track value. Processes and optimisation were considered the least important themes, as there was no or limited collaboration, which led to the various activities being conducted in isolation. At the same time, people and skills were rated as 3, indicating the importance of expertise and specialism being shared. Finally, for Project Manager 4 (**Table 4-5**), like Project Manager 1, data readiness was rated first, but also recognition that data cleansing was problematic. The project manager also recognized the importance of processes and optimisation as being essential to be embedded into business processes.

For Project Manager 3 (**Table 4-4**), like Project Manager 2 (**Table 4-3**), strategic leadership was important and was then linked to the importance of having tangible benefits and the ability to track value. Processes and optimisation were seen as being the least important theme, as there was no or limited collaboration which led to the various activities being conducted in isolation. At the same time, people and skills were rated as 3, indicating the importance of the expertise and specialism being shared. Finally, for Project Manager 4 (**Table 4-5**) also below, like Project Manager 1, data readiness was rated first, but also the recognition that data cleansing was problematic. The project manager also recognised the importance of processes and optimisation as being essential to be embedded into the business processes.

Table 4-2. Outcome of Project Manager 1		
Theme	**Priority**	**Summary of the project manager's perspective**
Strategic leadership and senior management commitment	1	Leadership and top management tend not to support business model transformation, and there is a lack of consistency.
Data readiness and usage	5	High data availability and quality need to be achieved through continuous improvement processes, with the data being used for continuous improvement when applied to the AI business modelling.
People and skills	3	The new AI solution simplifies previous complex processes and therefore assists the teams, but needs full informed involvement, to avoid confusion.
Process and optimisation	2	There is increasing simplification of business processes and enhanced user knowledge of what used to be very complicated. At the same time, the outcomes should not be compromised.
Implementation of technology and integration	4	New real-time data can be provided automatically and in real-time.

Table 4-3. Outcome of Project Manager 2		
Theme	**Priority**	**Summary of the project manager's perspective**

Strategic leadership and senior management commitment	5	Leadership and top management need to reward behaviour and results which are aligned with the overall long-term strategy.
Data readiness and usage	2	Data needs to be readily available and of good quality without any inconsistencies.
People and skills	1	Users and managers are not engaged during the solution-building process. Users and managers tend to be detractors of AI solutions and processes. There is a need for users to be involved with collaboration responsibilities.
Process and optimisation	4	There is a need for permanent collaborative workflows and an innovation environment to be set up and designed to improve business performance monitoring.
Implementation of technology and integration	3	Technology needs to be adaptable and linked to the existing processes and various resources, such as sensors and WCT meters.

Table 4-4. Outcome of Project Manager 3

Theme	**Priority**	**Summary of the Project manager's Perspective**
Strategic leadership and senior management commitment	5	Key project owners need to be able to justify tangible (real) benefits including value tracking linked to finance and organisational outcomes
Data readiness and usage	4	Data gaps need to be constantly monitored through acquiring new data, for example paying for third-

Table 4-4. Outcome of Project Manager 3		
Theme	**Priority**	**Summary of the Project manager's Perspective**
		party resources, installing new hardware, or establishing internal data governance processes to transform the existing business.
People and skills	3	Users and managers need to be engaged at every stage of the design and solution. Users and manager support need to embrace the solutions and then understand the results generated by the AI tools.
Process and optimisation	1	There is ad-hoc or no collaboration. Users perform workflows and run models in silos with individuals not sharing knowledge. Analysis results need to be disseminated accurately to users.
Implementation of technology and integration	2	Automatic regulatory control of targets needs to be set up correctly.

Table 4-5. Outcome of Project Manager 4		
Theme	**Priority**	**Summary of the project manager's perspective**
Strategic leadership and senior management commitment	4	There is a need for good communication and awareness across all stakeholders from a strategic perspective.
Data readiness and usage	1	Currently, data is poorly available, and quality is questionable for production optimisation. Poor data status limits the type of workflows which can be used

Table 4-5. Outcome of Project Manager 4		
Theme	**Priority**	**Summary of the project manager's perspective**
		to implement a business model transformation strategy.
People and skills	3	There is a need for cohesive team activities with different expertise. Individual skills need to complement continuous development.
Process and Optimisation	2	New ways of working need to be embedded in the business processes, but this is not fully understood.
Implementation of technology and integration	5	AI could provide new insights which can help innovate and develop new business models and processes.

As mentioned above, the project managers checklist, which was presented in MS Excel, required the participants to rank their perceived importance as to the five themes, which is shown below, which focused on the readiness of the data, the people in the organisation possessing the necessary skills and knowledge, the processes and need for integration strategies required for deploying AI, and finally the strategy and need for leadership. As can be seen below, the ranking and outcomes were represented in three colours. These outcomes were based on their perceived importance, with the project managers asked to reflect on the commencement of the project, which acted as a baseline, then how the AI changed the working practice, which was represented in dark blue, and the perceived gaps that still need to be addressed so that AI can be effectively implemented in the future, denoted in red. The light blue column was the perceived initial perception or baseline as AI was initially deployed. As can be seen, there were differences in perception, but also the graphic indicates potential perceptual gaps which need to be addressed but were contextualised during the interviews.

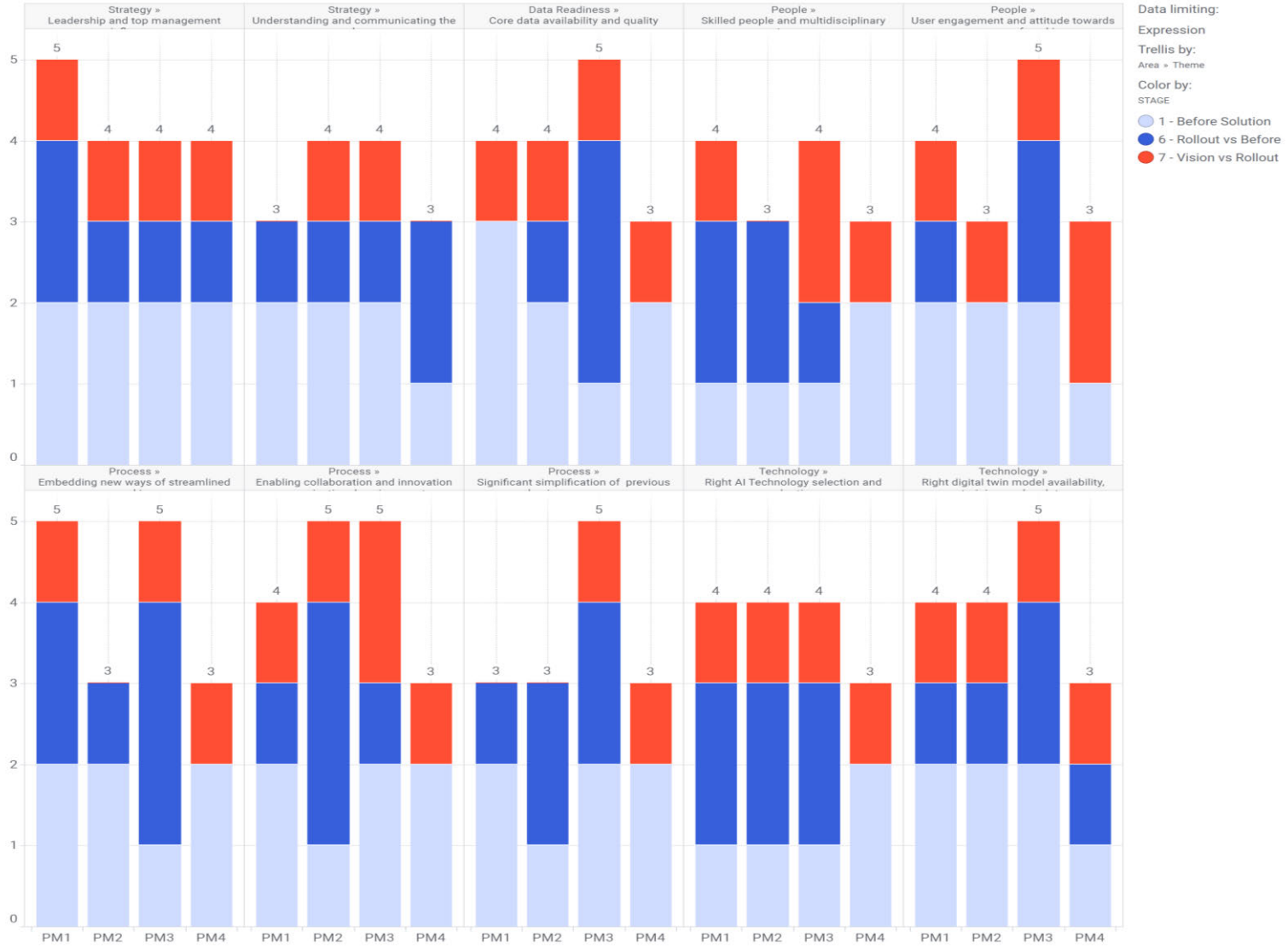

Figure 4-2. Initial perception and baseline (Light blue), AI contribution to working practices (Dark blue), and Gap and future (red).

In contextualising the key insights of Figure 4-2 above, the key findings of the MS Excel activity which was completed by the project managers, indicated that around the theme of *data readiness* and core availability and quality, that there was a range of views, which ranged from two project managers rating the initial perception and baseline associated with the operational activity as being acceptable, with no perceived AI contributed benefit to the working practices while there was a potential gap for future activities which needed to be addressed. In contrast there were two other project managers who highlighted the contribution of AI, with one of these interviewees seeing AI has having a considerable significance. This category indicated that the individualised projects were uniquely beneficial and challenging. The next category of interest was the *people* group, which was associated with user engagement and attitudes towards AI. The project managers also provided an inconsistent picture. Three of the four project managers indicated an acknowledgement that working practices before AI being implemented was acceptable, however, as to future gaps, one interviewee indicated there were a significant challenge which still needed to be addressed, while one project manager indicated that the AI solution did not change the working practices, with another interviewee highlighting the potential benefits.

In the lower section of Figure 4-2, the next category was associated with enabling collaboration and innovation, with the MS Excel activity indicating a discrepancy of opinions under the heading of *processes*. These differences ranged from a project manager who rated AI providing a significant benefit, but also indicated that there was a potentially significant future gap, while another interviewee saw AI as to providing a unique contribution but also presented a future challenge, indicating the paradox of this technology. The last grouping of interest was related to *technology* and AI being the right digital model. The findings showed again the inconsistency of the project managers viewpoints with all the interviewees indicating that there were future challenges, but the AI contribution ranged from being equally beneficial to the existing environment, with one indicating the significant benefits.

4.3.1 Phase 2: Strategic leadership and senior management commitment.

As noted by Stranrzali et al. (2019), Ng (2018), and Koroteev and Tekic (2021), the implementation of AI in the oil and gas sector in the UAE has encountered a range of challenges, which was confirmed by the outcome of the interviews. The following was identified from the spreadsheet all the participant project managers agreed that leadership and

senior management commitment was vital in the implementation of AI in the oil and gas exploration. Following the ranking process, three of the project managers saw the right technology selection and adoption as being essential, while the correct selection of staff and skills was seen interestingly as being not in total agreement, however, the correct digital model or solution and its availability, training and being up to date were seen as important by all the project managers.

Following the ranking process, the interviews identified and contextualised the themes in the spreadsheet. To emerge from the interviews was interestingly the importance but also recognition of the role of the senior management team:

> "…the lack of consistent support and vision from leadership and top management can impact negatively on the project" (Project Manager 3).

In explaining this, Project Manager 3 stated that instead of embracing business model transformation while using AI there was a disconnection.

> "…many leaders have favoured maintaining the status quo, resulting in a lack of clear value propositions and effective communication with stakeholders" (Project Manager 3).

Project Manager 3 then noted that there was a:

> "Disagreement among top management in the early stages, which further hindered progress, preventing AI from being recognized as a tool for driving sustainability and transformation" (Project Manager 3).

For Project Manager 2, while there were sporadic attempts by some leadership and management to advocate for AI-driven transformation to happen, there was initially a lack of a joined-up leadership approach:

> "…efforts lacked cohesion and were not underpinned by a unified vision or strategy. This is despite acquiring certain capabilities, such as talent and AI technology" (Project Manager 2).

This theme of the need to acquire certain capabilities and skills was originally identified by Haroon et al. (2018) who noted that essential resources remain missing, which can impede the project or the digital solution. For Project Manager 2, there was also "…the absence of an agreed-upon AI strategy which prevented the alignment of efforts towards business model transformation" (Project Manager 2).

In providing examples as to what happened, Project Manager 2, illustrated their perspective with the introduction of a new AI business model, which was designed to improve existing work.

> "…value proposition, though its communication to stakeholders was proved to be too convoluted, which led to the evolution that was disruptive, leading to a loss of momentum" (Project Manager 2).

The intended solution, along with a clear message of management's commitment, can be achieved with the support of senior leadership. This need for support of senior leadership was supported by Lu et al. (2019) as an essential aspect of introducing and using AI, as it can "…foster and promote an environment of innovation" (Project Manager 2).

The role of senior leadership and management in implementing AI was also seen as essential for Project Manager 1, who noted that AI technology can provide the means to:

> "…create value and ensure the company's viability in the energy transition from the conventional methods to an AI technological solution" (Project Manager 1).

To achieve this, Project Manager 1 highlighted that the strategy needed to be accompanied "by periodic messages from leadership highlighting AI's importance and a clear digitisation and AI strategy" (Project Manager 1), which showed the need for leadership commitment which is firmly committed to the concept and usage of AI. This was also recognised by Project Manager 2, who mentioned the importance of "…leadership positively rewarding behaviours and results aligned with the AI-driven strategy" (Project Manager 2).

4.3.2 Phase 2: Data Readiness and Usage

The implementation of AI in the oil and gas sector of the UAE for project managers was facing significant challenges regarding data availability and quality, particularly in the key domain of production optimisation. The keywords 'production optimisation' 'data availability' and 'quality' were common among the four project managers. In explaining this, Project Manager 1 noted that these characteristics were influenced directly by the quality of data:

> "It is often the scarcity and questionable quality of data which presents one of the main obstacles in driving business model transformation and then in terms of generating effective workflows" (Project Manager 1).

This view of Project Manager 1 was supported by Project Manager 3, who recalled the challenge of insufficient or inaccurate data:

> "The disrupted data pipeline from wellsite to desktop can be hindered by the lack of support often due to insufficient data for the AI modelling to occur. While some data exists of reasonable quality, its inconsistency and limitations have led to the implementation of only a subset of an AI workflow, but the main issue stems from incomplete and low-quality data" (Project Manager 3).

This theme of data availability by Project Managers and the associated quality was seen as being pivotal for a successful AI initiative transformation. If the data is of a good quality which is free of any duplicates or errors and then being made available:

> "…more AI workflows become feasible to enact an effective transformative process, which permits new workflows to be introduced, but can only be initiated with the continuous improvement in data quality" (Project Manager 1).

To achieve this, both Project Manager 1 and Project Manager 3, agreed that the operation needed to have "…dedicated sufficient resources to rectifying data gaps" (Project Manager 1), and even consider out-sourcing new data through a "third-party involvement or internal data governance processes" (Project Manager 3).

4.3.3 Phase 2: People and Skills

Moving onto the third theme related to the integration of AI within the UAE oil and gas sector, which emerged throughout phase 1. For the project managers, there were challenges associated with the collaboration among key stakeholders including skilled individuals, like IT specialists, data management, and those in the AI discipline. The project managers mentioned examples of how working in siloes can happen, where stakeholders rarely convene to define requirements or validate AI model outputs can lead to delays and implementation problems. To address this, there was a need to identify expertise gaps, especially amongst specialisms such as geology, reservoir, and production engineering, where there is often a lack of digital and AI skills. To illustrate this experience, Project Manager 1 noted that the AI skills were now essential, "…. individual AI skills are acknowledged as being paramount" (Project Manager 1), however the issue of availability of these skill sets, "…they are not always accessible or adequate for the demands at hand" (Project Manager 1).

To address this potential shortfall of skills, Project Manager 3, stated that it is important for full engagement amongst both the users of the technology and the implementors/ managers, therefore the AI project can be successfully implemented by "… offering full rather than partial support to provide solutions, and address and limit the potential of new processes being rejected or not working due to misunderstanding or the inability to implement the project" (Project Manager 3). In reaching this conclusion Project Manager 3 mentioned the importance of change management, as "…an effective change management plan in place, can highlight any lack of consistency and clarity" (Project Manager 1).

A key theme emerging from the interviews was the importance of seamless cooperation between participants. To emerge from the interviews was also the importance of seamless cooperation between the project management team, IT, data management, and AI experts, as can be seen with the comment of Project Management 2, who noted the importance of people skills:

> "…the possession of effective people skills which can enable a comprehensive validation of AI model outputs" (Project Manager 2).

Project Manager 2 then expanded on this theme, and added that while individual skills were recognized as essential there was also the recognition of the involvement of external expertise, and the need for:

> "…users and managers to be involved from design to implementation, …. leading to more robust support and understanding of the tools needed and the outcomes sought" (Project Manager 2).

Part of the issue with the resourcing of an AI project is the need for innovation through collaborative teamwork. Through teamwork "…novel concepts can emerge which may need to be refined through prototyping and piloting" (Project Manager 2). With the correct expertise, there is the possibility of "…continuous development but it needs geologists, reservoir engineers, and digital and AI experts which are either in-house or external, but these individuals need to maintain up-to-date capabilities and skills" (Project Manager 2).

4.3.4 Phase 2: Optimisation of Processes and Integration

The project managers also identified other challenges associated with the implementation of efficient and integrated AI solutions in the UAE's oil and gas sector. The project managers perspectives were initially based on the need for a focused, clear, and simple solution, which could be in the form of a "…. iteration of an AI solution, but could fail if not simplified" (Project Manager 2), particularly as to the enhancement of processes, which was recalled by Project Manager 2, as to the importance of following a robust project management methodology:

> "…plagued by a poor user interface and usability issues. Then the absence of a solid digital project management understanding and a dedicated project manager, who can address any shortcomings, can lead to ad-hoc collaboration and isolated user workflows occurring, and potentially lead to the project being unsuccess. Sometimes if this occurs the outcome could be the wrong dissemination of a solution analysis result which can be hazardous resulting in new processes which could lead to the failure in AI workflows" (Project Manager 2).

To address this, Project Manager 1 noted that "…the AI solution needs to evolve with a streamline of existing business processes but can be impeded by the practice of underestimating the process by confusing interfaces" (Project Manager 1). This confusion of interfaces can be seen with the research of Pargaonkar (2023) who highlighted the need for software

transformation to be designed, developed, and then implemented in an operational environment correctly.

Project Manager 4 noted that there was "… limited collaboration and the role of dedicated project managers was needed to improve the implementation process, such as addressing the challenges which could persist when embedding new workflows and processes into the business model" (Project Manager 4).

The outcome for the project managers as to the optimisation of processes and integration was that the AI solution needed from the beginning to have certain levels of simplicity being introduced, which can lead to the "…reduction of human effort and cost by over 60%" (Project Manager 1), which has led to the monitoring and assessing through the introduction of "…various KPIs, value tracking, and governance committees, which now guide the ways of working, ensuring continuous improvement" (Project Manager 2).

From these findings, it is possible to surmise that AI implementation is characterized by a reduction in human effort and cost. Where AI solutions in workflows are aligned to business process automation to ensure the participation of necessary decision-makers is made.

4.3.5 Phase 2: Implementation of technology and integration

The introduction of AI within the UAE's oil and gas sector has encountered many challenges as identified by the project managers. These project managers identified the lack of available process models which could be used to align with the required business processes. However, in explaining this, Project Manager 1 noted that the AI models can "suffer from inadequate training or unreliability due to inexperience, compounded by the absence of real-time and model updates" (Project Manager 1).

For Project Manager 3, the challenge was more related to the selection of AI algorithms, which were currently "…not adequately supported for the ongoing business model transformation requirements", and that the "AI models remained unused for production optimisation" (Project Manager 3).

But there was also a reluctance to adopt new AI technologies which was partly due to a lack of a technology adoption cycle, but as improvements were made, and selection of AI algorithms became better understood, these project managers saw the future benefits. For Project Manager

3, the AI model can provide a production optimisation to the existing oil and gas exploration methodology.

> "…misuse or incorrect use of AI tools can prolong the technology adoption cycle, and ultimately the implementation strategy" (Project Manager 3).

To provide more contexts from a project management perspective, the project managers noted that the sector has begun to measure flow rates from reservoirs and wells, facilitating allocation through sporadic test separators or surface flow meters, which can only be achieved with the usage and implementation of AI. While manual setting of target operating and reporting measurements are still used, some automatic control brought in by AI has been established and is now seen as essential, as remote parameter adjustments cannot be feasibly achieved manually. In explaining this, Project Manager 1 noted that:

> "AI algorithms and data platforms are now integrated, which is effectively now achieved through the business model transformation, as machine learning models can now successfully contribute to production optimisation" (Project Manager 1).

This adoption of new and increasingly crucial AI technologies was beginning "to occur seamlessly" (Project Manager 1). For Project Manager 3, AI has enabled the introduction of:

> "…continuous wellhead pressure and temperature measurements, alongside irregular applications of downhole temperature and pressure sensors and water-cut off system meters" (Project Manager 3).

As AI models can now provide an accurate representation of the data through the usage of deep learning processes, means that there can be an enhancement of production optimisation in the oil and gas sector. This can include the "…extensive and continuous measurements at the wellhead and the downhole, providing a thorough analysis and interpretation of the data in real-time and the generation of comprehensive data outputs" (Project Manager 2), which Project Manager 2, has been achieved through the "evolution of AI infrastructure and the associated modelling, which can stimulate innovation and create new business models and ultimately increase the productivity and efficiency" (Project Manager 2).

Finally, the study found that the integration of AI-related advanced measurements can assist in the "…monitoring, maintenance and prediction of pressure flow and the temperature per zone, alongside managing permanent downhole flow allocation and the saturation metering of production at each site and zone" (Project Manager 1). This was confirmed by Sami and Ibrahim (2021) who noted the automated approach which can calculate new setpoint parameters, along with monitoring longer-term integrated optimisation needs. These findings indicate the transformative potential of AI within the oil and gas sector, and how this technology has changed the sector in the UAE.

A theme that emerged from the interviews was related to meeting the cyber security standards of the UAE Government and being compliant with the laws/rules governing cyber security. This included the usage of cloud storage facilities and where the data is physically located. For Participants 2, 4 and 6, this was an important consideration, as the technology and storage needed was on cloud technology beyond the confines of the UAE. Interestingly, this theme of remote storage and cloud technology has been extensively researched (Yamakawa et al., 2012; Lu et al. 2019; Lawan et al., 2020), but these studies have neglected the relevance to this sector and location. In addressing this theme, the project managers acknowledged the challenges associated with regulatory compliance and the UAE Strategic Vision but also noted that there had been compromises made:

> "We need to be pragmatic. If the resources whether that is human, as in skill sets, or technical servers or storage are not available here, we need to go outside technical solutions in the UAE, or even beyond. Cloud storage is North American, and that reality. We want AI and therefore we need to go with the technology" (Project Manager 3).

Project Manager 1 supported this, who noted that his perspective was informed and shared by the operational staff and through learning from previous projects.

> "I know the challenge as data scientists here have told me and what needs to happen. The challenge lies in managing the best we can but also ensuring that the technology can operate effectively. The cloud is the cloud, and it has no real boundaries, or at least that is how is presented" (Project Manager 1).

4.3.6 Summary of Phase 2

In summary, this section based on phase 2, which involved four project managers was related to the emergent themes from the first phase and then presented in an MS Excel spreadsheet. The outcome from the interviews showed that the theme of strategic leadership and senior management commitment which is denoted by the term 'strategy' as presented in **Figure 4-3**, represents the identified need for full commitment of the Senior Management, which needs to be supportive and to assume the role of being committed digital leaders. The next theme was data readiness and its usage, or 'data,' where the lack of data is needed to inform the AI acquisition strategy, where the processes followed need to be visible. Without data, it is impossible to understand the needs of the organisation, as well as any potential risks associated with the AI acquisition strategy. Additionally, processes must be in place to ensure that data is properly collected, stored, and used so that the AI acquisition strategy can be effectively implemented and monitored. People and skills as seen in **Figure 4-3** 'people,' represent the project management needs for highly digitally skilled with AI competencies, but also the need for the workforce and business to have personnel who are fully involved and committed to AI, and prepared to work in new and novel ways. 'Process' categorised in **Figure 4-3** is the fourth element which is the process and optimisation. The process is the need to avoid the silo attitude and to move towards one which is more collaborative. To achieve this, there is a need to embed AI solutions into the business process and integrate them into existing systems. This approach can lead to a simplification of existing systems and processes. The final category was the implementation of technology and integration, noted as 'technology', which is the selection and adoption of new digital and AI technological solutions, but also needs to be designed for the specific purpose and then updated, together with a team that is adequately trained (see **Figure 4-3**).

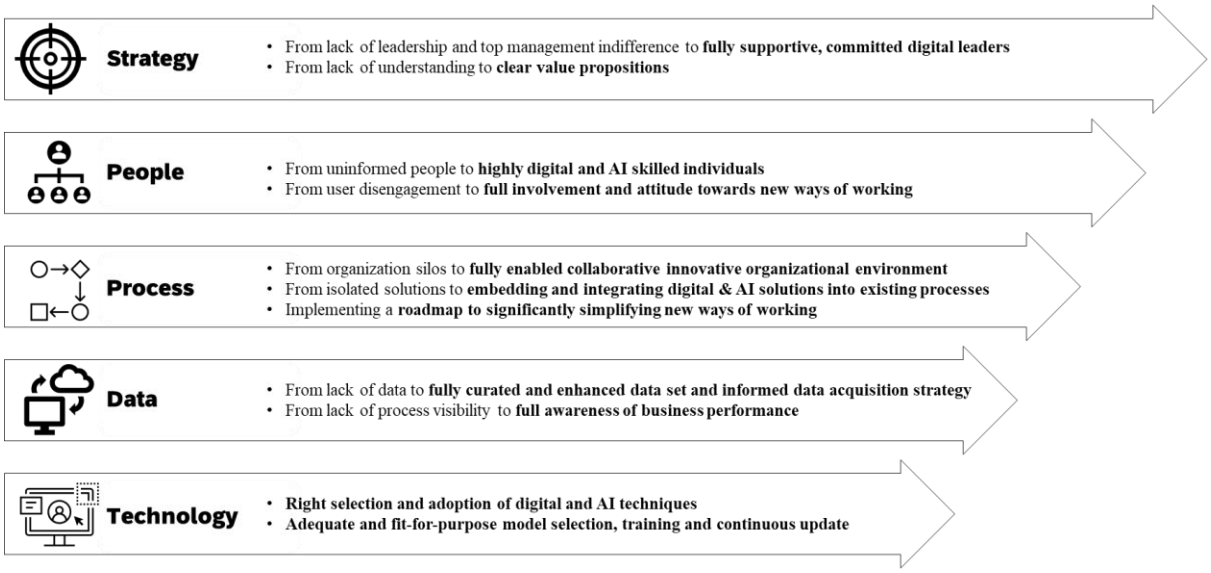

Figure 4-3. Summary of Phase 2

4.4 Phase Three – Senior Management and Leadership

The study then focused on the strategic leadership and management team, with interviews based on the themes generated from the literature review and conducted as part of the first phase, but also informed by the second phase. The structure and the outcome of the interviews of the three senior management are presented below in **Table 4-6**. The senior management was also informed by the researcher as to the intention of building and presenting a model to represent how AI should be implemented. Based and informed by this, the senior management provides a critique of themes but also attributes which should be included in the model or framework.

The feedback collected from the senior management and leadership team offered a more holistic and strategic perspective on the themes generated. Senior management saw their role as being critical in the delivery of the entire process of using AI in the UAE oil and gas industry. Senior Manager 3, who was the global director, saw the senior team's role as being comprehensive and any process which is followed needed also to be reflective of this:

> "Based on the themes presented and my knowledge, any model or framework suggested for business transformation to be used for an AI implementation project needs to be all-inclusive and comprehensive. However, an important aspect I feel is that there is a need to include economy-based objectives and vision, as this is why AI is used. This focus on the economic benefits must include identifying

> whether the AI technology can help achieve economic benefits, reduce downtime, optimize drilling activity, enhance reservoir management, and improve safety" (Senior Manager 3).

For Senior Manager 3, the first part of the focus was on economic benefits. However, he expanded and brought in the importance associated with the individual's knowledge and level of specialism.

> "Also, any recommendation to capture this in a model needs to offer some criteria for identifying the AI-based skill gaps. I would consider training for existing employees as paramount and to have the correct skills and in the future hiring the correct AI specialists" (Senior Manager 3).

The importance of having the right specialism was important in achieving the economic benefits. From a technical side, Senior Manager 2, who acts as chief technology officer added that the monetary value was more important and stressed the importance of the means to assess and monitor progress and activity, through KPIs linked to return on investment (ROI):

> "In the current state of the oil and gas industry of the UAE, these themes are interesting and if the intention is to create a business transformation model it must capture the need for the evaluation of the data from both a quality and quantity aspect. To achieve this, the IT infrastructure needs to be fully understood. I also see methods of data collection in real-time from sensors and equipment need to be considered in the form of tracking KPIs with an emphasis or focus on ROI. This will generate better opportunities to adjust maximize value as the project develops" (Senior Manager 2).

Finally, for Senior Manager 1, the technology vice president, the focus was on having the specialist in place which was reflective of Senior Manager 1 perspective:

> "I would say that the recommended model will need to effectively represent how the implementing AI in the oil and gas industry, should include details on predictive maintenance or at least the process of managing the supply. To achieve this, it is

necessary to have collaboration between data scientists and testing instructors" (Senior Manager 1).

In expanding on the theme but informed by the categories from Phase 1 and Phase 2, Senior Manager 1 then added the importance of monitoring, optimisation and encouraging innovation:

> "I also think that the inclusion of monitoring and optimisation proceedings for the implementation of AI is essential. Along with this initiative, I would suggest that innovations, datasets, and optimisation solutions are vitally important, and this requires innovators" (Senior Manager 1).

All the senior management emphasised the importance of developing a long-term AI roadmap while also being up to date with emerging technologies and industry trends. This could also include exploring partnerships with AI solution providers and research institutions for ongoing innovation (Senior Manager 2 and Senior Manager 1). Finally, the Senior Management saw that they were committed to AI and provided financial support indicating their stance on the technology. What was not mentioned by any of the senior management team was the influence or necessity of using AI solution and being informed by the project management methodology of lessons learned.

Table 4-6. Phase 2 to Phase 3 Mapping activity

Themes generated from Phase One	**Themes generated from Phase Two**	**Themes generated based on the outcomes of Phase Three**
Implementation of lessons learned	Data Readiness and Usage, People and skills, Strategic leadership, and senior management commitment	
Monetary value	Strategic leadership and senior management commitment	KPIs and the incorporation of ROI
External Factor	Implementation of technology and integration	Availability

Level of Knowledge	People and skills, Strategic leadership, and senior management commitment	Investment in specialism and on-going commitment are paramount.
Change Management	Implementation of technology and integration	Up-to-date technology and collaboration

4.5 Conclusion

This chapter was divided into three distinct phases. The first phase was related to the operational engineers and managers who were asked as to their experiences and perceptions towards five themes generated from the literature review, being: the importance of implementation of lessons learned, the monetary value, external factors, level of acquired knowledge, and change management. As a result of these findings, it emerged that senior management was essential, but also that skills and qualified individuals were needed, as indicated by the level of knowledge category. This meant that the business needed to invest in technology but also in human capital. The strategy of using AI as a solution for the oil and gas sector in the UAE needs to generate some form of monetary value in terms of production optimisation. For this to be achieved, again senior management needs to be visibly supportive of this. In implementing an AI solution, it was recognised that external factors needed to be considered and planned for, which are often out of the control of the business, for example, sabotage, but also the growing reliance on cloud technology, an external service. Finally, change management and learning from previous projects in the form of lessons learned are both fundamental considerations when implementing an AI technological solution.

Leading from the data gathered from the first phase which involved eleven participants, the findings were then grouped and categorized into five new themes. These themes were: strategic leadership and senior management commitment, data readiness and usage, people and skills, process and optimisation, and the implementation of technology and integration. These new themes were then presented to four project managers who had been actively involved in an AI project recently. These project managers were then asked to rank the themes and then provide commentary. The outcome of the second phase was that strategic leadership and senior management commitment were essential. As to data readiness and its usage, quality data is needed to inform the AI acquisition strategy and have visible processes. The next theme people and skills saw the project managers highlighting the need for highly digitally skilled individuals

who possess AI competencies, but also the need for a workforce which is committed and possesses an innovative mindset. As to the process and optimisation, the process needed to avoid silos being created and instead nurture a collaborative environment. To achieve this, there is a need for an embedded approach and for AI to be fully integrated into existing systems and processes. The final category was the implementation of technology and how it is integrated. For the project managers, this was the selection and adoption of new digital and AI technological solutions having to be designed for the specific purpose and then updated, together with a team that is adequately trained.

Finally, the senior management team was asked to comment on the first and second-phase themes from a strategic perspective. The senior team emphasised the importance of developing a long-term AI roadmap while also being up to date with emerging technologies and industry trends. To achieve this, partnerships with AI solution providers and research institutions were seen as important. The senior management team also perceived they were committed to AI and provided financial support indicating this. To emerge from the findings was one of the contributions of the study, the creation and development of a business transformation model to represent the implementation of AI in the UAE oil and gas industry, which will be presented in the next chapter.

Chapter Five - Discussion

5.1 Introduction

This chapter presents how the current knowledge presented in the literature review (chapter two) relates to findings, as presented digitisation in the previous chapter, chapter four. To achieve this, the outcomes and themes generated from the existing literature and the study's findings will be set out in a logical manner, together with the professional knowledge of the researcher from the operational oil and gas sector business practice. The research questions were based on the themes derived from the literature review and the interviews with the project managers and operational staff, as discussed in chapter three. In setting this out, the following headings will be presented in six steps, including the importance of identifying skills gaps and talent acquisition, then the data strategy used for AI model development.

The chapter presents a conceptual model that shows the steps and factors involved in using AI as a digital transformation solution in the oil and gas sector. The model can help organisations in the oil and gas sector that want to use AI as part of their digital transformation strategy. The model can also be used by other industries that are going through digital transformation and want to use AI solutions. However, each industry may have different issues and requirements, such as data availability, quality, and security, regulatory compliance, and innovation, which need to be accounted for.

The following stage will concentrate on the implementation, integration, monitoring, and optimisation of the data. Then, the topic of compliance and security will be discussed, followed by the importance of change management and culture. Finally, the need to measure ROI and KPIs along with a future roadmap will be presented. The next section will begin with step one: define and assess objectives and vision, which is regarded as essential for the successful adoption of AI in the oil and gas sector as a digital transformation solution.

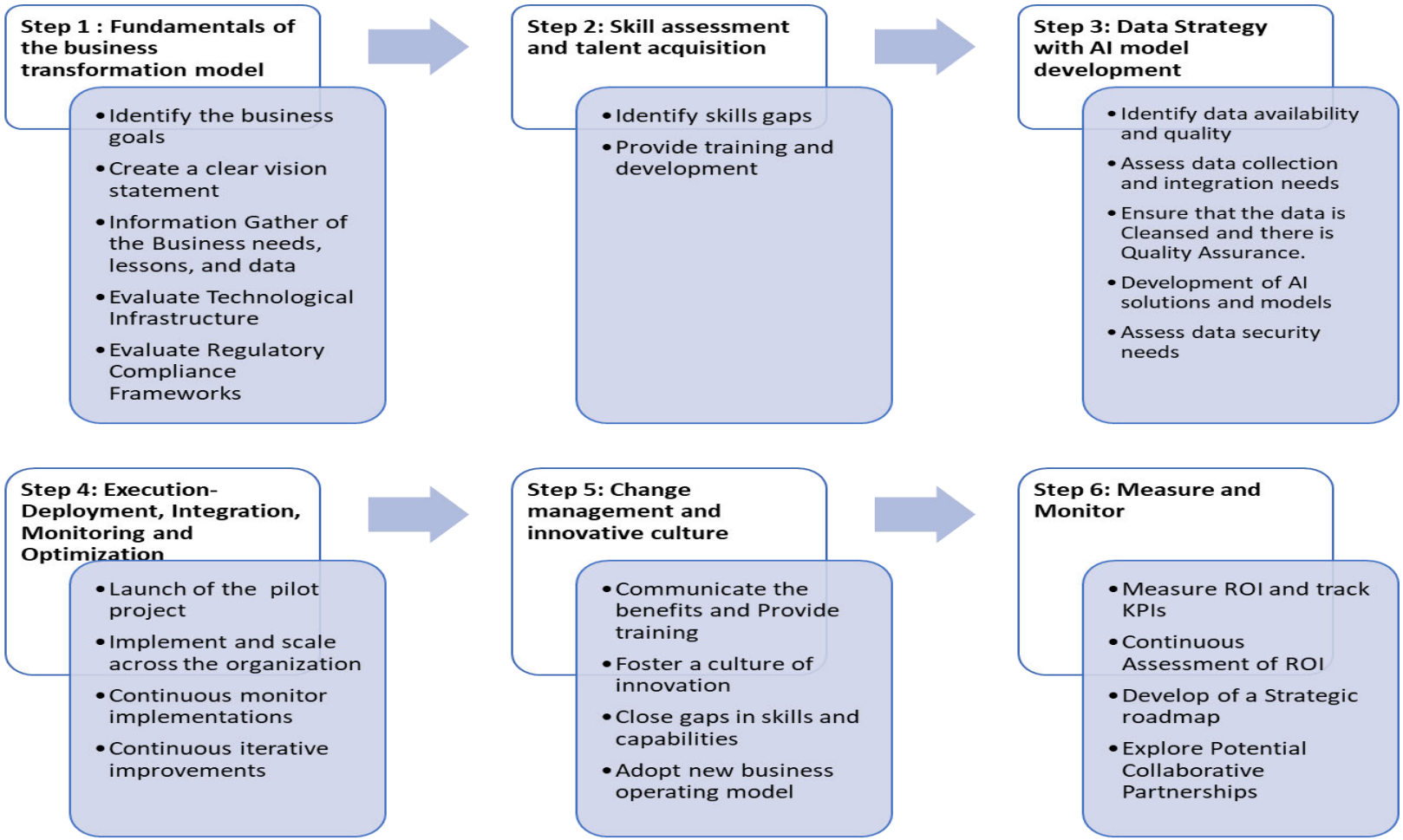

Figure 5-1. Conceptual model based on the findings (Own Creation)

5.2 Step 1: Fundamentals of the Business Transformation Model.

Step 1 of the Business Transformation Model sets out the fundamental components that must be present for any AI implementation strategy to be effective. Reflecting this, part of the discussion in this chapter is based on information from existing literature, but also from the findings of this work, together with normal business practice protocols. Initially, any project needs to establish and recognise the business's strategic objectives and vision. Invariably this is set out by the executive or senior management team in the form of a vision and objectives. This was presented in Burke's (2013) generalised project management ten stage methodology, and was the first stage of any project, including implementing a digital technological solution.

5.2.1 Step 1: Identify the Business Goals.

This theme, although not specifically a focus in the study, emerged as being critical, as there were indications and acknowledgment of the importance of identifying the business goals during all the phases of a digital implementation project. It is particularly important to ensure that the AI technology is aligned to the business's oil and gas exploration requirements, but as noted through the first two stages, this needed to be clearly set out and then fully committed to, by senior management from a strategic perspective. The importance of executive commitment was explained by the senior management team as to their perceived on-going commitment to AI in the exploration of oil and gas in the UAE. From a theoretical perspective, defining and assessing the strategic direction of the business is seen as being fundamental from an AI perspective (Lu et al., 2019) and from a project management standpoint as advocated by Burke (2013) and Munns and Bjeirmi (1996). In the case of this study, the operational environment including the project managers recognised and highlighted the necessity of this senior management commitment from the outset of the project through to the implementation stage and even beyond when the digital solution is fully released and live. This also involved acknowledging the future business objectives and plans to be implemented, which required alignment with the organisation's strategic direction.

5.2.2 Step 1: Create a Clear Vision Statement.

As with the identification of the business goals, there is a need for a clear and unambiguous vision of the future business's direction, so that the project can deliver and be measured on this by its various stakeholders and interested parties (Burke, 2013; Munns & Bjeirmi, 1996). This

is required regardless of whether the project is related to normal operation activities or involving adoption of AI. The findings of this study did not contradict this fundamental project management theory, however, there were echoes of agreement from the various phases in the project. Many of those in phase one and two noted the need to fully understand what the strategic vision of the business was, and to what extent AI was an integral part of this. To make this happen, the consensus was that the senior management team needed to be visibly supportive, becoming almost digital leaders. This theme was supported by Yilin et al. (2008) and later by Salazar-Aramayo et al. (2013) who highlighted the importance of support by senior leadership and management, becoming almost native advocates of the technology, even though the sector is perceived as a latecomer in digitalisation (Kohli & Johnson, 2011; Kane et al., 2015).

5.2.2 Step 1: Information Gathering: Business Needs, Lessons Learned and Data.

In processing the information to make an informed decision based on the vision statement of the business and the identified business case, as presented by both Burke (2013) and earlier by Munns and Bjeirmi (1996), there was a need to gather information in support of the decision process to make an informed decision. This often involves conducting a business needs assessment, collection of lessons learned, understanding external factors, and defining the readiness of the data. Needs assessment may include a SWOT analysis and associated internal and external factor analysis (Burke, 2013; Babich & Hillary, 2020). The SWOT approach has been used in the oil and gas sector for various purposes, including in machine learning to determine its effectiveness, to determine the potential threats and opportunities of its application (Hajizadeh, 2019). Iwaszczuk, and Wolak (2021) also used the SWOT to identify the potential strengths and weaknesses associated with development scenarios in the gas industry in Turkmenistan. However, to date this approach has not been used for assessing the experiences and perceptions of those in the oil and gas sector when implementing an AI project. As the findings have indicated, AI produces and presents some unique challenges such as the dependency on external factors such as reliance on cloud technology, and related storage solutions (Lawan, Oduoza, & Buckley, 2020), as AI needs sufficient flexibility to process and store data. Cloud technology is often housed externally and is provided by an external provider; therefore, the business loses some direct control of the accessibility and management of these facilities. Out of the interviews it is noted that external and internal factors are interrelated. For

example, while the technology solution was provided externally, internally there was the need to ensure that the data was stored securely.

Another influential factor was the image or reputation associated with changes in the various operational activities, including jobs, responsibilities, and roles. External factors can include and encompass internal factors. For example, the implementation of AI technology can depend on external factors such as cloud technology and storage solutions, which are often provided by external providers. However, the successful implementation of this technology also depends on internal factors such as the skills and training of employees, their ability to adapt to changes in operational activities, and their willingness to embrace innovation. Therefore, there can be an overlap between external and internal factors, as both can influence the success of a project or initiative.

As noted in the findings of this study, from the data gathered, lessons learned should be generated to provide an accurate documented solution to problems previously faced. This strategy can provide an invaluable insight which can inform and guide the project before it commences, which for an AI or digital transformation implementation, often have similar challenges. Throughout the interviews, the first phase, which included the data gathering process, and then during the second stage, saw the importance of learning from the past. For the users including project managers and operational specialists, the accurate data gathered can provide invaluable insights about tested solutions to new projects, particularly as AI is still in its infancy.

5.2.4 Step 1: Evaluation of the Technological Infrastructure.

The last part of stage one before the commencement of the project is the need to evaluate the readiness of the technological infrastructure. This is particularly important for the implementation of an AI solution since it needs to have robust technology including support infrastructure, such as storage, and processing power. Throughout the interviews a common theme from the first two phases of the study was the need to have the correct physical infrastructure. The physical infrastructure included the hardware, software and personnel with the necessary skills and expertise. The specialist may need to be brought in externally, due to the lack of certain skills in the organisation. This need for external expertise is often required when the skill sets are not present, and the specialism is needed immediately, therefore cannot be met by the existing workforce.

In determining these requirements there is a need for an in-depth and transparent audit, fully supported by senior management, to be conducted on the existing infrastructure. In addition to the audit results, there is a need for senior management to support the AI solution investment from a financial standpoint. This need for a transparent audit for implementing AI was advocated earlier by Lu et al. (2019) but this study was only a systematic literature review, who stated that AI and its associated cost of investment needs to commence from senior management, but also that the infrastructure must be adequately future proofed. While this study agrees with this perspective of Lu et al. (2019), the reality was a little different, as there was a perception that senior management needed to be more visible in the feasibility process, and then allocate the resources for the needs. Along with this is the need for correct expertise and skills set in the business, otherwise the algorithms and processes will be implemented ineffectively (Ransbotham et al., 2017). Again, the first two phases acknowledged and were aware of the requirements but highlighted that fundamental to the digitalisation transformation process was the need for the availability of specialist and experts, irrespective as to whether they were resourced internally or externally.

5.2.5 Step 1: Evaluate Regulatory compliance Framework.

As indicated above, the senior management were critically aware of the need to comply with regulatory requirements. There was an acknowledgement that governments and associated regulatory bodies are beginning to now recognise that AI and associated digital transformational solutions, like machine learning, are needed to be regulated differently. The challenge will be to balance regulatory requirements and compliance with the need to operate efficiently, and this may include the continued reliance on external bodies and providers. Underpinning this was also the need for a strategic commitment by senior management to this technological solution.

Any company must consider the legal and commercial responsibility towards the government and customers. Companies must follow all the laws and regulations that apply to them, such as those concerning data protection, consumer protection, and fair competition. If they do not, they can face legal and financial penalties, such as fines, lawsuits, and harm to their reputation. Companies must also make sure that their products and services satisfy their customers and do not cause damage. This can mean providing good customer service, keeping warranties, and dealing with any safety issues. Companies that do not fulfil their duties to their customers may risk legal action, loss of business, and harm to their reputation. In fact, by not implementing

prompt digitalisation practices, companies may be prone for violation of local and national codes of business practices. For example, in the UAE and many other oils producing countries, testing wells at a monthly frequency is a legal requirement. This may be impossible to execute using manual traditional technologies. By the application of well digitalisation and remote operated facilities, operators have been able to fulfil these requirements.

5.2.6 Step 1: Summary of the fundamentals of the Business Transformation Model.

In summary as can be seen above in Figure 5.1, the first stage is associated with the fundamentals, identifying the business goals which the project will be based, judged, and assessed on, which needs to be informed and aligned with the vision statement of the organisation. This is often created and set out by the senior management team, which will be the financiers. From the vision statement and business goals, the next stage is the gathering of the data to determine what is needed and the type of AI solution required, which is dependent on the requirements of the business. In gathering this information, this study recognised at least from an operational and project managers perspective that lessons learned, learning from the past is a vital methodology and source of information. From this, the existing technology infrastructure needs to be audited as to its suitability to address the AI requirements related to certain requirements such as processing power, storage, and personnel expertise.

5.3 Step 2: Skills Assessment and Talent Acquisition

Drawing on the findings of the study, combined with those from the existing literature, the next stage is related to the assessment of the existing skill sets and talent in the organisation to determine what is needed for the project and when the outcome is delivered. AI technology and associated digital transformational projects require specific expertise and specialisms in both oil and gas sector and knowing how to interpret data models and data outputs. From the perspective of this study, often the expertise was based on the traditional oil and gas exploration and production techniques, such as geoscience and engineering, while an expertise in AI was often missing, and therefore needed to be resourced externally. Part of this is to ensure that the problems raised by Ranaoldo et al. (2021), like inadequate programming, do not occur.

5.3.1 Step 2: Identifying skills gaps.

The literature review, the results from phase one and two, and the confirmation from senior management in the final phase, all emphasized the importance of detecting skills gaps and

ensuring the team has the right mindset. In the area of skills and talent, Koroteev and Tekic (2021) and Haroon, Viswanathan, and Shenoy (2018), provided a generalised overview of the need for specialised teams, which was important when implementing a successful AI digitalised project. However, there is a lack of qualified and suitable candidates both within the organisation and externally. As noted in the literature review to address this as well as the shortage of the specialist, businesses are now turning to AI lead companies, and (Koroteev & Tekic, 2021). Part of the strategy to address this challenge has included the sector's active seeking of collaborative opportunities with external third parties such as the case of GE and Statoil investing in Ambyint (Koroteev & Tekic, 2021), Saudi Aramco partnering with Earth Science Analytics to develop the next generation of petroleum geoscience AI software, and BP working with Belmont Technology, to gain AI and digital capabilities for upstream activities (Koroteev & Tekic, 2021). Then there is Shell, Saudi Aramco, and Chevron joining together with an AI startup called Maana together with a partnership with Microsoft to use its cloud computing platform Azure (Koroteev & Tekic, 2021). The intention is to attract and retain this AI and digital expertise, then integrate them with the data scientists, petroleum engineers, geoscientists, reservoir, and drilling engineers, so there is a sharing of knowledge through creating collaborative partnerships. These partnerships will then provide the means to manage the large amounts of data being generated, finding patterns and relationships, allowing then for petroleum engineers, geoscientists, reservoir, and drilling engineers to apply their extensive industry understanding and knowledge to the AI modelling solutions (Ferreira, Segua & Fucs, 2019).

In this study, the need for suitable professionals or specialists was identified as being particularly critical as an AI project was often high value in terms of investment and requires accurate data output to be generated, then understood. This theme of high value was earlier noted by Agbaji et al. (2021), as being essential. To address this, the participants identified the need to assemble a complete team, with an array of skills and expertise, which could be internally or externally resourced. Some of the participants in the study recognized, there was the recognition for the need to establish an interconnectedness of skills acting as a pool of expertise, a theme earlier recognised by Ranaldo et al. (2021), They also recognized the need to possess the correct skills and specialisms, which could include an array of other expertise, such as hardware and data flow, as well as the need for a digital mindset, which was seen as fundamental through all the teams including at the executive level.

In delivering a digital transformational solution, part of the process often involves the projection of future needs as the project commences, but also when the final product is

delivered. To achieve this, the findings recognised that often these specialised skills do not exist, and for the operational and more importantly for the project managers, they highlighted the need for these skills and expertise to be brought from external entities from the context of the implementation stage of the project, the first phase of the study highlighted that in the past, gaps in skills and expertise may have potentially resulted in the AI solution being less effective than it was intended to be or designed for, meaning that the predicted and actual production efficiencies when implemented into the live operational environment did not achieve expected results, as scoped out in the original project brief and business case.

This potential change to working practices and procedures and even jobs can lead to passive resistance and internal sabotage. To prevent or reduce this from happening, the project managers, operational engineers, scientists, and managers agreed that it was important for the different employees to have the right skills sets and to keep up with the latest technology through training, while also fostering innovation in the operational setting. This finding addresses the question presented by Close (2006) and Weijermars (2009) as to which skills are required for implementing AI in the oil and gas industry. This perspective was earlier supported from a project standpoint by Munns and Bjeirmi (1996) who noted that when a project is being implemented, operational staff including end-users as identified in this study, need to be firstly fully informed, and secondly become part of the early decision-making process. This is as important of having access to the right data. Although not specifically labelled or specified in step one, the importance of lessons learned as a methodology or means to gain invaluable insights based on previous projects as noted by Burke (2013), and from a Nigerian Offshore Operator perspective was seen as essential (Zuofa & Ocheing, 2017). This importance was also part of the business's normal project management protocol, which was identified as a gap in existing academic knowledge early in the review of the literature.

5.3.2 Step 2: Provide Training and Development.

Once the skills and expertise gaps have been identified and recognised, then the participants in this study advocated the need for training and development of operational staff to gain an awareness of AI and to acquire new skill sets. To achieve this, both the first and then the second stages of this study highlighted that often during the earlier phases of a project, skills acquisition and expertise was needed almost immediately. There was evidence that these potential skills shortages or gaps could be addressed or met through the acquisition of external expertise, which was highlighted by the senior management, who mentioned that their

strategies included the linking or collaboration with third party commercial companies and educational institutional involvement. This perspective was supported by Close (2006) and Lu et al. (2019). However, unlike these reported studies, this research identified and recognised that addressing skills and expertise gaps become almost paramount from the outset, recognising that existing employees needed to possess AI expertise at the planning stage of the project. This also enabled the operational teams to be fully informed and aware of the digital transformation solution, and therefor becoming advocates of the project. In this study, the operational specialists had received AI training, about the artificial intelligence program. This program introduced the participants to artificial intelligence, to the challenges and opportunities including the security and ethical risks connected to its adoption. The program enabled the participants to gain a strong understanding of current global trends in artificial intelligence technologies. The course covered the following.

1. Basics of deep learning techniques.
2. Understanding artificial neural networks.
3. Training a neural network using the training data.
4. Convolutional neural networks and their applications.
5. TensorFlow and tensor processing units.
6. Supervised and unsupervised learning methods.
7. Machine learning using Python.
8. Applications of deep learning in image recognition and NLP.
9. Real-world projects in recommender systems.

The study confirmed the benefits of ensuring that operational employees possess the necessary skills in AI. For the participants there was an awareness that when these new skills sets are acquired, the benefits of AI can be maximised, as the teams become for example, more proficient in responding and managing the outputs of the algorithms. Furthermore, by training the teams and expanding their expertise not only indicates to the rest of the organisation, the level of senior management commitment to this technology and project, but also an understanding amongst the team as to the importance of their role. The potentially even minimising the possibility of malice activities due to the perceived threat of this form of digitalisation on their working practices.

5.3.2 Step 2: Summary of the Skills Assessment and Talent Acquisition

In summary, findings and the literature confirmed the importance of employees' skills and the need for specialist expertise associated with digital transformation solutions using AI. Being a new technological solution, which requires certain specialisms, the participants recognised that previously this expertise needed to be sought externally, which may have led to potential problems amongst the existing workforces. To address this, the participants recognised the need for these operational staff and end-users to attain the necessary skills and knowledge. This perspective also confirms the need for the senior management team to be committed not only to the changes occurring in the existing operational environment, but also showing to future proofing the existing talent base, as an identified by Bello et al. (2016) who studied the Nigerian petroleum exploitation companies' usage of AI.

5.4. Step 3: Data Strategy and AI Model Development

The next step which is confirmed from the interview data and the literature, is based on the two previous phases, where the project is driven by the strategic direction of the operation or organisation to ensure that the people, skills, knowledge, and expertise required are identified, recognised, and met. This stage is focused on the strategy for the data implementation and the associated development of the AI modelling. To achieve this, there is a need for specific expertise and specialism which can enable the AI solution to be created and developed, as well as the right amount and quality of data. Prior to this step, there is a need to identify what data is available, the data types, and/or sources. As noted by Lu et al. (2019) the digitisation process in most companies, including in the oil and gas sector, tends to be slow and often problematic as this technological solution can be complex, which requires a certain level of expertise and knowledge.

To enable the successful implementation, and then the management of the data in the operational setting, there are various digital transformational solutions available such as machine learning, which provides the means to understand the relationships between input variables which then generate forecasts and predictions (Ali, 1994). Sircar et al. (2021) in an Indian deskbound research project together with Sami and Ibrahim (2021), who used data from Middle East oilfields, indicated that the sector is now investing in AI learning systems to create models which can be used to construct and then evaluate real field data. But to achieve this, there is a need to have the correct data through which machine learning algorithms can be used to generate the predictive models and datasets (Hassanvand et al., 2018; Priyanka et al., 2021),

but there is a need to acknowledge and address that these technologies are still reliant on human intervention and specialised expertise.

5.4.1 Step 3: Identify Data Availability and Quality

For AI to be effective in the prediction, exploration and extraction of the oil and gas reserves there is a need for data to be readily available. This availability includes extensive datasets which are related to the intended purpose or activity of the project, as set out in step one. The process also involves the creation and generation of the algorithms needed to produce the intended outcome. For Ng (2016), artificial intelligence is critically dependent on human intelligence and intervention, therefore indicating the importance of having experts and specialists. The basis of this need for human intervention is the acknowledgement that an AI solution is not generic, therefore it cannot be manufactured or bought in readymade, but needs to be customised to suit the business context and the data available, hence the need of human expertise (Ng, 2016). Behind this was also the recognition that the organisation needs to follow the specified governance framework, which provides the guidelines for both data access and its application. But also, there was the recognition that the data owners and application leads may vary from project to project, but still need to adhere to this governance. As seen in the interviews and a common theme throughout this chapter, is the need for this expertise to be shared, and potentially require increased collaboration within the organisation, both internally and externally.

5.4.2. Step 3: Assess data Collection and Integration needs.

From the findings, the theme of data readiness emerged as a critical issue. This perspective was highlighted by Ransbotham et al. (2017), Hajizadeh (2019), and Ng (2019). The process was associated with the collection and integration of the data, to ensure that the information/ data has the required integrity, therefore being adequately cleansed and checked for quality. The process also included the identification of the data owners and data stewardship. Then there was the consideration as to the availability and reusability of the data, which in this study was governed by a data manager, who also functioned as the data steward. Again, the previous theme of evaluating the existing and future technological infrastructure is essential, whereby ensuring that the digital transformation AI solution includes the checking of the hardware, software, and storage capabilities so that the equipment is future proof, and not simply adequate for the short-term. This review also needs to include the skills and talent within the teams

indicating the important prerequisite for this project to provide the intended outcomes, with the expertise in areas such as data collection, dataset analysis and the algorithms programming. This finding indicates the close relationship between having the correct workforce with correct skill sets, the need for data readiness, and an infrastructure which is sufficiently robust, but there is also again the need for collaboration and senior management commitment. This finding concurs with writers including Koroteev and Tekic (2021), who highlighted a critical challenge of ensuring that certain related skill sets, and knowledgebase are needed to be embedded into the operational environment and into the business governance policies. The governance oversaw the processes, structures, and principles designed to ensure the organisational activities are transparent and ethical. To achieve this, the study found that business governance involved the establishment of policies, procedures, and decision-making frameworks that guided the actions of the organisation and its members. For Koroteev and Tekic (2021) there was an importance associated with the need for data integrity and readiness. The authors also recognised that AI and digital transformation expertise was vitally important, due in part to the profile of the sector being latecomers to this technological solution, which can only be achieved through open collaboration (Koroteev & Tekic, 2021), and external parties (Haroon, Viswanathan, and Shenoy, 2018).

5.4.3. Step 3: Ensure That the Data is Cleansed and there is Quality Assurance

The success of an AI project is dependent on several factors, including the technology, software, algorithms, expertise, and specialisms needed, but also for data integrity, quantity, and quality. This aspect of AI requires the data to be cleaned so that the datasets and outputs are as accurate as possible. For this to be achieved, as seen in the interviews, the project needed to be resourced correctly with teams possessing the necessary expertise to ensure that the data is processed and adequately checked for integrity. As noted by Ransbotham et al. (2017), to be effective, AI requires good quality data which is of a suitable volume which can be then trained before being used in an operational mode.

In this study, quality assurance is seen as being the systematic process of verifying that a product or service meets specified requirements and standards. To achieve this, the quality assurance process involves establishing a set of activities designed to ensure that the outcomes meet the prescribed requirements. From the perspective of this study, quality assurance needs to ensure data integrity is achieved by implementing and adhering to established standards and procedures. Then as the process progresses the data is continuously monitored, with

improvements made to the existing processes to meet the prescribed quality standards. It should be noted that while using smarter algorithms reliable results are acquired from the datasets. However, inferior quality data can still hinder the accuracy. Therefore, initial data integrity checks and the need for specialists with the correct knowledgebase is essential.

5.4.4 Step 3: Development of AI Solutions and Models.

The final process associated with the planning stage is the actual creation and development of the algorithms to generate or achieve the intended outcomes. This requires AI expertise, together with an in-depth knowledge of geoscience and engineering which is related to oil and gas exploration and extraction. The interviews in the first and second phased noted that the team needed to be collaborative and multi-skilled. To achieve this, the findings indicated that the experts need to have knowledge of other areas of expertise, such as IT and data science. Furthermore, the team could gain an appreciation and a more holistic understanding of business. This theme for the need for greater collaboration was supported by Haroon, Viswanathan, and Shenoy (2018), who noted that these transformative technologies need to have related expertise and knowledge embedded throughout the organisation, creating a digital transformational AI culture. In achieving this, there is a need to remove the sector's traditional data silos approach. Part of this collaboration could be through the adoption of cloud solutions or drawing on external expertise both within the sector and beyond the sector, through connections with educational institutions and commercial IT related companies.

5.4.5 Step 3: Assess Data Security Needs

Interviews revealed that implementing an AI solution must comply to data security considerations. The interviews, in both the first and second phases, communicated an increased reliance on external providers expertise and facilities, particularly with the advent of cloud computing and storage. To ensure that the data which is vitally important for the exploration of oil and gas is available, there was also the recognition that the data was still seen as being confidential to the business activities, therefore the information needed to be suitably secured. An evolving concept following strict data regulations is the recent trend in the sector of sharing and collaborating including, data being shared to external parties, as noted with the recent report that the UK's oil and gas National Data Repository in which their data are open-sourced (Oil and Gas Authority, 2019) and the USA Energy Commissions. As digital solutions become increasingly reliant on digital transformation and AI, there is the potential that these

technologies and their usage will be increasingly open and while adhering to data security requirements.

Since the introduction of digital transformational technology and AI in most business environments including in the oil and gas sector, there have been improvements in various activities including:

1. Trading of products and contracts.
2. Enabling management to make informed decisions by providing accurate information in real-time.
3. Generation of accurate self-maintenance records.
4. Administrating and ensuring that the data is compliant and adhering to any rules and regulations.

This latter benefit of a digital transformation solution is strongly associated with cyber-security, which involves ensuring that the data is encrypted, and access and storage is secured, through the usage of technology, including Blockchain. As noted in the literature review, while studies by Lu et al. (2019), Feblowitz (2013) and Subramaniyan (2021) have been informative as to the potential of this technology's application in the oil and gas sector. Our research has not investigated in detail the challenges associated with ensuring that the data is secure and compliant.

5.4.7 Step 3: Summary of data strategy with AI model development

In summary, the last four components associated with step 3: Data Strategy of the AI Model Development, included first the identification of the data needed, and its relevance for the project. Second, ensuring that the quality and integrity of the data is suitable, therefore being cleaned and checked as to its relevance for the intended purpose of the project. Third, the integration of the data through the development and tailoring of algorithms designed to generate the outcomes and datasets to achieve the intended purpose and objectives. To achieve this, again the importance of having the technology, software, storage, and knowledgebase was seen as being essential.

5.5 Step 4: Execution - Deployment, Integration, Monitoring, and Optimisation

This stage of the project is related to the execution of the project following the completion of the planning phase. Execution may involve building a new solution and deploying the solution in the operational environment. In this step, the focus is on the execution stage, integrating the

original data sources and monitoring and optimizing the AI solution. It is also essential to manage resources properly while keeping the project within scope to satisfy the original requirements. The preceding stages are related to other activities prior to the execution phase, such as creating the project idea theoretically and embedding the lessons learned. Once the AI technology has been implemented, there is a need for continuous monitoring to maintain and enhance the solution. Where changes or improvements are needed, updates and modifications are implemented through an iterative strategy. This strategy could follow, as indicated in this study, the recognised change management process of ITIL. Although not extensively researched, the study has provided an academic and professional insight into how the ITIL methodology has been used in a digital transformational AI oil and gas project.

5.5.1 Step 4: Launching of the Pilot Project

The pilot project stage is at the commencement of the execution phase, which is seen as the start of the delivery part of the project. The pilot stage involves implementing the AI solution in a test mode. In this study, there was active end-user involvement, which was seen to be important, that this commenced at the early planning stage. Part of this decision was based on the realization that AI results are perceived to be difficult to understand and interpret, due to an increased number of AI-generated outputs. Additionally, building AI model has some artistic and subjective component which needs to be demonstrated. This has led to the technology gaining the reputation of providing a “black box” solution. Black box refers to the lack a humanly understandable direct relationship between inputs and outputs. This uncertainty as to what and how AI is generating outcomes, has been illustrated with the emergence of the Uncanny Valley of Mind (UVM) concept. UVM has captured the unease or discomfort people feel when encountering AI chatbots with features that are almost, but not quite, human, which indicates the uncertainty that individuals have, when engaging with this technology (Chattopadhyay & Macdorman, 2016; Stein & Ohler, 2017).

This creates a general lack of understanding of this technology’s potential. An important part of the implementation / execution stage is the use of a methodology to apply lessons learned to inform and guide how the processes should continue, change, or be modified. For the project managers, at this stage, the lessons learned log was not only identified as being important, but also needed to adopt a change management methodology. This change management process must ensure that all the modifications are reviewed and accurately documented. In this

documentation, will also include the final AI solution specifications and algorithms which were created and deployed.

The pilot enables the project team to review and assess external factors such as the storage strategy and capacity, the robustness of the technological infrastructure and expertise and knowledgebase of the operational team, to determine the viability of the project, together with determining how the new processes and data can be optimised. The theme of process and optimisation of the data, emerged from the first phase of the study as being aligned with external factors such as the storage of the data and accessibility, which the project managers recognised as needed to be constantly reviewed, assessed, and evaluated. In both phases, the interviews highlighted the importance of expertise knowledge which included an awareness of AI, but also retaining the fundamental skills associated with oil and gas exploration and extraction, including geoscience and engineering. Finally, for these participants the testing/pilot stage enabled an opportunity to assess the data readiness and to ensure data integrity and quality both essential components of implementing a digital transformation AI solution (Ransbotham et al., 2017).

5.5.2 Step 4: Implement and scale across the organisation.

Following the testing of the project in the Pilot stage, the solution is then implemented. The actual execution stage is the rollout of the solution, which for a digital transformation AI project can be complex. Drawing on the findings generated from the interviews, a common theme was related to the need for all end-users and stakeholders to be fully informed about the digital transformation AI solution, including having an awareness and the necessary knowledge base. Reflecting on the project's execution and implementation phase, the first two stages of the interviews highlighted the importance of senior management team's commitment to the digital transformation AI solution, indicating that this group should become digital leaders and champions advocating the benefits.

Fundamental to the project execution stage was the recognition that external factors are often out of the direct control of the organisation, therefore needs to be carefully considered and assessed. Again, the project managers highlighted the importance of using and drawing on the lessons learned methodology which could be used as a roadmap to assist in the rollout of the project. From the findings, the lessons learned is a critical part of any project, especially in the context of digital transformation in AI projects. The methodology provides an invaluable insight into what worked well and what could be improved, helping to inform future decision-

making and project planning. The lessons learned experiences can be applied by incorporating these reflections and experiences into the project plan and execution strategy to inform best practice and help to mitigate risks and improve project outcomes. Finally, lessons learned also could be shared with other teams and stakeholders, promoting knowledge sharing and collaboration. This strategy could also be used to inform training and development programs, helping to build the necessary skills and competencies to support the successful implementation of digital transformation AI projects in the future.

5.5.3 Step 4: Continuous Monitoring of the Implementations

Closely aligned to the previous step of 5.4 was the need to be continuously monitoring data availability, quality and the algorithms being created, deployed, and used, as well as how the datasets and outputs are interpreted and acted on. This step which was generated from the interviews was a combination of the processes which needed to occur and followed by the optimisation to ensure that the data readiness and technology is being as efficient as possible, requiring constant monitoring and reviewing.

The project management highlighted the need for a clear change management process to be established and advocated the usage of the principles of ITIL (Figure 5-2).

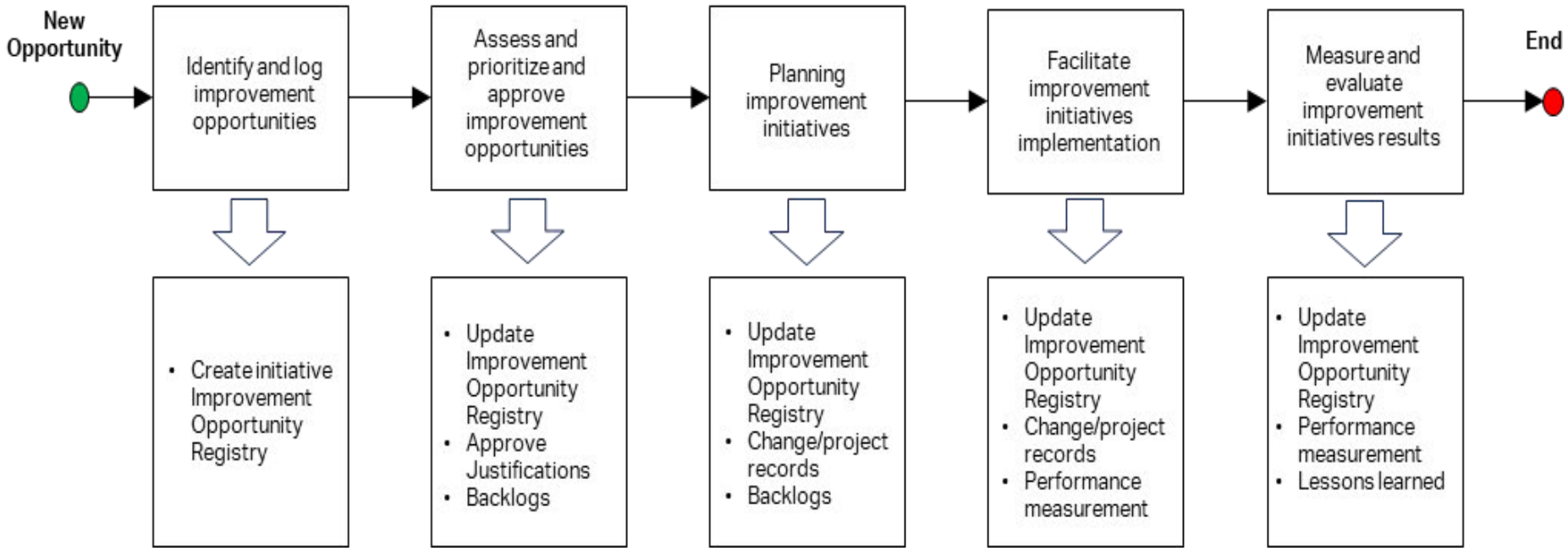

Figure 5-2. Continuous Improvement Management (Axelos, 2019)

5.5.4 Step 4: Continuous Iterative Improvements

As with any project, there is often the need for continuous iterative improvements (Burke, 2013). In the case of a digital transformational AI solution, due to its dynamic nature, and irrespective of the outcome of the pilot project, there are often changes or modifications to be made. Partly because it is related to the constant updating of the data through the algorithms, and the increasing amount of data being used. From the outcome of the interviews, particularly from the project managers perspective, and although not directly linked to the existing literature, this study noted the importance of change management, and the need to ensure that the technological solution was being constantly monitored and modified or updated when needed. As mentioned above, there was a consensus as to the need for a change management methodology to be adopted. This aspect has often been ignored or excluded from most AI related studies both in the oil and gas sector, and other industries (e.g., Lu et al., 2019; Koroteev & Tekic, 2021; Siccar et al., 2021; Wagar et al., 2023). For the project managers in this study, the usage of the service value chain, an important part of the ITIL process and methodology which sets out the steps to follow to ensure that the change does not impact adversely on the availability of business services, was essential. This was even more important for these participants as they recognised the increasing changes which need to occur when using an AI solution that often-included machine learning algorithms. This need for a defined and robust change management methodology solution as being critical has until now, seen limited academic interest into the importance of managing a digital transformational AI solution in the oil and gas industry, without too many interruptions.

Linked to this need for robust change management processes, is the need for ensuring that the teams who are directly involved have the correct knowledge and understanding to interpret the AI output, but also, they possess the experience to ensure that the infrastructure is also able to meet the changing needs and requirements.

5.5.5 Step 4: Summary of The Execution - Deployment, Integration, Monitoring, and Optimisation

Based on the discussion related to the execution stage of deploying, integrating, monitoring, and optimising the AI solution there are various themes identified from the findings which complement current academic understanding. The importance of testing or piloting the intended solution was seen as paramount. This included drawing on lessons learned to understand previous outcomes and solutions from previous projects, evaluating the existing

infrastructure including the hardware, software, algorithms, storage facilities, and that the team has adequate knowledge and expertise. These aspects were seen as being unique to the implementation of an AI solution within the oil and gas sector. Throughout this stage the importance of change management was seen as being critical in the management of an AI IT solution, so that any change can be managed and controlled without significant disruption to the business.

Prior to the execution stage, a pilot needs to be conducted to test the solution from the software, algorithms, hardware, and team's knowledge-based perspectives, from which lessons can be learned. The execution stage involves the rollout of the AI solution which needs to be conducted in a managed and scaled approach. This involves ensuring that the infrastructure is suitably robust as with AI, the technology requires increasingly larger amounts of data. As a result of this the hardware infrastructure needs to be future proof, the storage facilities which are often external on the cloud are accessible, and that the skills and expertise are constantly updated, which is a link to the monitoring stage as presented in 5.5.3. Finally, as the AI solution is delivered, there is the need for controlled iteration improvements to be implemented through following a change management methodology, which needs to be constantly reviewing the consequences of the modification, in relation to infrastructure, and including external providers and facilities as dictated by the level of knowledge and skills within the organisation.

5.6 Step 5: Change Management and the Culture Innovation

Along with the previous and the next section, change management and creating a culture of innovation, are outside the scope of a traditional project management methodology (Burke, 2013, Munns & Bjeirmi, 1996). However, throughout the interviews the importance of change management but and innovation was clearly communicated. Change management noted the importance of embedding this methodology into the organisation's working ethos, practices, and culture.

In this step, there is an opportunity for the organisation to adopt new information technology improvement standards such as ITIL 4, which can assist in change management through innovation. The usage of ITIL and its systematic approach to delivering change in an organised but controlled manner was seen as being the most effective.

In reviewing the current academic debate there was limited research into this theme from an AI perspective. This was interesting and unexpected as this form of digital solution required an effective change management approach due to the nature and amount of data, and the fact that

the development of the technology and algorithms need to be constantly monitored and upgraded, requiring an effective and recognised IT solution.

5.6.1. Step 5: Communicate the Benefits and Provide Training.

From an operational and project management perspective the interviews revealed that there was a need for training to be provided as a matter of necessity. While often a project will bring about changes, due to the nature of the AI and digitalisation often the employees do not possess the correct the skills and knowledge. To address this, there is a need for expertise and knowledge to operate and maintain the technology (Lu et al.,2019). This needs to be provided on a regular basis to ensure that the operational staff are fully informed and possess the knowledge. Linked to this is the role and responsibility of senior management to ensure that the culture of the organisation is one that provides being a learning and development environment. Closely associated with the need for on-going training and competency development is establishing and maintaining open communication, to ensure that all stakeholder and end-users are fully informed. Again, this technology can be problematic as to its perception of being changes in the working practices and job roles. As a result, there needs to be a clear communication plan to inform those involved of the implications and potential outcomes and benefits of the solution implementation. To underpin this, the need for proactive communication and providing training as needed is the part of a robust change management methodology, which requires coordination and control, and needs clear communication with the various stakeholders and user-groups. Again, the interviews particularly from both the project managers and communicated was the importance of the project to follow an execution methodology, such as waterfall, or using the ITIL change processes.

5.6.2 Step 5: Fostering a Culture of Innovation.

A common theme which emerged from the interviews was the benefits which this digital transformational solution can provide. Many of the interviewees, irrespective of their role mentioned the word innovation, and how it will transform the sector. For many of the interviewees, there was an acknowledgment of the potential changes that AI and related digital technologies will bring. But there were also concerns as to the changes in roles, processes, and practices that have traditionally been used. For some participants, there was also the realization that AI will be transforming all business activity, and the oil and gas sector needs to embrace it as it will provide opportunities for productivity increases. Furthermore, there

must be a culture of curiosity and experimentation, where employees are encouraged to explore new possibilities, test new ideas, and learn from failure. This can help the organisation adapt to the changing environment and embrace AI's opportunities. Throughout the interviews, again irrespective of their role and even theme, senior management's involvement and commitment was seen as being critical. This included the promotion of opportunities, providing training, encouraging collaboration but also enabling the team to create new innovative ideas.

5.6.3 Step 5: Close gaps in skills and capabilities

This requires constantly evaluating the people's abilities and skills and taking the appropriate action to address the gaps. To deal with the gaps in skills and capabilities, operators need to invest in ongoing learning and development for its workforce as it related to digitalisation and AI. This includes offering access to online courses, workshops, mentoring, coaching, and other resources that can help employees learn and acquire the needed knowledge and skills for working with AI and related digital technologies. Moreover, the sector needs to use the expertise and experience of external partners, such as universities, research institutes, consultants, and vendors, who can provide guidance, advice, and support for applying and using AI solutions.

5.6.4 Step 5: Adopt new business operating model.

This requires changing how a business works to fit the new solution, and if needed, modifying the processes, and setting up a permanent governance structure. To use a new business operating model, the operators need to rethink the processes and workflows to take advantage of the AI solution's abilities and features. This requires identifying the tasks, activities, roles, and responsibilities that will be affected by the AI solution, and how they will be changed, improved, or replaced by the AI solution. The operators should also figure out the interactions and dependencies among the different processes, functions, and systems, and ensure that they work together smoothly. Creating a governance structure and framework for the AI solution requires setting the policies, standards, guidelines, and best practices for developing, deploying, using, and maintaining the AI solution, as well as the roles and responsibilities for managing, checking, and reviewing the AI solution. The operators should also set up the methods and tools for assessing and measuring the performance, impact, and value of the AI solution, and for ensuring its compliance, security, and ethical use.

5.6.5 Step 5: Summary of Change Management and the Culture Innovation

The interviews revealed that the participants acknowledged both the benefits and potential ramifications of AI and related digital technologies like machine learning and blockchain technology. There was however the identified need for open communication to be established as the solution is being developed and implemented, and this needed to be initiated and supported by the leadership team. With AI there are often skills and expertise gaps, and being a new concept, there is a need for collaboration with external bodies but also for the operational teams to acquire the necessary skills.

5.7 Step 6: Measure and Monitor.

The final theme to be presented which emerged from the three stages of the study, was the means to measure and monitor the progress of both the project phase and then when the solution is implemented into the operational environment, It was, also recognised the need to provide a vision or roadmap for the future, which provides a direct linkage back to the step one, as to defining of the business goals and direction of the organisation. While the need for measuring and monitoring was important for the project management team and the operational staff, it was the senior managers who identified the necessity for KPIs and the means to assess the return on investment (ROI), as to how the project was providing a monetary value. For the project managers and the operational staff importance was given to have a strategic direction and a roadmap setting out the direction of the digital transformational strategy of the organisation, and the extent to which senior management are prepared to embark and invest in collaborative and innovative partnerships, as seen with other companies including BP, Shell, Saudi Aramco, and Gazprom Neft who have invested into various AI initiatives with third parties (Koroteev & Tekic, 2021).

5.7.1 Step 6: Measure ROI and Track KPIs.

Although the operational team and the project managers recognised the importance of monitoring and assessing performance and progress, including techniques like the optimisation of drilling and flow activities through the use of the earned value management technique (EVM), which is one of the ways that project managers assess progression from a time, cost, and work to date perspectives (Burke, 2013; Meredith et al., 2020), the senior management were more focused on having the ability and methods to monitor high-level business activities. The senior managers recognised the importance of establishing KPIs to determine how the

implementation and usage of digital technologies have optimised the organisation. The senior management requirements were like the outcomes of Salazar-Aramayo et al. (2023) who conducted a study based in Brazil and the results generated included the monitoring of the effective usage of AI on the oil extraction activities. Finally, these KPIs apart from being designed and created to provide accurate information, they need to provide this in real time, one of the key features which AI and associated digital transformational technologies enable. There are various examples associated with the usage of KPIs related to AI including the accuracy, which AI provides as to predicting and classifying data. There is the speed and the time taken for AI to process data and provide new insights. AI provides cost savings, as to reducing expenses while potentially increasing revenue growth, and finally increased customer satisfaction.

5.7.2 Step 6: Continuous Assessment of ROI

The senior management was interested in measuring how much value their investment had created, and how much money it had generated for its stakeholder and shareholder / investors. This was related to the access to KPIs that they had. The executive team also required this type of metric to be accessible in real-time so that they could make accurate and timely strategic decisions.

5.7.3 Step 6: Development of a Strategic Roadmap

Interestingly, the final two categories associated with the last step were more important to the project management and operational teams compared to the senior managers. While the senior managers recognised the need and potential that AI can provide in enabling them to access real-time data on various predetermined datasets to assess performance and the optimisation of their investment, so assisting them to make informed strategic decisions, it was the project managers and operational teams who indicated the need for this information to be clearly communicated throughout the organisation.

5.7.4 Step 6: Explore Potential Collaborative Partnerships.

Finally, as noted above, with the oil and gas sector, the usage of AI and related digital transformational solutions are still in its infancy, (Gartner, 2019; Chowdhury et al., 2023), therefore there is the need to acquire externally the necessary expertise and experience. For this to happen, as noted by Lu et al. (2019) and Bello et al. (2016) this sector needs to shift from

their traditional organisational culture of working in a silo, to establish strategic partnerships with external bodies including those in the sector. This however needs be initiated and supported by the senior management team (Bello et al., 2016).

5.7.5 Step 6: Summary of Measuring ROI and Track KPI's.

To summarise the final step, which again was not directly aligned to the traditional project management methodology as presented by writers such as Burke (2013), the findings do have implications when introducing a digital transformational solution such as AI into the oil and gas sector. This theme was focused on the senior management and their perceived responsibilities for the initiation, investment, and commitment to this transformational solution. This included the need for a strategic roadmap and direction to be clearly communicated throughout the organisation, which needs to be linked to establishing and nurturing various strategic innovative partnerships which may not have existed before in the sector, indicating the need for a cultural shift to be more innovative and collaborative.

For the senior management team, the need was identified for them to be fully informed as to the project's progression in terms of operational efficiencies. This was also needed at an operational level, with the provision of data which could provide accurate KPIs and related metrics such as ROI. For this data to be effective it needs to be accessible and available in real-time, which is a key feature of AI.

5.7 Benefits and Limitations of the Conceptual Model

The proposed conceptual model has several merits and limitations, which will be discussed in this section. One of the main benefits of the model is that it is based on interviewing three key groups of participants from the oil and gas sector in the UAE. The study has provided a rich and in-depth insight into the challenges and opportunities of implementing AI in the sector. To illustrate this, the model reflects the perspectives and experiences of different stakeholders and their roles involved in the AI project. The model also has captured the specific issues and requirements of the oil and gas sector, such as data availability, quality, the necessity for security, regulatory compliance, and innovation.

The model has presented the planning, execution, and post-execution phases of implementing AI, providing a comprehensive and systematic approach that addresses the various aspects and dimensions of these project management activities. The model also incorporates the importance of collaboration and communication throughout the process, and acknowledges the need for

continuous monitoring, improvement, and innovation. Therefore, the model has a high degree of comprehensiveness and robustness, which could be used as a flexible and adaptable tool that can accommodate the dynamic and complex nature of the AI implementation process in the oil and gas sector.

However, the model also has some limitations. One of the main limitations of the model is that it is based on a single company in the oil and gas sector in the UAE. This can be seen as a limitation; however, this organisation is the major oil and gas producer in the Middle East and the seventh largest in the world. The model also does not capture the different AI implementation strategies adopted in other countries and regions, including regulatory requirements or cultural, political, economic, and environmental factors. Therefore, although a generalized outcome cannot be inferred from this study, its application does have creditability in the UAE. To address this limitation, the model may need to be tested and validated in other contexts and regions, then modified, and adapted to suit the specific characteristics and conditions of each environment. Finally, another limitation of the model is associated with the limited number of participants, as this study was qualitative. Therefore, the model may not reflect the views and experiences of all the stakeholders and actors involved in the AI implementation process in this organisation. However, this study does present the richness of the perceptions and experiences of those interviewed.

5.10 Summary of the Model

This chapter has discussed the findings of the study based on the interviews conducted with three groups of participants: the senior management, project managers, and operational staff. To conceptualize the findings, the chapter has presented a model to provide a theoretical framework that can guide practitioners and researchers to understand and manage the challenges and opportunities of implementing AI in the oil and gas sector.

Based on the interviews, this chapter has presented a model that outlines the steps and considerations for implementing AI in the oil and gas sector. The model is based on the findings of the study and the existing literature. From the discussion in this chapter and then represented in the model there are six distinct steps.

The initial step involves setting and evaluating the strategic goals and mission of the business. This includes determining the business objectives and the mission statement, then collecting,

and examining the data before aiding the decision-making process. By using an AI solution this can be done but there is a need to recognize gaps in expertise.

In the second step, a skills assessment is conducted, and a talent acquisition strategy is adopted. This step involves determining the skills and knowledge required for the AI project, offering training for the current staff, and also hiring external talent and experts when necessary.

The third step identified in the chapter is the data strategy and AI model development. This step involves the identification of data availability and sources, then collecting and checking the integrity of the data. This process ensures that the data quality and integrity is maintained before the AI solution and model is tested.

The fourth step was related to the execution or the deployment, integration, then monitoring, and finally optimisation of the AI solution. This step included the launching of the pilot project, before implementing and scaling the AI solution across the organisation, while also continuously monitoring the data.

The fifth step is the change management and culture innovation needed when implementing an AI solution. This step involves communicating the benefits and providing training for the AI solution. This might include the fostering of a culture of innovation and collaboration, and then adopt a change management methodology such as ITIL to manage and control the changes.

The final and sixth stage, is the means or methodologies to measure and monitor the outcomes. This step involves defining and tracking the key performance indicators (KPIs), assessing the return on investment (ROI), before developing a strategic roadmap for the future, which might include exploring potential innovative collaborative partnerships.

Chapter Six - Conclusion

6.1 Introduction

Following the critical review of the findings and the discussion, this chapter presents the conclusions. The chapter summarize how the findings contribute to the existing theory and understanding from a professional perspective which is the central purpose of a DBA. It also presents the limitations of the study before making recommendations for future research.

6.2 Aim of the Study

This study was focused on critically investigating the experiences of implementing digital transformation solutions involving artificial intelligence (AI) in an UAE operational working environment in the oil and gas sector. The focus has been researching how implementing an AI project can affect the UAE oil and gas sector as to the exploration, extraction, and production of petroleum activities, from three different perspectives, the operational team, the project managers, and the executive leadership team.

6.3 Research Questions

To achieve the aim, the study addressed the following research questions:

- How and why have artificial intelligence projects been implemented in the operational activities of the UAE oil and gas sector?
- What aspects have needed to be considered and implemented when introducing a digital transformation solution in the UAE oil and gas industry, why?
- To what extent and why has artificial intelligence transformed the current business practices in the UAE oil and gas industry, and how will this transformation inform future projects?

Leading from these core questions, the three stage interview questions were also focused on the three different participant groupings, for example with the operational technicians and engineers, the questions were informed by the current academic debate and professional practice. The themes covered included the importance of implementing and using lessons

learned within the execution methodology, the monetary value, external factors, level of acquired knowledge, and change management. The questions included:

- What were the challenges encountered during the project of implementing an AI solution into the operational production environment?
- What could be changed, modified, or required in the future when implementing future AI solutions?
- What are the challenges when implementing AI as to the workforce's skills, talent, and knowledge base?
- What external factors need to be considered when implementing an AI solution?
- To what extent has AI enabled optimisation through the digital technological integration project?

For the project managers, the focus was informed by the first phase, which was based on the following emerging themes: strategic leadership and senior management commitment, data readiness and usage, people and skills, process and optimisation, and the implementation of technology and integration. The questions for the interviews from the project managers included:

- What are the challenges associated with implementing a digital transformation AI solution?
- What external factors need to be considered when implementing an AI solution?
- What are the core requirements for implementing an AI solution?

The final stage involved three executive members of the management team. These individuals were then interviewed based on the first stage interview questions, but also drew on the questions and themes related to the project managers.

Throughout these three separate stages the findings of the previous phase were used to shape and fine-tune the next stage of the interview process, but also for the development of an updated version of a business transformational model which can be used for implementing future digital transformational solutions in the oil and gas industry. This model builds on the earlier work of Burke (2013) and also Salazar-Aramayo et al. (2023), by providing a new in-depth understanding as to how AI can be implemented. In updating the framework proposed by Salazar-Aramayo et al. (2023) this study has focused on the various stages or phases in the

delivery of the AI project as opposed to presenting the transformational process through a high-level view of the activities. This has included important aspects of the implementation stages including the importance of techniques such as lessons learned and change management from an operational, project management and executive teams' viewpoints.

6.4 The Outcome of the Study

The aim of the study was achieved through firstly addressing the questions which were related to the following initial themes, that had emerged from the current academic debate as to the importance of implementing and using a lesson learned methodology, namely: how important and how can monetary value be assessed, the influence of external factors, what levels of acquired knowledge is needed, and the importance of change management. Leading from these themes from the first phase, phase two was developed and fine-tuned by the outcomes of the operational team's perspectives, which led to the following themes: the importance of strategic leadership and senior management commitment, the need for data readiness and usage, people and skills, process and optimisation, and the implementation of technology and integration.

The outcome of the first part of the study highlighted the importance associated with a lesson learned methodology being used and how important this method was, as advocated in project management text (e.g., Burke, 2013). As a concept, lessons learned were seen as being critical for a digital transformational project, as AI as technological solution is still seen in its early stages of understanding from a project management and operational perspectives. This finding also agrees with Zuofa and Cheing's (2017) Nigerian study into the importance of lessons learned, but then extends their work from both a project management and digital transformational perspectives within the oil and gas sector.

Linked to the theme of lessons learned, this study has found that there is a specific need for a recognised and systematic change management methodology to be adopted, followed, and researched, but this theme had been neglected or omitted from previous studies in the implementing of a digital transformational AI solution in the oil and gas sector (e.g., Lu et al. 2019; Bello et al., 2016). This finding is an important consideration and theme as often AI needs to have iterative modifications or changes which need to be implemented in a controlled way, particularly as AI has certain complexities but the data also needs to be available for operational usage.

The current literature presents, the relevance of the monetary value associated with AI solutions from efficiency improvements and the optimisation of business processes (Agbaji, 2021), and

the potential benefits this technology can bring. As the investment in this form AI implementation project is significant, there is a need to assess the rate of return or ROI from a senior management perspective, along with accurate data needed for the project management and operational teams. This study found that AI can provide real-time information, but also needs to have the correct metrics designed. Closely linked, was the theme of real-time data usage, which was identified as a particular challenge associated with having the necessary technological infrastructure (Toufaily et al., 2021), expertise (Chowdhury et al., 2022) and storage facilities (Lu et al., 2019). The issue around storage is a complex theme, with the recent shift towards cloud solutions in the sector and other industries (Yamakawa et al., 2012; Toufaily et al., 2021). This can be a potential problem due to the storage facilities being often remotely owned by external providers, therefore no longer controlled, or managed by the operation. Finally, as mentioned previously, a digital transformation AI solution needs to have certain expertise and specialisms which may not exist currently in the receiving organisation, particularly as the oil and gas sector is seen as a late adopter to the technology (Kohli & Johnson, 2011; Kane et al., 2015). To address this, the study identified was the trend towards seeking collaborative involvement to address these gaps in skills and expertise, whereby combining oil and gas knowledge with those who have an AI background. But this was found to be also challenging as the industry is known for its silo culture and not sharing business data, thus leading to the question: what level of expertise and knowledge is needed when deploying AI? In addressing this question, the study identified that there was a need for closer collaboration but needs also senior management support. This finding also addresses the earlier work of Close (2006) and Weijermars (2009) who while providing an interesting insight into the original skills needed in the oil and gas sector, had until now not been focused on the attributes needed when implementing an AI solution. This study also updates the work of Bello et al. (2016), who from a Nigerian perspective, studied the importance of having a strong knowledge base and expertise, together with the need for senior management support, by providing a new rich qualitative insight, as opposed to the original desk bound project.

From these themes and the findings generated from the interviews, the study was able to generate a business transformational model to represent how an AI solution in the oil and gas sector can be accurately depicted, together with the creation of an AI Maturity Assessment Tool acting as a tool to reflect on themes or challenges from the past, partly based on lessons learned, and as a methodology to assist in the development of a lessons learned log, which will be presented in greater depth in the next section 6.5.

6.5 Professional Contribution

As mentioned earlier, central to the professional doctorate objective there is the business contribution component. In achieving the aim of the study, to critically investigate the experiences of implementing a digital transformation solution of artificial intelligence (AI) in an UAE operational working environment in the oil and gas sector, this was achieved by identifying two core unique contributions, namely: the development of an AI business transformational model for the oil and gas sector, and the creation of an AI Maturity Assessment Tool which requires the project managers to rank and rate five identified themes to enable them to focus on providing an effective AI solution in the operational workplace, but then act as a reflective methodology.

6.5.1 The Creation of a Business Transformational Model Representing How AI can be Effectively Implemented in the Oil and Gas Sector.

Drawing on project management academic studies, there was an acknowledgement that there was limited research into how AI can be effectively implemented. Although the study leveraged the generalised perspective and methodology presented by Burke (2013), it used the original project management methodology as a framework whereby acting as a reference point and a template for the project. From the findings the study found that there was a clear need for senior management support and commitment throughout the project, which was fundamental. This included the need to establish strategic business goals through a clear vision. To achieve this, there is a need for accurate data to be collected to provide informed strategic decisions to be made. Then fundamental in providing and implementing an AI solution there was the recognised need for an extensive evaluation of the existing and future technological infrastructure, which may need to be externally provided, for example through cloud solutions. To date, although covered from a generalised project management literature, the AI requirements are not covered to any depth, which this study has addressed through extensively researching and then mapping out the steps and components needed, to produce a new framework. Underpinning this first theme or step, was the importance associated with lessons learned. Although not researched from an AI perspective, this study contends that this methodology of reflecting and learning from the past is vitally important, particularly as this technology is unknown and previous solutions could enable the implementation process to be more effectively managed while achieving the intended monetary value outcome.

Leading from the initial stage, which is associated with the strategic leadership, was the identified need to ensure that the skills and expertise is available. This is particularly important when implementing an AI solution, as the implementation team needs to have certain specialised skills and knowledge like the creation and development of machine learning algorithms. To achieve this, this study highlighted the importance associated with changing the culture in the oil and gas sector to be more collaborative. In creating a collaborative environment, the study identified the need for close relationships with external parties including working with commercial companies while also connecting with educational institutions. Closely aligned to this theme of skills and talents, is the requirement to extend the technology infrastructure to include a review of the existing skills base. To assist in addressing potential skills gaps, this study highlighted the need for existing expertise to be shared and for on-going training and awareness through staff development to be embedded into the culture. Through following this strategy, the potentially negative perceptions associated with AI implementations may be minimized. This finding can enable the operational environment to be fully aware of the implementation of AI and its potential, while also indicating the organisation's commitment to the existing operational staff. Identified was also the possibility that the collaboration process can be enhanced to create an innovative environment.

The next stage of the model was associated with the data strategy and the development of an AI model for creating the algorithms, but these needs to be programmed correctly (Ranaldo et al., 2021). AI also requires extensive data, but as noted in the earlier stages of the framework, this study noted that the importance of using the lessons learned methodology, to assist in this critical stage.

As the project progresses from planning to the execution and ultimately to adoption stage, the study identified and captured in the model the need of implementing and then the continuous improvement processes needed in the form of iterative phases. Again, often missed from a project management perspective and particularly in AI studies, has been the need for a logical and structured change management process. From a professional perspective, the study identified this gap of understanding, and drew on the importance of Information Technology Infrastructure Library or ITIL as a possible solution. This methodology firstly classifies the change or modification into three distinct groups and based on these then sets out the protocol to minimize the disruption to the business, a vital consideration.

From the interviews emerged the associated need for the AI solution to have suitable and accessible data storage facilities, which were often needed to be provided in the form of a cloud solution. This however can be problematic for the UAE. Interestingly there was little mention

of this challenge in any of the existing literature from an oil and gas or AI perspective. For the UAE, the compliance regulations are clear as to the location of the data storage needing to be within the confines of the country. This can be challenging due to AI data storage and readiness. Data volumes are large, imposing requirements on the size of the data storage and data needs to be readily available so that the machine learning technology and algorithms can process the data in real-time. As to data readiness, this was originally highlighted by writers including Toufaily et al. (2021) and Chowdhury et al. (2022), who noted the importance of the infrastructure and data availability, which this study agrees, but then extends the existing understanding and knowledge from an operational end-user, project management and executive teams' viewpoint.

Then there is the challenge of ensuring that the data and generated outcomes are kept secure, as the datasets are important from a commercial confidentiality standpoint, but also requires external expertise to be brought in through collaborative activities and initiatives, a theme originally posed by Ng (2008). Related to this theme of collaboration which was originally identified by Korotev and Tekic (2021) who noted that there was a strong dependency on expert opinion in the sector based on experience, which ultimately informed the decision-making processes, According to Korotev and Tekic (2021), this has been transformed and changed with the introduction of digital transformation solutions such as AI and machine learning which are based on only the data available and not on subjective judgement, which challenges the traditional modes of practice. To address this, the study found that the nurturing and supporting of collaborative partnerships was an effective strategy to provide a more holistic subjective and objective insights to make informed decisions but needed senior management support.

Closely linked to above, is the need for ITIL practices to be established, along with a culture of innovation, but also agile to change. Apart from the usage of a systematic and logical framework like ITIL, the findings indicate the need for clear and established routes and protocols for communication, which needs to be supported by senior management. This theme of senior management was a common tread throughout the study and included the need for fostering a culture of innovation initiated and promoted by the executive team (Magill, 2021). Finally, although recognised from an operational perspective as to the benefits of AI in providing real-time information, was also the need for tailored metrics. This means of reporting was equally important for the senior executives as to monitoring ROI and enabling them to create and devise strategic roadmaps, which indicates that the new devised framework is not static or linear, but rather more cyclical.

6.5.2 The Creation of an AI Maturity Assessment Tool for Project Managers to Evaluate the AI project.

The study during the second stage of the interviews introduced an AI Maturity Assessment Tool (initially built as a MS Excel spreadsheet) to enable project managers to reflect on themes or challenges from the past, partly based on lessons learned. The spreadsheet contained five distinct themes which were based around strategic leadership and senior management commitment, data readiness and usage, people and skills, process and optimisation, and the implementation of technology and integration. From these themes the project managers were asked to rank as to perceived levels of importance while also assessing current gaps before and after the implementation process. The activity was then used to inform and act as a reference point as to the outcome of the study, which proved to be a unique but simple tool to use and then reflect on. Again, there was to date little if any research presenting or advocating this methodology. For the project managers, they saw the potential benefits of this tool before and then more importantly afterwards which could assist in the lessons learned log.

6.5 Academic Contribution

As noted in the previous section, lessons learned emerged as a key theme which has been omitted or neglected in the numerous studies of AI being implemented in various operational settings including in the oil and gas sector. This has included the works of Zuofa and Ocheing (2017) who focused on the Nigerian offshore extraction activities, Lu et al. (2019), who provided a comprehensive literature review, as with Weijermars (2009) who conducted a deskbound research project based on operational performance and financial indicators, or with Rui et al. (2017) who reviewed technical and project management research papers and reports to identify factors affecting offshore oil and gas projects. For this study as the technology is still relatively new and untested in certain industries, including the oil and gas sector, as it is seen as being a late adopter (Kohli & Johnson, 2011; Kane et al., 2015), learning from other sectors and projects is vital. This includes learning as to the specialisms and expertise needed, the infrastructure requirements, how the solution will transform the workplace and how to manage the existing team during this transformational process.

A related theme was the need for AI to have more academic research to be focused on the need for more understanding of change management in a project environment, as often as the project occurs or even after the delivery, there are often changes that need to be made. To manage this, although the delivery of the project has been studied from a specialised perspective (e.g.,

Munns & Bjeirmi, 1996) and with a generalised focus (e.g., Burke, 2013), there is little researched as to the importance of a systematic and logical approach is needed to ensure that the same concepts of project management as advocated by writers like Dinsmore and Cabanis-Brewin (2006), Kerzner (2010), Kerzner and Saladis (2009), and Nicholas (2004) are still followed to minimise the impact of business continuity.

Finally, again while there has been extensive academic interest into AI and the challenges of storage, due to the extensive data being generated (e.g., Yamakawa et al., 2012), together with the data associated with the oil and gas sector (e.g., Lu et al. 2019; Lawan, Oduoza, & Buckley, 2020), has led to the conclusion that external storage provisions are needed. However, what has not been addressed is the issue of not only corporate governance as pointed out by Bekker and Steyn (2007) and Derakhshan, Turner, and Mancini (2019) but also the requirement to comply with the UAE's rules of cloud and external storage, which came up from the interviews. This does present the challenge for senior executives as to how to ensure that the AI technology can be optimized for full efficiency (Almarashda et al., 2022), while also adhering to the current governmental strategies and rules related to external storage and cloud technology. This study found that a pragmatic approach is needed, but also reflective of the country's regulations.

6.7 Limitations

The study attempted to provide a new perspective to the adoption of AI in the UAE oil and gas industry, however there are several limitations which could limit the findings. A limitation was that the main study involved only eighteen participants, eleven operational staff, four project managers and three executive or senior managers. However, each participant had multi-company and global experiences, together with an average of more than 15 years of experience. Therefore, reflecting in the sample size, it may be not possible to conclude that this study can be a valid representation of the entire oil and gas sector, or even the industry based in the UAE. However, this study was not intended to provide a generalised outcome but rather a critical rich insight into the challenges associated with implementing a digital transformational AI solution into the workplace. Consideration was given to providing a generalised outcome, but there was limited access to the participants and even with the professional network of the researcher, to use a larger sample size, which intrinsically would be less accessible, would be prohibitively in terms of time and reliability of the provided information.

The findings were possibly limited by the fact that only one person, the researcher, conducted the interviews and the data analysis, but the study being qualitative based, enables the researcher to be part of the process and to act as an analytical device, whereby she could be used specifically to be immersed herself into the data. There is also the acknowledgement in doing this, that data could be seen as being tainted or bias. To address this concern, the researcher sought out every opportunity for the data analysis and its conclusions to be constantly reviewed and to be challenged by colleagues and supervisors.

Consideration was given to those instances where the research needed to be robust and reliable, for example, validating the use of a content analysis approach to code the interviews. Other potential methods to undertake the entire study were considered like grounded theory but was rejected as the methodology was not suitable as the researcher had prior or a priori knowledge. It should be noted however that the theoretical sampling strategy adopted in this study had its origins in grounded theory, but the overarching concept of using a posteriori strategy was not feasible.

Finally, there was the limitation associated with the study as to the association with the connection and complexities of the relationship between the interviewer and the interviewees. It should be noted that the interviewees were known from a professional perspective and there was no direct working or personal linkage to them.

6.8 Future Research

Reflecting on the outcomes from both the professional and academic contributions, future research should focus on firstly investigating the implications of lessons learned as to other AI projects and then potentially provide a comparative study to the oil and gas sector. This would then provide a comprehensive project management study using AI as a lens or vehicle to study this theme.

Another theme to emerge was to the extent to which the UAE regulations and rules have potentially impacted on AI need for suitable and robust off-site cloud technology solutions. Future studies should consider investigating the challenges and solutions as to how the sector and other industries in the country have addressed this need for cloud technology while also complying to national rules and regulations.

6.9 Conclusion

Drawing on the first module on the DBA programme, which was focused on reflective practice and process, I now see this project as a long research journey. The outcome of the journey and study has firstly provided a new academic insight into how AI and digital transformational solutions can be effectively implemented in the UAE oil and gas sector through the creation of a new digital transformational model to accurately represent the methodology while extending exists frameworks, and the development and creation of an AI Maturity Assessment Tool for project managers to capture themes to consider, for them to be ranked and prioritized before, during and at the end of the project activity. Finally, this study has been a process of self-development as a researcher. At the end of this research journey, I realise as to how it has been a personal challenge, but also the project has assisted me and the organisation in implementing future AI and digital solutions.

Nomenclature

ADIPEC = Abu Dhabi International Petroleum Exhibition and Conference

ADNOC = Abu Dhabi National Oil Company

AI = Artificial Intelligence

AIQ = Joint venture between ADNOC and G42 corporation.

APM = Association of Project Management

BMO = Business Management Office

BS6079 = British Standard for Project Management

BP = British Petroleum Corporation

CAPEX = Capital expenditures

DataOps = Data Lifecycle Management Operations

DBA = Doctor in Business Administration

DevOps = Development to Operations

GB = Gigabyte

GDP = Gross Domestic Product

GE = General Electric Corporation

G42 = A corporation with focus on AI

IIOT = Industrial Internet of Things

IOT = Internet of Things

IPMA = International Project Management Association

IT = Information Technology

ITIL = Information Technology Infrastructure Library

KPI = Key Performance Indicator

MLOps = Machine Learning Model Lifecycle Management

MS = Microsoft Corporation

NLP = Natural language programming

PE = Petroleum Engineering

PM = Project Manager, Project Management

PMBOK = Project Management Body of Knowledge

PMI = Project Management Institute

PRINCE = Projects in Controlled Environments

RACI = Responsible, Accountable, Consulted, and Informed

R&D = Research and Development

RM = Reservoir Management

ROI = Return on Investment

SME = Subject Matter Expert

SWOT = Strengths, weaknesses, opportunities, and threats

UAE = United Arab Emirates

UVM = Uncanny Valley of Mind

VBA = Visual Basic Application

VRR = Voidage Replacement Ratio

XGBoost = Extreme Gradient Boosting – machine learning library

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Appendix A. Preliminary Evaluation of The Conceptual Model

Introduction

It was never the original intention of this study to extend the research and apply the framework to an actual project. However, being a professional doctorate, and reflective of the need for a business contribution or application, the decision to apply the concept was made. Reflecting this, this chapter will present how the new conceptual framework was applied to an existing project as a preliminary evaluation of the model. To illustrate this, the model uses the six steps in the process as presented in chapter five, which included the basics of the business transformational model, the skill evaluation and talent acquisition, data strategy used in the AI model development, the execution-deployment, integration, the monitoring, and the optimisation of the activities, the need for change management and an innovative culture, and finally the assessment and tracking processes. In presenting this, this chapter intends to provide an initial summary of how the model can be used by mapping out the findings of the study with the actual processes followed in the project. The integrated capacity management project also referred as the digital project was chosen because it was one of the key digital transformation projects in the company where the study took place. It should be noted that there are no primary data used or presented in this chapter, just the documented outcomes.

Application of The Conceptual Model

The table below, Table A.1 shows how the outcomes of the **one project** follow the six steps in the proposed framework, providing a summary of the various stages. The table breaks down the key activities with associated numbers, based on the individual steps, along with the key processes and activities. The table commences with the identification of the business goals of the entire organisation.

Table A-1 Application of The Conceptual Model

ID	Key activity	Key processes and activities
1	**Step 1: Fundamentals of the business transformation model**	
1	Identify the business goals	The goal was to optimize the production capacity of the organisation by proactive identifying opportunities to reduce planned and unplanned gaps.

Table A-1 Application of The Conceptual Model		
ID	**Key activity**	**Key processes and activities**
1.2	Create a clear vision statement	Sets out the vision of the company, which was to be become a highly profitable and reliable producer of oil and gas. The company wanted to ensure to provide a quick reaction to unplanned downtime and market opportunities, which was then aligned to the model.
1.3	Information gathering from the business needs, the lessons learned methodology and the data	Business needed to automate integrated capacity forecast, planning, and management while integrating well capacities, unplanned downtime, and market opportunities. To achieve this, various departments and disciplines needed to participate in the production planning process using various, workflows, data, and cycle time, but become a complex exercise. The planning capacities relate to various aspects of the asset and the way the processes were managed: • The physical aspects of the asset including reservoirs, wells, surface facilities, pipelines, and terminals), as the system, which drive the technical capacities. It should be noted that these capacities have been traditionally calculated and maintained in models by specialists from multiple disciplines and organisations. • The projects and operational schedules needed to be combined and the set of activities clarified, which drive the asset's available capacities. Originally these processes were set and updated over time in various systems and reports by project managers from different disciplines and organisations. These include EPC projects, well delivery and well servicing, rigless operations, surveillance, and maintenance, integrity. • The operationally agreed target capacities were driven by the business to be executed through the operating teams. These include response to current market conditions and agreed scenarios for the future, adjustments in CAPEX and OPEX within the planning cycle, reaction to unplanned deferrals, and management of opportunities to compensate shortfalls. Lessons learned: • Ensure data is available before embracing workflow automation. • Organisational alignment while embracing such a complex process.

Table A-1 Application of The Conceptual Model		
ID	**Key activity**	**Key processes and activities**
		Identified data sources included: • timeseries data which included the actual and planned production data, the flow tests and pressure surveys, together with project data including the well completions, deviations, and fluids properties. • the low-volume and highly connected information, with the extract-transform and load (ETL) approach being used. • available data was inventoried, its current state defined, and data quality issues investigated. An ad-hoc ETL was then used to construct with the purpose of providing the most data and included several data quality and data population rules on a petro-technical basis.
1.4	Evaluate technological infrastructure	The digital project was then used to automate the work processes to be executed daily. This included the workflows needed to be completed on time to match business requirements. To achieve the intended outcome, hardware requirements were carefully planned and deployed to manage the loads at data, integration and automation, and application portal levels, including dedicated servers for database. The digital project had serial and parallel computations because of dependencies among workflows and performance requirements. This included to update the well modelling, while the ETL processes needed to be transferred the latest data corporate data sources to the project database. Finally, the well-level performance workflow was reviewed. The outcome was that the digital project provided sufficient capacity analysis, with information used to identify and changed on a daily calculation to assist management team decision-making. The result included that the digital project system benefited from parallel computation, which helped to improve performance of the whole system. The system required about 54 hours when run serial vs 11.6 hours when run in parallel computations, or 78.5% less time.

Table A-1 Application of The Conceptual Model		
ID	**Key activity**	**Key processes and activities**
1.5	Evaluate regulatory compliance framework	Integrated capacity planning and management was compliant to the UAE Law No. 8, which requires the periodic testing of wells and fields, and the various shareholder guidelines including reservoir and well management guidelines. This also stipulates the rate and pressure constraints while managing wells and reservoirs.
2	**Step 2: Skill assessment and talent acquisition**	
2.1	Identify skills gaps	All potential users' competencies were mapped at the appropriate level per competency. The definition of each competency was made to ensure that an individual performing a higher level of competency can coach.
2.2	Provide training and development	The training and development program include training material for enhancing eight process-system areas, as follows: (1) System and corporate definitions, e.g., what is "effective capacity"? (2) Petroleum engineering domain, e.g., well performance equations. (3) Model, e.g., well and network modelling techniques (4) Workflows, e.g., how to automate engineering calculations from data access to results. (5) Software, e.g., overview and understanding of the various commercial applications used for modelling, data management, visualization. (6) BPM Processes, e.g., overview and understanding of the various business process created for people-to-people collaboration including daily capacity review. (7) Use cases, e.g., overview and understanding of the use cases including shortfall analysis and opportunity identification. (8) Integration, e.g., overview and understanding of the integration components including data, models and cross-functional decision making.
3	**Step 3: Data Strategy with AI model development**	
3.1	Identify data availability and quality	Several new datatypes and data sources are required in production capacity planning.

Table A-1 Application of The Conceptual Model		
ID	**Key activity**	**Key processes and activities**
		This data included well completions and deviation surveys, flow and pressure tests, daily allocation and measured data, string status and function, simulation input data and planning and forecast input data. This data was housed in multiple databases across the organisation with numerous data quality, inconsistency, lack of standardization and availability issues.
3.2	Assess data collection and integration needs	The data supporting the digital project system was sourced from several locations, stakeholders and across various states in the data lifecycle journey. Data required to be organized and defined into consistent and standardized schema appropriate to state of maturity of the data in the data lifecycle journey. To manipulate and transform the data into minimally viable states sufficient for a first principles-based application, multiple data manipulations approaches were used, including formal extraction-transform-loading functionalities. In the extraction phase, data is extracted from scattered corporate repositories, spreadsheets, and internal databases. Each of these sources were utilized immediately upon discovery whilst plans for their eventual adoption and inclusion formalized and included into standard data management processes. During the data transformation phase, data is converted into formats suitable for digital project that are not necessarily a requirement from the corporate data repository or interim source data. Focusing on a standard data model for input data, while typically desirable, had an ostensible impact on delivery time and impact on the overall deliverability of the solution component. During the data loading phases, data was loaded into the appropriate final and/or staging tables for processing. The outcome, was that these ETLs took less than fifteen minutes to run and are singularly responsible for update, coordinating and refreshing data into project database for use by the overall solution.
3.3	Ensure that the data is cleansed and	The digital project results are consumable across several different stakeholder organisations.

Table A-1 Application of The Conceptual Model		
ID	**Key activity**	**Key processes and activities**
	there is quality assurance.	As per the data management lifecycle, the delivery of the analytical results as well as data quality flags and exception flags into the corporate analytics store. The upstream data analytics hub was used in other petro-technical and analytics applications, in addition to business intelligence visualization (BI) and business process management (BPM) user interfaces. This was important to maximize value realization from the results, as the results can be consumed by other applications going forward. Therefore, while planning the data management strategy for the digital project solution, the following was required: (i) accelerating data lifecycle journey for new and existing data types through a fit-for-purpose data management approach, (ii) incorporating corporate data repositories while enabling data stewardship process through qualitative, quantitative, petro-technical data quality rules. and (iii) mapping data management lifecycle with the goal of complete data stewardship for the organisation in support of current and future petro-technical workflows.
3.4	Development of AI solutions and models	The digital project was needed to process a large volume of data and run over 10,000 wells and network model every day in a short period of time to derive production capacities for over 8,000 nodes across the production network. The digital project considers the application of AI for predicting well performance and reservoir performance forecasts using AI models. Firstly, digital project was deployed as a methodology to create well proxy models to replicate well performance without using physical models in the automated computations. By using nodal analysis output as training data of a data-driven response model, the trained proxy was able to predict well behaviour for multiple operating constraints within the training region, and within a fraction of the time vs the physics model.

Table A-1 Application of The Conceptual Model		
ID	**Key activity**	**Key processes and activities**
		Secondly, future production capacity planning required for the digital project to access future well performance derived from reservoir performance forecasts. The outcome was that the digital project solution integrates more than one hundred reservoirs, related facilities through a single integrated network. It should be noted that traditionally, any modification in reservoir development plan will require to generate new full-scale reservoir simulation files and relevant well performance data, which would be computationally challenging. The digital project deployed a methodology now creates fast reservoir models to replicate the behaviour of the reservoir simulation model by: • using the full-physics simulation output as training data of a machine learning model • forecasting reservoir behavior for multiple rates, near the training region.
3.5	Assess data security needs	Data security in digital project follows standard cybersecurity and data management practices established by the organisation.
4	**Step 4: Execution-Deployment, Integration, Monitoring and Optimisation**	
4.1	Launch of the pilot project	Digital project solution was originally requested by senior management. Such a complex project was demonstrated to the used by a single level production capacity model and corporate definitions of rates and production management. The solution could then be planned and deployed for larger scales with a phased approach. The outcome was that the ***pilot phase***: integration of key data sources, build a capacity mode for 2-3 assets and test the concept of shortfall and opportunity identification. ***Phase 1***: integration of all data sources, build data QC layer, add automated well model building, completed a capacity model for all major assets, and deploy the concept of shortfall and opportunity identification at countrywide. ***Phase 2***: added compositional model, reservoir surrogate model integration and remaining assets.

Table A-1 Application of The Conceptual Model		
ID	**Key activity**	**Key processes and activities**
4.2	Implement and scale across the organisation	Digital project encompassed several automated functionalities including routine daily calculations at country, asset, field, reservoir, and well level. Also, the digital project provided a framework for the user for proactive shortfall identification and compensation through value-added opportunities. Digital project performed routine calculations to derive value added opportunities and identified proactively shortfall identification. The outcome was that the digital project components included a national model involving 7000+ wells, 100+ reservoirs, 8,000+ nodes of surface pipeline networks. This also included the processing facilities to terminals for effective calculating production capacity considering planned shutdowns and addition of new wells. The business process workflows include daily running of a set of predetermined scenarios, automated ETL, model and data quality, and quota management through stakeholder call-for-action issue and tracking.
4.3	Continuous monitor implementations	Continuous monitoring involved the tracing the functional requirements completeness through a traceability matrix (RTM) in the planned phases. The outcome was that the RTM provided a method for tracking the functional requirements and the implementation through the development process. Each requirement was included in the matrix along with its associated section number. As the project progressed, the RTM was updated to reflect each requirement's status. When the product was ready for system testing, the matrix lists was used for each requirement, determining what product component were addressed, and what test verify was needed to check the implementation process.
4.4	Continuous iterative improvements	Digital project development was seen as an ongoing process. Not only there was an iteration of ideas in the initial ideation, but once it was put online it was crucial to keep working through ideas to improve the product. There had been multiple designs or prototypes testes along every stage of development. The stages involved in continuous iterative improvements are based on the following:

Table A-1 Application of The Conceptual Model		
ID	**Key activity**	**Key processes and activities**
		• *Planning*: mapping out the business expectations and the requirements on the functional design specification. • *Analysis*: refining the needs of the solution and working on a design that fits the requirements. • *Implementation*: designing workflows in a way that fits the specifications and meets the solution needs. • *Testing*: Identify problems and challenges and work through them with various members of the business. • *Evaluation and review*: Compare the results of the iterative process and see if expectations have or have not been met.
5	**Step 5: Change management and innovative culture**	
5.1	Communicate the benefits and provide training	The success of the digital project investment centres on its continuous utilization to identify opportunities for optimisation and follow-up on value realized from the recommended actions. This was drawn from the stakeholders' perspectives. Stakeholders' engagement was sought from the onset as being essential since the digital project was a digital transformation project, which radically change how the original exploration was conducted. For this reason, two components of change management were built into the rollout plan: (1) training and (2) communications. The outcome was that the training programs following these activities: • *Awareness sessions*: these sessions covered objectives, scope, functionalities, system description, visualization of results and features upcoming from the following phase. • *Power-user training workshops*: The workshops consisted of 2-4 half-day sessions typically during the same week for groups of potential upstream users. The agenda includes digital project overview with a detailed explanation of the workflow, user interface and demonstration of its use, running the digital project model and obtaining results, data-feeds, database and data-outputs, automated workflows, network and, well models, and questions and answers.

Table A-1 Application of The Conceptual Model		
ID	**Key activity**	**Key processes and activities**
		• *User-group dedicated workshops*: These were held both as training and communication activities. The participants were mostly engineers and team leaders from a given asset. The workshops' content and format were a blend of awareness session with certain aspects of system demonstration, normally with actual data and models of the same user-group. The communication program was planned within a one-year's horizon, focused on the rollout in upstream, including value chain integration. The communication activities included newsletter, presentations, and opportunity reviews fitting the regular business schedule, which provided the right setting, audience, and business reason.
5.2	Foster a culture of innovation	Business process management (BPM) automation was incorporated in the digital project solution from inception, primarily to facilitate governance of the innovation and collaborative processes. To address this, BPM workflows were developed during phase-1 of the implementation for the following process areas: (1) call for action on shortfall validation and identification of opportunities for compensation and ramp-up; (2) business plan / quota validation; (Hafez, 2018) and (3) calls for action on data and model quality (Al Jenaibi, 2019). An alternate scenario BPM workflow (ASW) was implemented in to manage the generation of alternate scenarios for digital project. ASW facilitates execution of the following activities: (i) Initiate a new case with definition, detailed configuration, approval, and scheduling to run one or more alternate scenarios for a common set of objectives, justification, and expectations. (ii) Track status of execution of alternate scenarios within a case, evaluating and registering for future use of the results of the alternate scenario runs. (iii) Add digital project alternate scenario definitions for approval as required or close the case.

Table A-1 Application of The Conceptual Model		
ID	**Key activity**	**Key processes and activities**
		(iv) Search, retrieve and visualize previous cases along with digital project alternate scenarios within each case.
5.3	Close gaps in skills and capabilities	Development of a comprehensive set of skills for the digital project included a formal program to address the development of fifty skills. These were developed following industry best practices and general guidelines and standards from organisation. To achieve this, the target audience covered technical and business roles within upstream. Each competency was defined along with the evaluation criteria for each of the three applicable levels as follows: (1) aware, (2) performance, and (3) expertise, with the necessary skill sets set out above in stage 2.2.
5.4	Adopt new business operating model	The digital project Sustainability requires organisational adoption of the solution as a "living system." Part of the solution design included a proposal for an operational model that includes a description of roles send competencies for the users, process maps for the primary workflows, and RACI charts to be applied beginning with the rollout. The change management components, including training and communications, and the recognition of early adopters and wins were put in place to enable organisational adoption. The outcome was that the most effective driver for organisational adoption was to provide solutions to address real problems. Included was setting out and proposing new ways or solution centres on continuous utilization of the digital project to provide value. This also included a follow-up on value realization from short and long-term opportunities for optimisation. With changes in the global energy landscape, this has led to significant changes in exploration and the need to identify opportunities. This included to optimize large variations in the production forecast and multiple scenarios for the 2020-2025 business plan.
6	**Step 6: Measure and Monitor**	

Table A-1 Application of The Conceptual Model		
ID	**Key activity**	**Key processes and activities**
6.1	Measure ROI and track KPIs	Digital project has delivered tangible and intangible value. From the tangible point of view, digital project contributed both in terms of production gains by compensating during specific proactively identified shortfalls and after-the-fact events. The outcome was that the digital project has provided cost reduction scenarios and profitability due to the optimisation. Digital project has reported various intangible gains in terms of better data utilization, enhanced corporate data base quality and reduced overall human load in managing production capacity. **Tangible** **Value** *Maximize field technical rate* Multiple disciplines across the organisation participate in the maximization of FTR and FAR. Throughout 2023, assets established new capacity targets and perform capacity tests to demonstrate their compliance with the planned capacity growth. *Maximize NGL's in upstream facility* The outcome was the digital project now delivers pressure and fully compositional rate performance across the nation's surface pipeline network. This now allows multiple sensitivities at any modelled node in terms of pressure, temperature, rate, or component fraction selection. *Reduce operating cost by minimizing WCT* Digital project can run standardized scenarios periodically that focus on cost reduction while meeting the capacity constraints and target quotas. In September 2019, a scenario to reduce operating costs by minimizing total water handling and achieving the same oil business plan targets was performed on two major assets. The scenario reached the same oil target while recommending rate adjustments on wells above 40% WCT, reducing water production from 30% to 13.8%, and honouring all reservoir management guidelines. Translated into up to 48% water handling cost reduction and saving of ~120 MBD of water production

Table A-1 Application of The Conceptual Model		
ID	**Key activity**	**Key processes and activities**
		and injection. *Compensate during planned shutdowns* The planning cycle drives the line-of-sight of the production forecast and, therefore, performance management. During March 2020, a major asset planned shutdown indicated a ~20% reduction on the average monthly production availability, based on the traditional computations. After running digital project business plan validation scenarios and optimisation, the revised figure increased, enabling a production compensation within the asset. The resulting production gain exceeded 50 MB for the same 30-day period. *Compensate during unplanned shutdown* digital project represents a concept, including multiple assets and multiple production and injection networks, in addition to the planned maintenance activities and the active well strings schedule. In October 2019, a major asset planned a shutdown that would have caused a reduction in 15.1% on the target average monthly production availability. After running digital project production in 2023, quota maximization scenario, the revised figure decreased from 15.1% to 1.6%, enabling an 89% compensation within the asset. The resulting production gain exceeded 52 MB for the same 30-day period. *Maximize gas availability at constant oil quota* Digital project generates scenarios as to addressing multiple constraints throughout the process, including an asset level, fields, reservoirs, and wells, including minimum/maximum GOR. **Intangible Value** *Enhanced data quality stored in corporate databases* Initially, ~30% of wells had either missed or inconsistent data (e.g., completion, PVT, and pressure). Due to the continuous use of the digital project, data available in UDH and other sources had been continuously exposed to the system and users. *Providing a foundation of data quality management*

Table A-1 Application of The Conceptual Model		
ID	**Key activity**	**Key processes and activities**
		Digital project runs a data quality check on all data to be consumed. Due to the data quality workflows, less than 5% of the wells today have missing or inconsistent data. Digital project can create tables of curated data to be consumed by other organisational applications, including completion data, active strings, and future wells strings. Many of the data management quality assurance processes can reuse the ETL results since it has many business rules ensuring data quality. *Data quality KPI by cases*. The process creates a report of significant data issues, such as flow test data component missing, inconsistent units, lengths inconsistencies, invalid reservoir pressures, no active tubing, and casing dimensions inconsistencies digital project indicates the major exceptions occurring in the databases. *To compute capacity and business plan validation* Every quarter, several thousand person-hours are spent preparing, analysing, and approving quotas though the production management plan process. With digital project this process can be streamlined, and the labour requirements are reduced over 70%. Without it, this process would be impossible to do it daily to monthly. *Concession agreement compliance* Digital project allows the review of all assets, field, and reservoir level capacities (FTR, FAR, FSOPR) while following all reservoir management guidelines. This allows the automated and continuous review of business plans in accordance with contractual obligations.
6.2	Continuous assessment of ROI	Several value-added use cases have been continuously analyzed to highlight the benefits of a large-scale IAM. The outcome is that digital project can deliver tangible value by identifying production increase in the framework of a highly constrained on the nation's network, forecasting capacities within 1% of the actual tests, compensating shortfalls during specific events, and providing guidelines for cost reduction. Digital project has derived scenarios for increasing the nation's profitability by maximizing gas production while maintaining the same oil targets.

Table A-1 Application of The Conceptual Model		
ID	**Key activity**	**Key processes and activities**
		For planned maintenance and unplanned shutdowns events, digital project has enabled an 89% production shortfall compensation within the same asset, with a resulting gain exceeding 52 MB for the same period. The result was that project has enabled up to 48% water handling cost reduction and savings of ~120 MBD of water production and injection. In addition, digital project reported to have many intangible benefits including data utilization, enhancing corporate database quality, and reducing the overall human load in establishing and managing production capacity.
6.3	Develop of a strategic roadmap	The strategic roadmap for the solution can be established based on the following: • Provide work process improvements including expansion of nation's scenarios to integrate with downstream. • Expand user base across the various upstream functions, assets, and fields. • Provide system extensions and enhancements. • Ensure user adoption by monitoring user use and process standardization. • Provide continuous end-user support. • Monitoring system performance and ensure high availability. • Continuous corporate data quality assurance and model governance. • Review and upgrade solution technology.
6.4	Explore potential collaborative partnerships	It was not possible to explore or determine potential collaborative partnerships for digital project. However, possible collaborative partnerships could include: • Extension of the tool to include workflows with operating assets. • Commercialization of the solution outside the organisation's using one or more of its technology providers.

Appendix B Interview Results

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
Data Readiness	P2	I know. However, often we have the data originator being different person that the data custodian, and the data user for the new purpose. Many are gone and not available to involve from the beginning of the project. So, an integrated approach to have the right data is to promote updated data requirements. In data management people calls it data definition standards. The data definition needs to be stated, and the data quality requirements must come from the user community, because the users know what they need for the intended purpose.
Data Readiness	P2	Another key aspect for the success of AI is data availability. We all know that AI solutions normally depend on having lots of data: For example, historical data, benchmark data, expectable data patterns, relationships, etc. Even If there is data in the company, we may have an environment where it is difficult to get the data, whether because the IT infrastructure or policies will not allow it.
Data Readiness	P2	Another key aspect for the success of AI is data quality. We do not necessarily need all data to be clean and of 100% quality. What we need is data of "known" quality. Traditionally in our industry a few key users understand the qualification of the data, but many move to other jobs which makes difficult to use available data for AI.
Data Readiness	P2	I, I have worked close to the data in ADNOC over the last five years, but not so much in the last year. I think that the most important aspect about the data is knowing the quality of the data. Not necessarily fixing it or getting it perfect. The biggest challenge that a user of the data has in many companies, not just ADNOC, is to know what the level of quality required of the data for the intended use.
Data Readiness	P2	Let me give you an example: We needed to find wells in some fields where there is identified capacity in certain aquifers to CO2. We needed to pre-select wells based on certain criteria to be considered as candidates for screening to become re-used for CO2 permanent injection. These are wells that may be re-purposed. We need access data about those wells to evaluate the feasibility and remedial actions necessary to rise the integrity capability of each well regarding containment barriers, and many other aspects. This will ensure that the wells can be safely repurposed without damaging the reservable without damaging the environment and community for hundreds of years. In this case it was a challenge not only to find the required data, but to explain to those involves in the drilling and asset teams that different data was required to evaluate the well repurposing, and that things that were reported ok in previous well reports for a given well section and reservoir, wouldn't be ok for the new purpose. Other things were observed. How do I know if the data of the well shared with the study team is complete? Are there any more logs? When you are going to use this data for a different implementation or different technologies, you spend a lot of time qualifying the data, checking the data against offset wells, double checking against reports, etc. Not only we need to understand the level of completeness, but the precision and accuracy of the data acquired a long time ago.
Data Readiness	P3	After that, usually they know the data that needs to be used in order to solve this specific problem they give us, like insights in order to solve this problem, we need this data set, and this is my output. And to select dataset Usually they, when we, depending on the phase of the project, for example, when we are in a proof of concept, we usually do use perfect in order to solve a problem.
Data Readiness	P3	And the of course is selected by the subject expert mater and they support us along the process in order to visualize this data and understand it in terms or from scientific point of view and sometimes to give us insight how to fix some issues related to that product.
Data Readiness	P3	One of the biggest challenges is to have a good data set actually that can help you to solve the business case.
Data Readiness	P3	also, in terms of governance for certain projects when data is strictly confidential, so sometimes take a long time to get this data to be used in the project,
Data Readiness	P4	scattered data are in silos.
Data Readiness	P5	And so multiple systems that are doing something very well, where the value is obvious, and they see each system can talk to each other. That is the kind of approach that we are following here. So, the value needs to be super obvious, for example, in the ticketing system that we have created, the value is truly clear. People use it to communicate with different people. The virtual meter thing is truly clear because the problems are obvious, and you have a reference to fix the measurements. We fixed 80% of the measurement issues in two of the large fields.

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
Data Readiness	P5	But this is, you have a lot of different measurements, pressures, temperatures. What if we use those measurements to estimate flow independent of the transmitter? And then we can compare against each other. If they align, then it is more likely that your measurement is correct. If there are not aligned, the model is wrong, or the measurement is wrong, then it starts adding more evidence towards fixing that problem.
Data Readiness	P5	If you cannot describe the thing concisely with a few phrases, you are done. It needs to be well, scoped and needs to be obvious. It needs to be properly modularized. Like, if you have created one system that can solve everything, that system will solve nothing because people get overwhelmed.
Data Readiness	P5	it needs to be very obvious like, "oh, look, there is something that I did not know was happening. Now it has made it obvious, let us fix it," and then it has done. The moment the value starts becoming less obvious in value, then you have to justify why people should change their ways of working to adopt what you are producing. It starts becoming overwhelming. So, if you want to go too advanced, like if you want to run before you walk, we have a problem.
Data Readiness	P5	You may produce something that is super advanced, nobody will use it because you still do not have the processes and the systems that you need to get to that level of sophistication.
Data Readiness	P5	reservoir engineering top-down modelling for reservoir simulation and the false interpretation, just statistics application, all that stuff that is another degree of complexity. That requires expert data scientists with expertise in the domain for a lot of simple models.
Data Readiness	P5	There are several types of digital transformation projects, this is general, not only AI projects. So, one digital transformation project is about creating systems that are mandatory business process management, let us say SAP. You have no way other than using SAP to do your things. For the project that we did here, the automatic reservoir production reporting, annual reservoir performance reporting. This is a business process management tool that people will use. That was a success. Of course, there is no way that you will not succeed because everyone is forced to do it. Then once we have the decision support systems which is the other thing that we are working on, like the systems for production surveillance for managing the models for calculating the allowable, like optimizing the patterns. It is much harder for people to adopt.
Data Readiness	P5	Yes, and hopefully also see how some of these technologies can apply to whatever they are doing. They do not necessarily need to be the ones that are going to implement a deep learning algorithm for reservoir management, multiple scenario things, but enough to get the idea that you can do something with this technology. So, you can approach the experts or vendors who can implement it for you. It is difficult to replace creative workers. Knowledge workers, we are not there yet just forgetting it.
Data Readiness	P5	You have always played with all this engineering standards and equipment etc. But in reality, you may have configured the flow computer wrong or maybe you put the wrong flow element in the flow transmitter.
Data Readiness	P5	you need to check your well because there may be a problem. That is the abstraction that you have to do. So, you have only a neural multi-layer perceptron thing with the XGBoost and the whole thing on the back, but it is all about like, this well has a problem, and this is the problem that the well may have — please act! And this is a recommendation.
Data Readiness	P6	So first we need to define the need from the Asset, We need to see if this project will be helpful for ADNOC business, we need to build a business case to show how much it would cost us this project and how much it will bring as value for ADOC, and also the alignment with all the stakeholders to make sure that this tool or this project, when the project completed successfully, it'll be deployed Across ADNOC group.
Data Readiness	P6	There is a risk of DEC of our data. So, it is better to have someone within the team that team that can do this update, this training, and this guy need to know. I have minimum knowledge about machine learning, how to train these models, how to validate them.
Data Readiness	P6	And this is, this may have impact and the risk additional risk from data, which is SENSIT. so, uh, now fortunately we are pushing, uh, most of the major big companies and cloud service provider to move their cloud to UA. For example, Amazon web services are developing, uh, cloud in UAE group 42 as well. Uh, Microsoft, uh, uh, also they are building cloud in.

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
Data Readiness	P6	And this is, this may have impact and the risk additional risk from data, which is SENSIT. so, uh, now fortunately we are pushing, uh, most of the major big companies and cloud service provider to move their cloud to UA. For example, Amazon web services are developing, uh, cloud in UAE group 42 as well. Uh, Microsoft, uh, uh, also they are building cloud in.
Data Readiness	P7	how to manage the unstructured data or the manual data.
Data Readiness	P7	how to structure the data, not about the data availability, exactly how to build the database that can function for any model, to be flexible, to collect the data efficiently, and then to QA/QC the data.
Data Readiness	P7	this is important and how to incorporate unstructured manual data
Data Readiness	P7	To be part of the training process of the model, eh, has been challenging because, uh, you need to prepare. The database is good database in order to do not over feed or avoid low prediction.
Data Readiness	P8	the main factor that would discourage the application is the accessibility and quality of data. If, if you do not have good data and accessible data so that the person can play with-it, can-do things with it, you are not going to be able to in any way or. be successful to implement AI within your organisation?
Data Readiness	P8	it is related to the value proposition, but, but it is also. The, in my experience, one of the cha the major challenges are the, the, the recognition or the identification of the, the limitations that you may have related to the availability of data. The ai, excuse me, ai, the success of an AI project depends a lot on the availability and the quality of.
Data Readiness	P9	So, the technological challenge is the Capex if you want implement AI. you need data. If you want data, you need sensors. Sensors cost money, and oil and gas assets are sometimes scattered. You know, you have many units in a site and many sites in the group of companies and many of companies in a company. So, it adds up to be a lot of money and, that hardware also needs to be. if the hardware is in the middle of the desert or the sea, it is exposed to rust, exposed to many forms of failure.
Data Readiness	P9	To develop AI solutions. You need data. Let us say you do not need to install new hardware. You have already an existing data historian. Sometimes the quality of the data does not meet the expectations for the minimum requirements to build models. For example, instead of having one data point every hour or every day for a given tool, you have a data point. there is not much that you could do with that. So, this is a key challenge, the quality of the data.
Data Readiness	P9	You would have to use more than one data source. So, for example, let us say I am looking at a site in ADNOC gas processing. My first data source would be the most convenient data lake like Panorama or Thamama in a different context.
Data Readiness	P10	AI is actually the forefront and the last layer of software solution connected to data and sensors and simplify people day to day job and management to accelerate their decision making,
Data Readiness	P11	And these things may, go un invisible. And this is that is why a lot of talks about ethic and AI development and how to, what this regulation that can be. So that we do not fall into these traps and these sorts of forced behaviours and while developing the ai also from the external environment perspective back to the first point.
Data Readiness	P11	As an example, if you were talking about statistics there could be, some efforts discriminating efforts by some individuals by taking a part of the sample. Just for an example's sake, if we were talking about African a. So, you can take out the African American related data from your dataset and make the AI model to learn and to eliminate these automatically.
Data Readiness	P11	So, you will see more of these projects focusing on the on the environmental related initiatives, but also if we talk about other aspects of avoiding bias and the algorithms there, is there, there is a lot of talks about ethical development of ai and. And building bias in the AI by playing in the data.
Data Readiness	P11	There is we have a lot of challenges. One of the basic challenges that are related to AI is the availability of. And second thing, even if the data is available, it is in which form, or which systems is it accessible or not accessible?
Data Readiness	P12	So similar organisations, especially the direct management or direct supervisors, should have a little bit of understanding of what the results of the AI tool are about. They need to understand that they that the tool is like a model is like a simulation model that there are certain input data that that data needs to be of a certain quality, but even the results of the model can or could have certain, let's say, deviations from the actual they're not necessarily

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
		perfect, and they need to understand that the models need continuous improvement that the data needs to approved needs to be validated by experts to need to be implemented in the field, but then the results need to be fed back to the actual tool, so it's a continuous learning process by itself a colour implementation
Data Readiness	P12	the common factor across all the projects is about the availability of the data, which comes in many situations and most likely the availability of real-time data and they conveyed between the data on the user side and the project side another type of challenge has been to create the right convincing case to management and making sure that the project is accepted in other situation the challenge has been for example procuring the right resource for projects in sources I would say human but also it could be software and hardware for that particular project.
Data Readiness	P12	So similar organisations, especially the direct management or direct supervisors, should have a little bit of understanding of what the results of the AI tool are about. They need to understand that they that the tool is like a model is like a simulation model that there are certain input data that that data needs to be of a certain quality, but even the results of the model can or could have certain, let's say, deviations from the actual they're not necessarily perfect, and they need to understand that the models need continuous improvement that the data needs to approved needs to be validated by experts to need to be implemented in the field, but then the results need to be fed back to the actual tool, so it's a continuous learning process by itself a colour implementation
Data Readiness	P13	Savage in the companies to be the driver of this transformation means that today in majority of the exist, people dedicated to identified challenges that can be solved through digital technologies and AI. And this has been successful step to ensure that the organisation start to be more mature. And with more knowledge in AI and digital technology, this has been helping, this has helped accelerate digital transformation.
Data Readiness	P14	AI projects are very data intensive. Having excellent quality, timely and integrated data is key pillar for AI implementation and its success. AI projects most of the time are executed as pilot or PoC and many a time the existing organisation technical environment challenges and data challenges are overseen.
Data Readiness	P14	This is not possible until we have a clear business case that shall help improve the business process of the users. This requires defining clear objectives, early engagement of the key business users, business buy-in (management and users) and demonstrate measurable success while ensuring the solution is simple and intuitive.
Data Readiness	P15	examples where sensors deployed in the field, but that sensor is not connected to, uh, you know, it is just sitting there isolated
Data Readiness	P15	be able to link all that data-to-data historians that then feed into, uh, the required digital platforms to process the information.
Data Readiness	P15	need to have the data flow
Data Readiness	P15	PESS, I, its data management
Data Readiness	P15	the digital oil fields. Um, in terms of technology, it is having all the different, um, well, the sensors. You need to have all the right sensors calibrated. We need to have maintenance crews to make sure that is, that is working properly. Um, and you need to make sure that you have all the right inputs. PV T
Data Readiness	P15	you need it. to make sure that things are, uh, connected and flowing properly.
Data Readiness	P15	You need to have, um, data management to ensure that all the data is stored, and that people can access it.
Data Readiness	P16	think that today, every engineer has to have a minimum knowledge of data sciences of how to use data to be able to improve performance and efficiency. And, I mean, yes, we do not have data scientists in the subsurface, but we have AIQ to support. We have us, the data sciences that sits in technology function to be able to support, but minimal knowledge in terms of skills of reservoir, petroleum and production engineers is definitely, I think today it should be a necessity. At least the understanding. It does not have to be the technical, I mean, the technical work of developing an algorithm, but the understanding of how data analytics
Data Readiness	P17	its accessible to anyone from the company and the information is available in our internet even training sessions are available
People and Skills	P2	Data science competences should be adopted for technical and analytical roles in the company. There should be some set of skills that people acquire to the level needed by the job, just like using modern office business tools in present time. Subsurface teams are just a segment of the technical and business analytical employees.

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
People and Skills	P2	Some people in a project team need to be experts in the science aspect of data science and others need to be experts in making it work. So, I do not think we need everybody to be a data scientist
People and Skills	P2	, we are assuming that the tools will be there, also that we are going to have qualified people to use them
People and Skills	P2	Development and adoption of the solutions require engagement of several stakeholders, but that can be and is being done in all major digital transformation programs. Sometimes things take longer that we want, but with an excellent value proposition that addresses a well understood problem or opportunity, the solutions are normally approved and eventually deployed.
People and Skills	P2	It is going, it is very well crafted. We already finished the first cohort. There were a 10-participant company selected all of them through innovators. The programme is focused on de-carbonization and the transition to the new energy, digital, and also takes upon some of the petroleum engineering solutions. we are partnering with BP and Equinor to lead this program as strategic partners. I am particularly involved on that, and it has been a wonderful experience so far. We are going to go for two more years for two more cohorts. And our objective is to bring more of these innovations to address opportunities and gaps within ADNOC
People and Skills	P2	Management should create the environment for AI to work best, for example, setting the right infrastructure, facilitating data sharing, acquiring the right competences and experience, putting in place dedicated organisations (like AIQ) to help the business in definition of needs and then deliver solutions to real problems.
People and Skills	P2	There are digital teams in ADNOC, and they are quite active to my knowledge. Adding more digital teams may not improve the digital transformation challenges. There are a quite a few aspects that can be addressed to make those teams more successful, some of which I have mentioned already.
People and Skills	P2	this is an interesting question. A good model is an organisation that has team members with the right combination of domains knowledge or the scope of the project (for example: Drilling engineering, Reservoir or Production engineering) plus others with data management, data science, and analytical tools knowledge. Over time, some of them will learn from the others. I would not delay an implementation until the “perfect” team is in place. You may start by combining skills of different people, if they know well their discipline and they understand the problem we are trying to solve.
People and Skills	P3	for a successful rollout of your apps, last time I was talking to one of our customers and he said in certain projects it is 20, 30% technical, 70% it is alignment of the stakeholders. Because when you do this kind of projects, some only people, but with end users, you have management, we have finance, so we have lot of factors in the sea that they need to be aligned. For the same vision, work as a team toward the same goal. Even sometimes you can have some stakeholders that are in the line. So, it is especially important to have dialogue with them to explain why we are doing this, why it is important, and also to get feedback from them. They have to say about this, project, or this product.
People and Skills	P3	and to be agile actually to adapt to extent. And accept that sometimes you need to change a little bit of your direction and go of course, to have a high value product.
People and Skills	P3	So, in terms of knowledge of AI at least to have basics how to develop, the process of training the models, also to manage expectations because in certain situations we think that AI is magic stick you will solve problem quite easy. It is not that it is difficult to challenging to implement AI solutions. It is particularly important to explain this with examples.to highlight sometimes the cases where it is difficult to apply AI at the current stage as status of technology today. also, it is important to explain to organisations, the development processes. It is not waterfall or like you have the plan, so you, you must less, achieve timeline required for each milestone. Software it is more agile and agile, so it is important to educate end users mindset, understand the complexity of developing software.
People and Skills	P3	Also, in terms of hands on, I would say lot of stakeholders. Some pass actually there is IT department as well. There are certain security measurements to be done. it is important to engage them from the beginning as well. So, they are aware of the scope of the project. They are aware of the data sources to be used in this project and they will help you among the process to implement secure solutioning retrieve the data and use in your product.

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
People and Skills	P3	And the of course is selected by the subject expert mater and they support us along the process in order to visualize this data and understand it in terms or from scientific point of view and sometimes to give us insight how to fix some issues related to that product.
People and Skills	P3	it is one vision. You need to like one team, one from the customer side and from the development side with all the required resources to develop solution and of course with the continuous management support.
People and Skills	P3	One of the biggest ones is to have a complete team to manage its project. Basically, need software engineers for the software from architecture. We need the scientists to train the models, need machine learning engineers who will support data scientists to integrate models, to have some pipelines and so on.
People and Skills	P3	You will need the subject matter experts who know very well this subject and even the reservoir and the area where we are doing the project. And these people are especially important Because they will help software to understand the business. You need the product manager, someone ideally from this area of expertise who can help you unobstructed vision about your product, and clear roadmap, and the features that need to be implemented
People and Skills	P3	users' involvement during the project execution is particularly important to make sure to this agile mindset because we start by scope, features they want and by user's feedback and sometimes it can be especially important They give you one or two ideas and the accuracy increase by 10%. Amazingly simple to implement by the way they think, for example in this situation, look, if you have this sensor here and this sensor there means you very quickly increase your accuracy.
People and Skills	P3	But if we keep out the team alone without this feedback, they can spend months, months without achieving that accuracy.
People and Skills	P3	Well, it is actually, it is much, much easier because they are motivated, they understand the challenges and they know how to support the right way.
People and Skills	P3	And even in certain situations we can involve them in development process in terms of hands on to have supported scientists to develop Model. And even themselves because they have this knowledge and the best way to use it is to have hands on experience to implement, to see output on actions
People and Skills	P3	Well, when you start you project It is important to have the full team SMEs, Data Science because there is Certain applications are extremely specific and sometimes, we do not have at the beginning subject matter expert, so it is important to have the full team from the beginning. Also, from the customer side we need management support on all levels to make sure that the adoption of AI will be successful in the end.
People and Skills	P3	Well, for example, subsurface is abstract, you will not see it. You have an application with reservoir management. In reservoir You have few wells. I am not an SMEs, okay. I know enough to get myself into trouble, but not enough to get out of it.
People and Skills	P3	Okay. So, I will take the risk .in subsurface you do not measure for every wells. Sometimes we you need measurements pressure to improve production, but as in subsurface, you do not have the measurement from everywhere. And we will implement this solution which will improve, reserve management somehow.
People and Skills	P3	How you are going to prove that solution. It is difficult. Even if you use certain assumptions in other areas, for example, you implement, for example, a solution to improve rate of penetration drilling can be AI or it can be hardware. Do you proof of concept and then you rollout after one year you say, okay this year I drilled $100 with this cost. This year, for example, you improve the cost reduction by 10%, but who said that this, it is your technology used Because what will happen, these one hundred wells you have other technologies at the same time that are used. So how to isolate yours. it is overly complex process actually,
People and Skills	P3	So usually what we do, we ask support of end users and SMEs to help us
People and Skills	P3	So, in terms of knowledge of AI at least to have basics how to develop, the process of training the models, also to manage expectations because in certain situations we think that AI is magic stick you will solve problem quite easy. It is not that it is difficult to challenging to implement AI solutions. It is important to explain this with examples.to highlight sometimes the cases where it is difficult to apply AI at the current stage as status of technology today. also, it is important to explain to organisations, the development processes. It is not waterfall or like you have the plan,

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
		so you, you must less, achieve timeline required for each milestone. Software it is more agile and agile, so it is important to educate end users mindset, understand the complexity of developing software.
People and Skills	P4	if you want to start the. That you need big momentum.
People and Skills	P4	The data scientists, they are creating models. And data engineer, software engineers, they are taking these models and make it, make it really running.
People and Skills	P4	We have a word of software engineers, and we have a word of data scientists. Okay? And we have a word of products.
People and Skills	P4	we have to be aligned always about the, the goals of the. Okay. If we are not aligned in the goals of the project at the beginning, then the, the at the end will, will not reach the goals. And this is, it will be exceedingly difficult to close the project. And this is one of the, the
People and Skills	P4	challenges to sustain initiatives.
People and Skills	P5	And the fact that eight organisations are creating projects is a good thing. It sounds messy but messy is good. So long as we can deliver faster and fail faster. So, we uncover the true gems. So, in short, how to organisationally set up so you can get the company to achieve that more, fail fast to uncover the true gem. I do not know what the optimal organisation would be to manage all of this, but it would be nice to set it up.
People and Skills	P5	for every project we have to go the whole route, for example, with only one project for autonomous control in the NEB asset, and we have a letter right now, with the upstream director and so probably next week it's going to go to the ADNOC Onshore CEO, who's going to pass it to the senior vice president, which then passes it to the vice president, who'll pass it to the manager and then he assigns it to somebody, and therefore I need to talk to the team leader to make sure that we get everything ready. But by the time the letter arrives I already know everyone. I already went to the field and talked to him. So that is how we think it works here. It is slower, but it is like slowly but surely.
People and Skills	P5	for example, you want to get the engineering documents, and that is a different department. You have to send the letter through our VP, to the SVP, to the Director, to the CEO, to the SVP, to the other VP, to Engineering who then needs a letter from the VP of the asset to approve, so they can then talk to the Team Leader with the person that they will provide us the documents, and that takes time. So, what we do here is that while this whole mechanism is happening, you initiate a dialogue with the person who you expect to provide you with the required documents. And this person will tell you that he will not give you the documents right away, because he wants to avoid getting into any trouble with his management because they are giving out documents that are confidential, critical, sensitive, etc. That is fair enough, where you already build the necessary rapport with that person, who may already have all the documents ready for you, and then he is just waiting for his manager to say, yes, go ahead. And you may have even already talked with his manager, but the manager of the manager may need to give his approval. So, it is all Okay. And then once it all comes together, you are already old friends. And then the whole thing flows right away. So, you get all your documents in one go, so we have dealt with IT, engineering, etc. and it is important.
People and Skills	P5	It also depends on the scale of the company. If you are talking about, for example, a large organisation, like a national oil company like ADNOC or a small multi-national company. They are quite different monsters, and the difference is that you have way more stakeholders in a large organisation. So, what we have learned in retrospect, is that to ensure we have the right engagement of people, in advance, you have to go with both top-down and bottom-up approach
People and Skills	P5	In ADNOC, it is not there yet, but it is an interesting question. There are eight groups in the organisation, in the whole ADNOC-wide organisation that are pushing AI related projects, digital transformation projects in general. There is like eight different organisations within ADNOC that I have countered that are creating the digital transformation projects. It is interesting you may think, okay well in this large organisation, would not it be better to have one program manager that manages all this stuff, or we centralize all these initiatives into a single entity. Then make sure that you have a good strategy, and all the projects will go to that entity. So, what I say is that, if you have many people doing many projects, you are more likely to have a few of those projects to succeed than if you

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
		have fewer projects. The more the merrier, but how do you orchestrate and make sure that like, we are not like double dipping.
People and Skills	P5	The medium approach is to have some sort of a committee that just reviews regularly, all the different projects that are happening across the whole organisation. But instead of them doing, managing the projects so you have multiple project managers around just coordinating the whole thing
People and Skills	P5	The difficulty in ADNOC is that there are a lot of stakeholders. There is simply a lot of stakeholders and culturally, it is a more hierarchically oriented culture than, for example, Scandinavia. Scandinavian culture is flatter. You can just talk directly with the director, or it is just walking around having coffee and you say, "Hey, did you think it's okay?" It is a little bit more informal, but it is like you can talk to anyone, but you have to deliver. You are talking to me about this stuff, you are committing yourself by doing that, so it is not a free thing. Here it is a lot more hierarchical and that is just the culture, and it is the same culture in Latin America, and it is a similar culture in East Asia. So, the strategy would be quite different in every place that you go. Here what we found that works is this dual approach, like, top-down and bottom-up, establish relations, establish rapport with people and at the same time, you know, get like a top-down so all the managers are aligned. Convince the guy on the top to then get the guys below him to commit time and effort to your project to ensure that it is actually executed and then be okay if it fails.
People and Skills	P5	The digital factory is part of the Thamama centre and dedicated for subsurface projects. ADNOC technology involves surface, subsurface, upstream, and downstream. They also have a little digital factory group there and then you also have R&D, and you also have ADNOC onshore IT working directly with the asset creating some of these things, and you have ADNOC offshore operational excellence team who are also doing a bunch of projects like this. So, what we are missing is some sort of steering committee or something.
People and Skills	P5	These are all a set of constraints that need to be considered when you do these types of projects where it depends on what exactly you are trying to deal with here. Like for the particular project that I am doing on the production optimisation domain where we do not really have any problem with these external factors.
People and Skills	P5	Yes, they need to be acquainted with this stuff. It is necessary. Six years ago, if you were programming VBA, Excel and a lot of Python and stuff, people would look at you like, "hey, are you working in IT?" Nowadays everyone is doing the Python course. It is a different world now. People are realizing that it is a skill that is good to have, but it does not mean that everyone will be doing it, but people need to be acquainted with how the thing works.
People and Skills	P5	you may have like, for example, getting some letter of communication all the way from the CEO of one company. Because in our case, for example, we are in the headquarters, and we are doing projects that are building deep into the operations of an asset. But we are not the operating company.
People and Skills	P5	It's a different company, which means that it needs to go from the Upstream Director to the CEO of the operating company, to the Senior Vice President of the asset, to the Vice President of Operations and then to the Team Leader, to assign somebody so that they can work with us and then every once in a while, we need to then give feedback to the entire chain of people to get the whole thing work.
People and Skills	P5	People hate when they get imposed something from above, but it is important to get this stuff from above because otherwise, if you do not, you cannot ensure commitment. So, we found that what we have to do is to go both ways. So, we first need to meet people face to face and establish a good working relationship with the people and show them the obvious value to make sure that they have full clarity in their minds that they are not going to waste their time with this thing. You then just start collaborating with them. And then the letter will come from the top. The idea of the letter coming from the top is that this is set up in the asset's scorecard and in the end, it officialises the team.
People and Skills	P5	you need the same amount of people, but it depends. For example, when we engage with operations, with the production operations team about these systems that implement AI. The first thing that they are going to say is, "hey, is it going to put my job at risk?" Then we revert saying "no way!" Like we actually need more people. You see, this stuff will uncover hidden losses that you would otherwise never see. Therefore, you actually need more people. You will realize that your backlog is bigger than you thought. You need more people, and they are safe. The automation of all these analytics and all this stuff, like you may have people doing, for example, the processing of information and passing that typing in the analysis, etc. Some of those people can be the victims of automation. So,

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
		you rehash their skill set, their opportunities so they can get into this thing of AI and automation or put them somewhere else. The hardcore technical disciplines, including operations, the petroleum engineers, geoscience, geophysics, they are not at risk. We actually need more people. I do not see the risk at all. But we are not there yet.
People and Skills	P6	For this initiative, AI initiative, it depends if there's different background needed. So, for example for the scoping the work, we need people technical, not, not like from artificial intelligence or data scientists, people that they have a need, they have problem, and they will explain what they need to solve the problem.
People and Skills	P6	So, you need kind of SMEs subject matter expert on the not artificial part and artificial anti intelligence part, but in the, from the business. So, you need SMEs from the business, and you need some kind of colleagues that understand artificial intelligence, because you need to translate this need into algorithm.
People and Skills	P6	I think for the SMEs expert, we need to have multidisciplinary expert in to be part of this digital Transformation.
People and Skills	P6	some kind of colleagues that understand artificial intelligence, because you need to translate this need into algorithm.
People and Skills	P6	So, you need to see what the best way is to solve this problem. So, we need some kind of people that will hele to design the tool from the data scientist or software developers or kind of people that can help you to address the problem. and you need end user usually are like not necessarily SMEs of the subject matter expert, because this is the people that will use the project. So, they do not need to be expert, but at least they will tell you how they will use it and you need to convince them. You need to explain them how this tool will help them and how they can use it. So, you need to train them on the tool. So, it is better to involve them from the beginning.
People and Skills	P6	You need to align with different partners. You need to develop the project chart, get different approvals, go to the legal, develop the contract and all this work like you take time and sometimes you spend one year to prepare a contract for two- or three-month project.
People and Skills	P6	It needs to be technology department. I mean, all our department from digital unit or the R and D department, but yes, it is a tool that can be used Anywhere for ADNOC business for downstream, upstream in the digital units.
People and Skills	P6	not necessarily because you know, when you use, for example, let's say software like eclipse or whatever we are using here, people using this software are not data scientists just have sessions on the software itself and they know how to use it, but they don't know how it's developed. So, we do not need to have expert in artificial intelligence to use a smart tool or a tool using artificial intelligence,
People and Skills	P6	So, we need people that can understand what machine is and what is artificial intelligent. They will not be the end user, but at least at the expert level, we need people that understand the business and understand the technology from inside. Not like just only press button.
People and Skills	P6	So, you need different level of people in order to make it success,
People and Skills	P6	So, I think, yes, yes. I agree that it will be especially useful for organisation to have kind of expert in machine learning.
People and Skills	P6	The implementation process, so we need to always keep the alignment. If there is no alignment, even if you implement it, nobody would be using it. So, we need from day one to keep involving all your stakeholders, and same departments, for example, the different asset, different end user, keep them involved in scope of work because they need to design with, you the tool.
People and Skills	P7	because, uh, there is a very selected group of doing artificial intelligence. Okay. And, uh, then the majority of the company, they are no engaged on that and., this will at the end, bring some delays in the implementation and delay in the add value.
People and Skills	P7	each discipline now it has, it should have like data science with the SMEs to in the future
People and Skills	P7	having a data science by asset will accelerate the implementation of ai. Okay. And, um, what level of knowledge, what level of, of knowledge that you think that support the AI organisation actual knowledge. Yes. From the SMEs. Do you think they should have a knowledge and yes. Data science, a little bit of it.

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
People and Skills	P7	ISME with data science skills and computing really, uh, boost any. any project in artificial intelligence. One example, catalyst, the cat has brought, uh, huge, amazing add value through just one, uh, project. Uh, but he is having all these skills combined. So, if the company for the future, he.
People and Skills	P7	S M E that understands what is the problem behind how to behave the system, uh, based on the physics, right? And the engineering background
People and Skills	P7	special people that can combine all these skills together and to boost the AI implementation. Okay, but this requires a lot of training. Yes, because normally people are particularly good technically, but they do not know anything about computer or they are not aware of artificial intelligence, so you have to train them in the weak area.
People and Skills	P7	What careers are good Environment of AI
People and Skills	P7	collaboration, having, uh, Different disciplines, uh, working together, um, having a strong it, uh, group. Okay. That promote the use of AI and uh, um, solid training process to bring the level of AI knowledge, uh, to the point that will be sustain. because we can do a lot of projects, but if the people can, does not have the knowledge, cannot sustain the, the, the technology for long.
People and Skills	P8	Having the competency development of the person who is going to be maintaining, supporting, and, and the end user is very important, I think because of the nature of AI projects in the sense that as new data becomes a., the, the system or solution or the initiative may change and may improve and need to be improved.
People and Skills	P8	I do not think we have the, the right tool. There are some tools in the market, uh, and, but the engineer or he or she is going to need to improve to. Definitely the capabilities that you have in Python or, or in Jupiter or will definitely help you in many ways or forms. But he is not going to be out of the box and the person is going to need to invest some of his, his or her time into developing that capability.
People and Skills	P8	knowledge and competency need to be in place to be able to analyze the, the new data and to be able to do something with that new data
People and Skills	P8	level of knowledge? Should the support organisations have regarding ai?
People and Skills	P8	I do not think I do not think they need to be experts on ai. They do not need to be fully know, knowledgeable in ai, but they need to understand the requirements that an AI project imposes into their, their particular domain or their part. area of support. As I was talking about, the IT example, I do not expect or, or nobody would expect data management personnel or IT personnel that support the IT functions of a company to be experts on ai.
People and Skills	P8	But they need to know, or they need to understand how the accessibility, the integrity, and the quality of data will impact an AI project. So that basic level of knowledge is actually very., other organisations besides it, again, eh, besides it, data management and, uh, the end users.
People and Skills	P8	not only about the infrastructure and the access to data, but it is also about competency development. I think, uh, access of the personnel or the employees to classes, to, and, and, I mean, nowadays we have so many things online and even offline but giving access to the individuals. to this type of competency development and then giving them the mechanisms or the environments where they can put into practice.
People and Skills	P8	organisations are needed to support AI projects. I. in general, and, and when I say the IT organisation or the data management organisation or data governance mechanism within the company is a key, a key a, a stakeholder, or organisation that is going to require to support an AI project.
People and Skills	P8	Eh, not only., they are interested in supporting the project, but in some cases even you are going to find that the infrastructure, the IT, and data management infrastructure that a company has may result or may influence the success of an AI project. We have had cases where even though the stakeholders in the client organisation were very engaged, very in.
People and Skills	P8	but the mechanisms to have access to the data in an easy manner with, with high quality, with high integrity, were just not there. And it does not matter how much interest they may have, if the infrastructure is not there, you are not going to be able to have that access to, to the data that is required.

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
People and Skills	P8	not only about the infrastructure and the access to data, but it is also about competency development. I think, uh, access of the personnel or the employees to classes, to, and, and, I mean, nowadays we have so many things online and even offline but giving access to the individuals. to this type of competency development and then giving them the mechanisms or the environments where they can put into practice.
People and Skills	P9	Historically, you would have other companies come in, take your Data. Build models and sell it to you and sell it to others, and they would be valuable. So, I want it to be made in ADNOC. It contributes to the UAE GDP that is why, the organisations would be anyone who would be using other people's products, they should be working together to create their own through AIQ.
People and Skills	P9	The data owner and the subject matter expert are definitely especially important contributors to the success of any AI project. I am a data scientist with a background in chemical engineering, so I understand of what goes on in the energy sector.
People and Skills	P9	Then you also need the resources. I think a big challenge might also be talent. You do not have a lot of software engineers. You have a lot of data scientists.
People and Skills	P9	You know, you are, you are just putting together a number of roles. So, the intelligence comes from the correlations, the areas in the data that the SME usually would not be able to see because of the size. So, one area to derive intelligence from is just the size of data. When you are looking at one site versus sixty-five sites and you multiply it by the number of assets within each site, it is not humanly possible to do an excellent job with extremely low error at analysing all of those.
People and Skills	P10	because people started to understand the concept and the value, because once you have the first success story been accomplished other would love to be part of journey
People and Skills	P11	description is changing in the future, and as well, we will be demanding for. More capable engineers with the basic data science knowledge at least. Okay. And for the existing employees, what we are doing is we have launched a program with partnership with our colleagues in Etsy to upscale our existing employees.
People and Skills	P11	And you will need, different representatives and people from starting, from the business. S. Or understand the challenge and understands the nature of the problem. You will need a data science who will develop these models, help into analysing the data and so on
People and Skills	P11	Anyone can participate. The specialized one would require line manager approval confirming that this employee really needs this skill, and he can use it within his function.
People and Skills	P11	Each individual need to have some basic skills of basic data science similar to your basic skills of Excel sheet. So, within Excel sheet, you can build a lot of these simple models and a lot of analytics you can do. So, we should be moving into data science democratization. You do not necessarily.
People and Skills	P11	Full-time data science sitting with you and IT person sitting with you. We need to simplify the process. The process is getting simplified. The tools are getting advanced, so they are becoming more drag and dropped. A lot of these fundamentals are being taught in the university. So, the newer graduates will come with some basic data science skill.
People and Skills	P11	If you have multidisciplinary and one within one team, for example, in subsurface Yeah. You have the data science work with the, okay. Yes. The nature of the digital and AI projects is a collaborative process.
People and Skills	P11	It is the maturity. It is when they have the engineer, petro engineer, they have to, they need to have like data sales and IT within the same team, within their teams. Yes. That is one model. So, you have various models on how you can develop these things. The newer concepts are moving into data science citizenship, they call it.
People and Skills	P11	job descriptions will change or reflect the new, the, even our recruitment processes will change. We will demand for these skills increasingly similar to innovation. So today, part of the interviewing process, you will see an assessment on. Innovative thinking the person is carrying with him, especially if he is in a profile where he needs to think out of the box or go beyond the norms, then they are looking for this type of skillset.
People and Skills	P11	Not all engineers need to be expert in data analytics and AI, but key personals who are leading AI project. However, the users should understand the data analytics/AI so that they can use the solution effectively.

Phase I Interview Results after Coding		
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People and Skills	P11	The ones who are coming from the business and they have then developed data sciences skill on top of their business knowledge compared to data science who come from computing or mathematical backgrounds only. So, more people with more business knowledge are much more successful.
People and Skills	P11	They will not resist it. What we started with the knowledge uplifting program. And it had various levels. So, we had the fundamental level where people could learn about digital 1 0 1. So, what are these basic principles about which we are talking? And then there is a digital expert program that is launched for the people who are willing to take an extra step and further develop them.
People and Skills	P11	we simplify it when we say. Sometimes it is one person. It can be many persons. It depends on the complexity of the topic. It depends on the scope, scope that we are building. But this is in terms of project. But in terms of the current organisation within the team itself, for example, with the team and subsurface, they need now within this, a lot of initiative within AI project.
People and Skills	P11	whole purpose is for this. Once the people have knowledge of digital and ai, they will appreciate what we are doing, and they will demand for this because people, when they fear something, there is a tendency of resistance. They will push back. But when they will understand it and they see the opportunity in front of them, they will embrace it.
People and Skills	P11	Within with, within the coming few years we will need less of pure data scientists. We will need more of a mix of discipline engineer Okay. With the data sciences skills. So that will be a better makes even today, the industry, there is a lot of applications that the most successful data scientist.
People and Skills	P11	Within, within that space also, we launched a nanodegree in data science and ai, and that is, you can call it the third level where people will go and develop further skills on, on, on how to do coding using some of the tools that are available in the market. Okay. And anyone can participate. Yes.
People and Skills	P11	You will need a project manager. You will need it department to support them to, into, if we, if this solution, can affect some of the security related. And integration with our existing infrastructure. It is preferred to have someone with the knowledge of Agile so that he can guide the team into agile sprints and or Scrum but, and then the number of SMEs.
People and Skills	P11	description is changing in the future, and as well, we will be demanding for. More capable engineers with the basic data science knowledge at least. Okay. And for the existing employees, what we are doing is we have launched a program with partnership with our colleagues in Etsy to upscale our existing employees.
People and Skills	P11	job descriptions will change or reflect the new, the, even our recruitment processes will change. We will demand for these skills increasingly similar to innovation. So today, part of the interviewing process, you will see an assessment on. Innovative thinking the person is carrying with him, especially if he is in a profile where he needs to think out of the box or go beyond the norms, then they are looking for this type of skillset.
People and Skills	P12	Well, one important aspect is that and I will generate a large volume of data, so we need to have a certain level of both data management and statistical analysis skills time I understand a little bit of the subject matter expertise. For example, we need to know a little bit about production engineering so that we can understand what technical rate field available rate changing the choke, the implication of low VRR, etc. is, so any user having knowledge about those three aspects that management statistical and the subject matter expert will we be a person that is more capable of understanding and processing the results of an AI if an engineer is weak in any of these aspects either an I or the technical aspects then this person sees the results. We feel overwhelmed by so many results, so many outputs so many scenarios, and this could be to the detriment of accepting the value of AI.
People and Skills	P12	having continuity of the human resource human resources typically come and go or bringing up to speed the human resource order making sure that the that the discontinuity when somebody is going in vacation or coming back. Also, sometimes the human resources they need to connect to the user they need to understand the users very well, and sometimes me as a project manager, may not be able to explain everything to them to the coder. To the developer and that creates a challenge.
People and Skills	P12	having the right people it means that they you see the project flowing OK in terms of knowledge activities there are no delays in the in the in the project planning there is a good communication between the project manager and the user and the upper management there is a good motivation of the people coming every day so all of this make components of there is not only technical but also soft skills of the of the team confirming the project

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
People and Skills	P12	in general, the in terms of people as we say having the right resources to participate in the project in terms of profit.
People and Skills	P12	One important aspect is that AI will create a large volume of results that require interpretation, both from technical and AI matters. Then, any user having knowledge around his/her technical background and a little bit of AI, then such people will have a better way to defend the results and embrace the new tools.
People and Skills	P12	Then, during project execution, the challenges are how to find the resources and people I refer to the hardware and software to implement in every organisation and then finding the resources, the people and how to help.
People and Skills	P12	To improve the implementation process, I would say that key people in the organisation, like management, the people from it, the people from procurement, human resources, they all need to have like a minimum level of knowledge about the digital transformation of their processes.
People and Skills	P13	to create a digital transformation community.
People and Skills	P13	that has representatives of all the group of companies. this was key to try to start to drive that, transformation, that per level of knowledge is different. Can go from awareness for a more expertise in a different area of technology. If you talk about AI, for instance, at this moment, we have already in the team that was not before experts in computer science.
People and Skills	P13	Well, AI and digital transformation tools or technologies are always involvement. In that, more than ever, we need to be updated, the same way that we have started to give training to identify people and try to give awareness for the majority of the people, to in the organisation, maximum people possible. It is important that in the future we have like exist here, a team dedicated to understanding technology.
People and Skills	P13	After that, in the process side is to ensure that when you change, business process, you ensure or when you bring a new technology, but because digital transformation in AI is a transformation driven by technology is to ensure that you impact people like I mentioned before, and you impact the processes.
People and Skills	P13	If you bring a new technology, you need to ensure that the process is transformed also, that you don't bring technology and you leave the process the way that was before that, if you have a of the process as its today, you need to ensure that process to be, is transform, is changed to ensure the technology and new way of work is completely, reflected in the business model. From the technology point of view is always trying to scout for modern technologies, be more, active, and aggressive in the pursuit of innovative technologies and bring the technology, try to find how the technology can create Value to ADNOC.
People and Skills	P13	are overall three pillars existing challenge, but people are the key because people is one that will ensure that another two work well.
People and Skills	P13	Knowledge, we have, during the development of the transformation office and the, the development of the digital factory framework. We have created metrics training and awareness needs. For the various levels of the organisation, which was for diverse types of, level of organisation, the knowledge need
People and Skills	P13	Savage in the companies to be the driver of this transformation means that today in majority of the exist, people dedicated to identified challenges that can be solved through digital technologies and AI. And this has been successful step to ensure that the organisation start to be more mature. And with more knowledge in AI and digital technology, this has been helping, this has helped accelerate digital transformation.
People and Skills	P13	the key pillars of digital transformation. if you talk about, well, people are the key one.
People and Skills	P13	training plan has been put in place has a cultural change. thousands of people have been already trained in that plan. That was the building blocks for digital transformation and some specific training to ensure that we can start to change culture. To start to identify people that is more willing, more technologies,
People and Skills	P13	We know how to, design and transform the processes. The key point is like I was mentioned before is prepare the People. To be ready to go a little bit more challenging and more willing

Phase I Interview Results after Coding		
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People and Skills	P13	We know how to, design and transform the processes. The key point is like I was mentioned before is prepare the People. To be ready to go a little bit more challenging and more willing
People and Skills	P14	AI team can be mix of Business SMEs, Data Scientists, Data Management, IT is depending on the company's maturity level. It would be best if the lead SME of the AI solutions can also wear Data Scientist role and build AI algorithm/solution.
People and Skills	P14	Not all engineers need to be expert in data analytics and AI, but key personals who are leading AI project. However, the users should understand the data analytics/AI so that they can use the solution effectively.
People and Skills	P14	Other than PE/IT background a good understanding of data analysis techniques, data science, and programming knowledge in Python/R and other scripting knowledge is required for implementing AI solutions.
People and Skills	P15	mean, one of the important things we talked about is Modeling, so ensuring that um, you have the skillset and capability to keep the models up to date calibrated
People and Skills	P15	? So, you need to have, um, all the technical capabilities to deploy stuff. Uh, these technologies subsurface surface.
People and Skills	P15	focus is there for the organisation
People and Skills	P15	for example, and subs. Teams, they have known to have, uh, data science IT within working at this.
People and Skills	P15	go forward with your project or they need to be part of the project, which organisation are needed to support the ai.
People and Skills	P15	I do not think, well, I. Aware of all the groups in a No, but I am not sure that we have like artificial intelligence, digital oil field, dedicated team.
People and Skills	P15	improve the implementation process? Okay. Um, I think one of the important things is knowledge across all of the organisation
People and Skills	P15	need to have the people
People and Skills	P15	organisational structure to, to ensure its successful
People and Skills	P15	So, if you are going to implement a project, you need to make sure that you have the organisation in place to, to make sure that it is successful.
People and Skills	P15	So organisationally, you need to have, um, people in the field to deploy people in the field to calibrate.
People and Skills	P15	So, you need to have, um, the right organisation for deploying subsurface, uh, sensors that are going to feed into the, into the AI system
People and Skills	P15	the job description for the engineers, it will be, would fight in the future or, yes, sure. Absolutely. Um, the skill set is, is constantly evolving, you know what I mean? Um, the ability, um, for engineers to, to program, use Python, use other, uh, programming, uh, languages, all that is, is. is, is becoming more, um, critical and important for implementing these types of projects.
People and Skills	P15	then supported by, you know, people that are ensuring that this, the sensors are deployed, actuators are in place for rest.
People and Skills	P15	there is no one five teams Exactly. Not initiative. Like we have anomalies. Yes. Have an adapt technology. There is eight distinct parts of the organisation that one way or another is looking at.

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
People and Skills	P15	whether is what engineer and I think, I think for successful projects you need to have an integrated team where you have, uh, a group, a multi-disciplinary group.
People and Skills	P15	whether is what engineer and I think, I think for successful projects you need to have an integrated team where you have, uh, a group, a multi-disciplinary group.
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People and Skills	P16	People again, it is the mindset, the set of skills and the change management process that we have, for the process. It is a huge organisation and the organisation structure itself makes it a little bit difficult to accelerate it.
People and Skills	P16	think that today, every engineer has to have a minimum knowledge of data sciences of how to use data to be able to improve performance and efficiency. And, I mean, yes, we do not have data scientists in the subsurface, but we have AIQ to support. We have us, the data sciences that sits in technology function to be able to support, but minimal knowledge in terms of skills of reservoir, petroleum and production engineers is definitely, I think today it should be a necessity. At least the understanding. It does not have to be the technical, I mean, the technical work of developing an algorithm, but the understanding of how data analytics
People and Skills	P16	People again, it is the mindset, the set of skills and the change management process that we have, for the process. It is a huge organisation and the organisation structure itself makes it a little bit difficult to accelerate it.
People and Skills	P16	For us speaking to people, make sure that we are all aligned with the business users, that what we do today, however, we should have, I believe we should have one unified technology set. We cannot have technology centre in one company and other technology centres in other companies doing the same.
People and Skills	P16	So, the other technology centres should support the initiatives that comes only from the central team, the unified central team. So, this is one particularly important solution. The other solution is to have certain exemption, I would say legal, IT, processes to make it easier for companies like start-ups, to be able to collaborate with us.
People and Skills	P16	think that today, every engineer has to have a minimum knowledge of data sciences of how to use data to be able to improve performance and efficiency. And, I mean, yes, we do not have data scientists in the subsurface, but we have AIQ to support. We have us, the data sciences that sits in technology function to be able to support, but minimal knowledge in terms of skills of reservoir, petroleum and production engineers is definitely, I think today it should be a necessity. At least the understanding. It does not have to be the technical, I mean, the technical work of developing an algorithm, but the understanding of how data analytics
People and Skills	P16	We have a particularly good knowledge; I would say especially today we have data sciences team sitting within the technology function. We have AIQ that with huge resources sitting here to specifically support the ADNOC technology and digital project s. So, we are from a resources side we are doing very well.
People and Skills	P16	Yes, that is what we have been doing in AIQ for example, we will have SMEs and project managers from the Business Side to make sure that we are aligned from day one from the ideation process. I mean, as early as possible, and they need to lead it at the end of the day the end users have to lead the technology from stage zero tell the full scale for implementation.
People and Skills	P17	hundreds of people have been involved more than one thousand people we have.
People and Skills	P17	Knowledge, we have, during the development of the transformation office and the, the development of the digital factory framework. We have created metrics training and awareness needs. For the various levels of the organisation, which was for diverse types of, level of organisation, the knowledge need
People and Skills	P17	For all the digital transformation pillars insight from the technology point of view, from the transformation point of view, and from people's understanding point of view, the metrics was created. Training has start to be, given to all and was one crucial step was also to create a digital transformation community.
People and Skills	P17	that has representatives of all the group of companies. this was key to try to start to drive that, transformation, that per level of knowledge is different. Can go from awareness for a more expertise in a different area of technology. If

Phase I Interview Results after Coding		
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		you talk about AI, for instance, at this moment, we have already in the team that was not before experts in computer science.
People and Skills	P17	That is the key pillars of digital transformation. if you talk about, well, people are the key one. Technology is available process. We know how to design and transform the processes. The key point is like I was mentioned before is prepare the People. To be ready to go a little bit more challenging and more willing to disrupt the processes. Uh, this is the key point in the people side is training people and create awareness that people understand how AI and additional technologies can impact the business.
People and Skills	P17	Well, AI and digital transformation tools or technologies are always involvement. In that, more than ever, we need to be updated, the same way that we have started to give training to identify people and try to give awareness for most of the people, to in the organisation, maximum people possible. It is important that in the future we have like exist here, a team dedicated to understanding technology
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Process Optimisation and Integration	P1	The creation of value necessitates converging on domains where it can have world-leading assets and unique opportunities. Furthermore, adopting recent technologies including AI, which enable creation of new economic opportunities for citizens, governments, and industry.
Process Optimisation and Integration	P2	Digital factories develop and re-use functional modules of tools that can co-exist in a common digital environment including standards. Rather than using a common single industry commercial tool, like a simulator - for example, their products deliver functionality fit for purpose to resolve a problem or take advantage of an opportunity. And they typically work effectively and often in an agile manner.
Process Optimisation and Integration	P2	I see really the business plus process. Adaptation, Re-engineering, or the business process needs to be part of the solution. If we do not take this hand on hand, this is not going to work easily.
Process Optimisation and Integration	P2	Management should create the environment for AI to work best, for example, setting the right infrastructure, facilitating data sharing, acquiring the right competences and experience, putting in place dedicated organisations (like AIQ) to help the business in definition of needs and then deliver solutions to real problems.
Process Optimisation and Integration	P2	the process is especially important but my suggestion for an AI project is that if the solution disrupts with something very new, we should not be constrained by the old process.
Process Optimisation and Integration	P2	Yet, the process is especially important from the point of view of re-engineering of the process, if it adds value to the solution
Process Optimisation and Integration	P2	We need to consider changing the process if it is adding value to the delivery of the solution. For sure.
Process Optimisation and Integration	P2	There are techniques for agile development that are useful for AI projects.
Process Optimisation and Integration	P3	One of the biggest ones is to have a complete team to manage its project. Basically, need software engineers for the software from architecture. We need the scientists to train the models, need machine learning engineers who will support data scientists to integrate models, to have some pipelines and so on.

Phase I Interview Results after Coding		
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Process Optimisation and Integration	P3	You will need the subject matter experts who know very well this subject and even the reservoir and the area where we are doing the project. And these people are especially important Because they will help software to understand the business. You need the product manager, someone ideally from this area of expertise who can help you unobstructed vision about your product, and clear roadmap, and the features that need to be implemented
Process Optimisation and Integration	P3	You can start, for example, by the market. If there are solutions in the market tickle the same subject with AI Without AI extra need to decide either yes or not this one from the beginning, when you do your market search, you will see, okay, if this solution is in completing you, it is niche. We can do it. However, if it exists and there are many solutions, it does not make sense to do it, other factors in oil, gas, we do not have, lot of personal data used in our apps. So, it is more about measurements from subsurface and so on. So, in certain situations when we are dealing with the confidential data. we have to implement certain security measurements in terms of software. To secure this data, to encrypt it sometimes because of the nature of the data and this can impact, for example, timeline. Certain number of approvals to get there. Also, one of the factors as, as usual is the value.
Process Optimisation and Integration	P3	also, one of the external factors in the of top management because it is having common vision to be from the top to the rest of the company. It is not from end use they cannot, they cannot actually, it is difficult for them to initiate an idea. And it is very, complex. We need constant, support from top management at all levels and to achieve this startup,
Process Optimisation and Integration	P3	There are certain processes and procedures which can influence positively the adoption of AI. one of them has explained this to involve end user from the beginning, democratization of AI among the management, end users, because for certain situations it is politic to say, but some people are afraid that AI will replace them.
Process Optimisation and Integration	P3	And actually, it is not the case. we are here to enhance, the performance with AI. It is just a new tool to help users enhance performance. It is not to replace them. So, it is important for them to understand it. And it is not easier. It is will not be in one meeting. It will happen. It is a lengthy process involvement in the project to see those, to have this kind of technology.
Process Optimisation and Integration	P4	do an impact on, on changing the work of flow, uh, to make it. If you do not change the workflow, everybody will get back to their old way of doing things.
Process Optimisation and Integration	P4	I think the governance's model. Uh, if we are talking about the parties that engage in that, in the project executions, uh, yes.
Process Optimisation and Integration	P4	You need, you need some people to be like accountable, some people responsible
Process Optimisation and Integration	P4	we play the responsible party that we are really execute another time and the client should be the accountable
Process Optimisation and Integration	P5	A good example of this kind of company-wide strategy for doing more and failing fast is BP, so you can dig into the BP Caspian Unit, and you can ask Mr RY. BP Caspian is a pilot of BP for applying this agile methodology. They also call it scrum and agile. Doing more and failing fast, screwing up here and there, but having some few big wins. Seventy percent loss 30% big win pays for everything else. Every company is doing different things. Total created an entirely different digital transformation group in Paris. It is weird because all the hardcore technical people are in Pau, in the southwest of France and the digital transformation people are in Paris which is in northeast of France. They are not like next to each other, so I am not sure how that is working out. It is interesting and it depends on the nature of the project itself.
Process Optimisation and Integration	P5	And these models that manage this logic, can have any degree of complexity we like, so it can go from simple rules, like going above or below to time series analysis. So, moving averages, ARIMA models, etc. to probabilistic graphical models that we have tried, works, magician networks and to deep learning. We have tried the deep learning approach at work because with just not enough data and you have to level thousands and thousands of things manually, which is exceedingly difficult.

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
Process Optimisation and Integration	P5	companies like Shell, for example, they also apply this and everything. So, some projects are for this size, and this is deep learning, convolutional neural networks, and a lot of complicated stuff. The generalized adversarial networks are very advanced and heavily well applicable to all this subsurface modelling domain.
Process Optimisation and Integration	P5	For the operational domain, it is just a collection of a lot of small models. So, Shell has got like 30,000 machine learning models for surveillance of valves running in a platform called C3.ai and then you have similar things, you know, some other companies with Cognite and it is a scale running a lot of simple models. So, in this different approach everything depends on how your organisation is and depends on what kind of monster you are trying to solve. What are its characteristics, and the shape of the beast?
Process Optimisation and Integration	P5	in my little domain of surveillance optimisation, our approach is dividing and conquer. Make many, many models, many small models, and orchestrate them all together. So, it is all about orchestrating many models. Each one of those bubbles, they can actually be created by a petroleum engineer with some basic understanding of how this AI works. But then once you go to the reservoir management domain or for example, geoscience, and you want to create an AI model to depict the falls in the seismic queue, now this is a complex math project.
Process Optimisation and Integration	P5	In terms of the implementation of the AI strategy, okay, so this is not about the projects and services, but more about the strategy. Having a good strategy ensures that you put the right focus where you need to put. What we have seen around is that there is like a lot of focus on AI. You see AI everywhere and just because that is the more attractive thing for the moment. Once you dig into the things, it turns out that most of the projects do not need AI. You need to create the foundation. So having the right strategy of how to embed this AI, you have to check if it deals well with the foundation, it will facilitate so many things.
Process Optimisation and Integration	P5	In terms of the implementation of the AI strategy, okay, so this is not about the projects and services, but more about the strategy. Having a good strategy ensures that you put the right focus where you need to put. What we have seen around is that there is like a lot of focus on AI. You see AI everywhere and just because that is the more attractive thing for the moment. Once you dig into the things, it turns out that most of the projects do not need AI. You need to create the foundation. So having the right strategy of how to embed this AI, you have to check if it deals well with the foundation, it will facilitate so many things. So, you think that you can apply AI to a certain process, for example, maintenance, the monitoring of rotating equipment, you may have a half a million instrument tags, no organisation in a historian. It is lacking the real-time data model which is part of data engineering is missing. Before you do data science, you need to do data engineering. So having an AI strategy should, you know, if it involves also mapping out, what are the building blocks that you need to get to the cherry on the pie, which is the actual AI, it is extremely useful. So, this is how I see.
Process Optimisation and Integration	P5	It is not reading the wall here, we have a strategy where we have this link or system or what is the name of this, agile process where you see and then you fail fast and then you move to the next one. You put more effort to succeed at all that but that is effectively what we are doing.
Process Optimisation and Integration	P5	know, we just copy paste, copy paste, copy paste, adapt, and then just copy paste hundreds and hundreds of times and they orchestrate the whole thing into a well oil machine.
Process Optimisation and Integration	P5	let us say you want to run your short-term production forecast, what we call in ADNOC, Field Sustainable Oil Production Rate (FSOPR), one and a half years going forward forecastable what every well will be producing given all the constraints that you may have. It is a complex one, I want to run it with models, and you want the asset teams in the operating companies to run with their models that process every quarter, and you want to implement it right away. That is not going to work, first of all, because you first need to get people used to using the models to maintain tables, create that workflow, people get confident and make it like a day-to-day process. They just start eyeing, saying, so now we expect from your models to get this and then get people to adapt. This takes some time, but if you go and pick the ultimate thing and you want to implement it first, it is not going to work. People are just going to find an excuse why not to do it… so it is going to be gradual. It is good to be start with a walking phase before you run. So, it is all about making sure that you have got all the building blocks in the business in the right order.

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
Process Optimisation and Integration	P5	Making sure that nobody is wasting resources is unnecessary but letting them fail or succeed. So, you know, doing more, failing fast. That is what we want. Because you cannot start these projects with the assumption that you will succeed. Like if you check these statistics for the implementation of AI projects worldwide, it is poor on the success. Eighty percent of the projects are a failure
Process Optimisation and Integration	P5	Of course, it depends on the criteria they used to measure that. But most projects fail, and it sounds like a horrible thing, but it is not. Because innovation works like that. In innovation, it is trial and error. You try and fail and then you hit the jackpot with one or two projects.
Process Optimisation and Integration	P5	Those projects that succeed will pay for all the projects that fail plus more. It is like a venture capital type of thing. More projects, fail faster, learn, and continue, so we do not have a clearly defined framework for achieving that within ADNOC. But what we do have is a lot of projects, which is good
Process Optimisation and Integration	P5	one of the nice cases was the model of the vector meters, rate estimation using neural networks and XGBoost and Random Forest algorithm, which are simple models that can do the job.
Process Optimisation and Integration	P5	we need to make sure that it is implemented for the users in the most brutally simple fashion. It needs to be in as simple delivery as possible. So virtual meters of gas lift, we created, nobody knows that is running some neural network that fits with another analysis model in the back end or that, the machine learning models we are running like ensemble models of multiple algorithms, or multiple control volumes, and they do not need to know that. What they need to know is that you have multiple alternative estimates of flow from different control volumes that are giving you different numbers.
Process Optimisation and Integration	P6	As long as you keep involving them tracking the project in different meeting workshops, awareness session to show them the new functionalities of the tools, keep them involved. I think you do not have any resistance.
Process Optimisation and Integration	P6	There is a risk of DEC of our data. So, it is better to have someone within the team that team that can do this update, this training, and this guy need to know. I have minimum knowledge about machine learning, how to train these models, how to validate them.
Process Optimisation and Integration	P7	I will not say for by discipline because the discipline, the SME has the knowledge and they know what the problem is, how to fix it, and what should be the respondent of those models.
Process Optimisation and Integration	P7	But for that, you need to have a good database that can pull data and push data. in as expected to be in the, in the, in the rate that is expected to be. Because if they are too late, uh, or too slow, then uh, people get discouraged.
Process Optimisation and Integration	P7	people, uh, will not be overwhelming about, okay, if I do this workflow, I have to go here, I go to the, for this, I have to use another tool. So, it should be kind of., how to say, embedded in the business processes, yes.
Process Optimisation and Integration	P7	through alert what could be done to improve the implementation process, implementation process. Hmm. Yes. But I think from the beginning of the project, we need to have a clear architecture orchestration because, uh, there could be many initiatives, but if they do not plug in together Yes. Then uh, the engineers are overwhelmed with a lot of solutions, but they are in.
Process Optimisation and Integration	P7	we need to have a clear, uh, framework and organisation and see where those applications will go, how they will communicate.
Process Optimisation and Integration	P8	need to have the mechanisms in place to be able to review and modify the process to take Advan full advantage of the particular technology that is being adopted.
Process Optimisation and Integration	P8	A governance structure that will incentivize the, or would, would provide an environment where innovation and, uh, self, uh, self-driven initiatives could be implemented or conducted. And again, this is a little bit related with infrastructure. If you have the right. Infrastructure from a development environment standpoint, access to the, to the

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
		general employee, to a mechanism where he or she can experiment, can run, run things, can play with, with, with, uh, with the different technologies and, and, and, uh, and tools that, that are in place today, can access data, can analyze that data.
Process Optimisation and Integration	P8	That is important and is going to help on the adoption of, uh, the, the ai, the technology, and in the capture of the benefits of that, eh, item C is, uh, uh, what creates a good environment for ai I think is, is a little bit repeated to the, to the previous question. We need to give the tools to the employee. To be able to innovate within the context of ai.
Process Optimisation and Integration	P8	because of the data, the continuous data generation and consumption of additional data makes it even more important Then.
Process Optimisation and Integration	P8	During employee execution is always good to have the end user. It does not need to be as, it is not as critical as at the beginning of the project, but it is good as part of the mechanism or the process to develop the competency and the familiarity of the end user with the system that is going to be put in place.
Process Optimisation and Integration	P8	It is also good to create a sense of, uh, owner. Of the end user. So, the end user needs to feel that the system is their system. It is not a system that is being defined by a project team that is not related to them.
Process Optimisation and Integration	P8	during execution on an AI project. Well, it varies. Every project, uh, has to have, has to have good project management. Okay. There is no doubt about that. And AI projects is the same. I mean, you have to have good, good, good project management. But I think AI, pro AI projects have an additional degree of, uh, complexity, if you want to call it that way, that, uh, as you review the data and, uh, analyze the.
Process Optimisation and Integration	P8	knowledge and competency need to be in place to be able to analyze the, the new data and to be able to do something with that new data
Process Optimisation and Integration	P8	preferred governance model for project execution?
Process Optimisation and Integration	P8	I think for AI projects, although I am not a fan of, uh, agile development, I am a fan of more, more, uh, structure execution. I think because of the, the nature of AI projects a, a mix of a structure execution approach with milestones and, and, and a very well-defined schedule will a mechanism of agile development.
Process Optimisation and Integration	P8	That will allow the project team to, if necessary, modify the execution approach, modify the objectives, modify the way to get the objectives in throughout the project would be the preferred governance model based on my experience.
Process Optimisation and Integration	P8	to be successful in the rollout you need to do., like in any, any other project, the change management issues and to make sure the end user will own the system or solution are especially important on an AI project in particular.
Process Optimisation and Integration	P8	You had a, a, a, a defined for your project. So, I think from execution, that that will be the most important thing that I, I actually would like to highlight now the challenges that are faced.
Process Optimisation and Integration	P9	continuous engagement between the team that's marketing or selling the product and the potential customers Because I think what I see a lot nowadays is you have the group that makes the technology being the data scientist, data engineer, the software engineer, the designers, and others, and then you have the marketing and sales.
Process Optimisation and Integration	P9	So, so through lessons learned, I think one way to improve the implementation process is to make them happen at the same time.
Process Optimisation and Integration	P9	So that is one challenge during execution. Another one is keeping it within a scope. When you are looking at numbers, you think of, I can do so many different things. So, it becomes, challenging at some point to stay focused on the very particular, even if it is a limited goal. Deliver that and then think about, you know, future production, production as in software production and not oil and gas production.

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
Process Optimisation and Integration	P9	The boundaries are already clear, the scope is already clear, and then we would work hard to make it happen. So, I suppose the project is them, the project.
Process Optimisation and Integration	P9	You could do the math, but to have you know, an application that is used by others, you need to have the work of a software.
Process Optimisation and Integration	P10	AI is actually the forefront and the last layer of software solution connected to data and sensors and simplify people day to day job and management to accelerate their decision making,
Process Optimisation and Integration	P11	The ones who are coming from the business and they have then developed data sciences skill on top of their business knowledge compared to data science who come from computing or mathematical backgrounds only. So, more people with more business knowledge are much more successful.
Process Optimisation and Integration	P11	Within with, within the coming few years we will need less of pure data scientists. We will need more of a mix of discipline engineer Okay. With the data sciences skills. So that will be a better makes even today, the industry, there is a lot of applications that the most successful data scientist.
Process Optimisation and Integration	P11	we simplify it when we say. Sometimes it is one person. It can be many persons. It depends on the complexity of the topic. It depends on the scope, scope that we are building. But this is in terms of project. But in terms of the current organisation within the team itself, for example, with the team and subsurface, they need now within this, a lot of initiative within AI project.
Process Optimisation and Integration	P11	Okay so there are a lot of external factors influencing the AI strategy. So, we know that there is a lot of drives on sustainability, on environmental protections and so on. These, affect, the, ours. Not only the AI strategy, but also affects your business plans.
Process Optimisation and Integration	P11	You will need a project manager. You will need it department to support them to, into, if we, if this solution, can affect some of the security related. And integration with our existing infrastructure. It is preferred to have someone with the knowledge of Agile so that he can guide the team into agile sprints and or Scrum but, and then the number of SMEs.
Process Optimisation and Integration	P12	To sustain the initiatives, the most critical challenges are that the new project it is embedded into the business process for which the project was intended to. So, for example, if we're talking about ICM, what makes a sustainable is to have a process where the production management utilizes the ICM as a key component if the new system is used as a, let's say as an optional what is used as an as an alternative to the current process then the new process may not be sustainable very easy it requires some other thing, but if the process the new process is used in the actual business process. It is improved, it enhances criticism, then we can see how in the process the new project is sustainable through time because you can demonstrate the value the users are using it, and the project is improved. Hence, all these create a virtuous cycle that creates and make it sustainable.
Process Optimisation and Integration	P12	Another external factor would be to have, let us say good procedures from the technical and the It point of view. I would say that in many cases because Its organisation is learning how these new projects are being developed somehow has been delayed or creating a delay an additional challenge for project to be implemented.
Process Optimisation and Integration	P12	having the right people it means that they you see the project flowing OK in terms of knowledge activities there are no delays in the in the in the project planning there is a good communication between the project manager and the user and the upper management there is a good motivation of the people coming every day so all of this make components of there is not only technical but also soft skills of the of the team confirming the project
Process Optimisation and Integration	P12	how to create value for this the other process will be is that having proper procedures to consider a AI tools in the organisation put it simple data quality management I should expect to have a quality control of the of the data being used for example in business plan or I should expect to have a let's say the results of the optimize trajectory of the well or the placement of the well should come from a highly and say digital and AI base process or I should be able to if I'm going to search literature inside an organisation I should take it from a robotized searching algorithm so there are many ways to apply into the they the day today that they procedure if the procedure the process the governor requires that a I procedure is embedded then the AI projects will also be more required

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
Process Optimisation and Integration	P12	in terms of processes, I will say the most important thing is to design A process that will improve and add value to particular use case, but it will be also embedded so as I say not as an option, but it will be part of the way of doing things into the future
Process Optimisation and Integration	P12	Other challenges are related that once you have finished the project, once you have your project put online, you always have the challenge to start using the product. The key consideration is that the people will need to be adapted to the new workflow.
Process Optimisation and Integration	P12	So, in general, in summarizing good governance, so basically leadership and bottoms up project development.
Process Optimisation and Integration	P12	To sustain the initiatives, the most critical challenges are that the new project it is embedded into the business process for which the project was intended to. So, for example, if we're talking about ICM, what makes a stainable is to have a process where the production management utilizes the ICM as a key component if the new system is used as a, let's say as an optional what is used as an as an alternative to the current process then the new process may not be sustainable very easy it requires some other thing, but if the process the new process is used in the actual business process. It is improved, it enhances criticism, then we can see how in the process the new project is sustainable through time because you can demonstrate the value the users are using it, and the project is improved. Hence, all these create a virtuous cycle that creates and make it sustainable.
Process Optimisation and Integration	P13	the digital transformation framework has been available and can be used for by all organisation and training in awareness has been done for all organisations.
Process Optimisation and Integration	P13	After that, in the process side is to ensure that when you change, business process, you ensure or when you bring a new technology, but because digital transformation in AI is a transformation driven by technology is to ensure that you impact people like I mentioned before, and you impact the processes.
Process Optimisation and Integration	P13	If you bring a new technology, you need to ensure that the process is transformed also, that you don't bring technology and you leave the process the way that was before that, if you have a of the process as its today, you need to ensure that process to be, is transform, is changed to ensure the technology and new way of work is completely, reflected in the business model. From the technology point of view is always trying to scout for modern technologies, be more, active, and aggressive in the pursuit of innovative technologies and bring the technology, try to find how the technology can create Value to ADNOC.
Process Optimisation and Integration	P13	The framework has been implemented for more than one year. And is, a framework without end means that can be updated with time but is a framework that helps the companies to grow from all full technology implementation cycle from identification to sustainability of the solution that is a tool that helps group Companies to implement technology in the formal and the structured way and standardized way across the organisation.
Process Optimisation and Integration	P14	Digital Factory is an ecosystem to conceptualize, initiate, design, develop, test, pilot, rollout and manage digital solution comprising of people, process, technology. The Digital Factory typically follows Agile methodology in implementing the solution. The focus is to accelerate the digital adoption of the business.
Process Optimisation and Integration	P14	There are multiple ADNOC Companies with different technical environment and technical teams in each of the company. In addition to ADNOC HQ which has different technical environment and technical teams. This brings challenge in terms of technical and stakeholders' complexities and management. Any AI solutions need proper planning and coordination with these stakeholders and to engage them as part of the project team.
Process Optimisation and Integration	P15	you need to have all the right processes to make sure that that is, uh, things are updated as you drill new wells, the new wells can, can feed into the system, things along those lines.
Process Optimisation and Integration	P15	barriers in the system.

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
Process Optimisation and Integration	P15	there is no one five teams Exactly. Not initiative. Have an adapt technology. There is eight distinct parts of the organisation that one way or another is looking at.
Process Optimisation and Integration	P15	you need to have all the right processes to make sure that that is, uh, things are updated as you drill new wells
Process Optimisation and Integration	P16	We do not know. I mean today. We have technology function. It is a centralized technology centre. However, I would say the responsibility accountability, is not really clear, you know, so that is why it is especially important for us to clarify it, to have it formalized for us to be able to, I mean that we need technology metrics across the whole. Yes, it is important
Process Optimisation and Integration	P16	The external is, I think COPP 28, for example, is a, is a major influence on the focus that we had recently for the sustainability projects, how the global warming.
Process Optimisation and Integration	P16	The, the conferences that you look at, the certain regulations that are today, not only on us, but on oil and gas industry, all of these are pushing us to definitely focus on sustainability. And it has been always the core of our business. It is just a sustainability. Um, this is, a mandate as an oil and gas as ADNOC, not only for the world, but for our country as well.
Process Optimisation and Integration	P17	My role was first; we established the digital factory framework. This framework allows us to accelerate and run the digital project s and it shows like a guideline on phases, how to start any digital project until we completed.
Process Optimisation and Integration	P17	I was part of the team who established the framework. And then we operationalized the framework within the group companies. We run few projects within the framework, and we trained few employees from the operating companies for this framework to escalate it to the other companies, so they have this awareness. also, we did awareness session to the operated company let us say the digital project s in every operating company, about the framework.
Process Optimisation and Integration	P17	If you bring a new technology, you need to ensure that the process is transformed also, that you don't bring technology and you leave the process the way that was before that, if you have a of the process as its today, you need to ensure that process to be, is transform, is changed to ensure the technology and new way of work is completely, reflected in the business model. From the technology point of view is always trying to scout for modern technologies, be more, active, and aggressive in the pursuit of innovative technologies and bring the technology, try to find how the technology can create Value to ADNOC.
Process Optimisation and Integration	P17	My role was first; we established the digital factory framework. This framework allows us to accelerate and run the digital project s and it shows like a guideline on phases, how to start any digital project until we completed.
Process Optimisation and Integration	P17	the digital transformation framework has been available and can be used for by all organisation and training in awareness has been done for all organisations.
Process Optimisation and Integration	P17	The governance is a bit challenging at this moment. So, we just maybe started the journey in two years. and like the governance to be established, like officially from here as the centralised function here So we are working on it. We try, for example, we have the portfolio management tool plans where we report all the projects. Now, the operating companies also. are requested to report the digital project s there at least to have the governance. But it is, it will be there, but it will take some time. We are starting this. It will take some time to establish this governance, because for example, there are digital project s in some of operating companies. For example, in upstream, there is digital project, team. So, they are governing the upstream projects. In downstream there are like in some operating companies, they have digital project s. So, we need to align together, uh, on the roles and responsibilities and how we will manage. This is something that we are working on currently. That is only at the delay. I will not say it is taking time. Uh, even it is not.
Strategy Leadership	P2	That was a success. Of course, there is no way that you will not succeed because everyone is forced to do it. Then once we have the decision support systems, like for production surveillance, calculating the allowable, it is harder

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
		for people to adopt. So, the value needs to be obvious to the users. The moment the value starts becoming less obvious, then you must justify why people should change their ways of working to adopt what you are producing. It starts becoming overwhelming. So, if you want to go too advanced, like if you want to run before you walk.
Strategy Leadership	P2	I have said. And of course, good implementations of AI programs include the right change management element to bring the people on board.
Strategy Leadership	P2	That was a success. Of course, there is no way that you will not succeed because everyone is forced to do it. Then once we have the decision support systems, like the for-production surveillance, calculating the allowable, it is harder for people to adopt. So, the value needs to be obvious to the users. The moment the value starts becoming less obvious, then you have to justify why people should change their ways of working to adopt what you are producing. It starts becoming overwhelming. So, if you want to go too advanced, like if you want to run before you walk.
Strategy Leadership	P2	Improvements on the drilling technique supported by analytical visualizations and dissemination of best practices resulted in significant improvement in drilling (time) performance. However, we were over the years establishing target performance drilling time based on past records. For example, in Field "X" the estimated time to drill a given hole section was determined based on history. So, the drilling target considered the benchmark for that section in that field. For years, we were satisfied if we met such target. When advanced analytical tools (visualization, automation, for example) started to become available, along with rich historic and real-time data integrated at the Real Time Drilling Centres, benchmarking was taken to a higher level, and the performance started to improve beyond historical targets.
Strategy Leadership	P3	Another challenge that we face as well is, change management because you start issue initially by scope and it can happen during execution that we have different understanding, or more understanding of the topic. So, you receive new requirements from either from the customer or even internally. The challenges, how can you achieve your project in specific timeline while having these challenges.
Strategy Leadership	P3	As I explained, switching people to use AI and Change management and also certification image of AI to solve the problem because of the quality of the data or even because of complexity of the problem. It is complex as of now. In future can be solve.
Strategy Leadership	P4	do an impact on, on changing the work of flow, uh, to make it. If you do not change the workflow, everybody will get back to their old way of doing things.
Strategy Leadership	P4	how you reduce the resistance and project rollout by our increasing awareness.
Strategy Leadership	P5	Not on the models, per se, and sales, like internal sales. You see what I mean, like convincing people, management of change, and other things. That is the biggest challenge, it is not really the technology per se.
Strategy Leadership	P5	There are diverse types of digital transformation projects, this is general, not only AI projects. So, one digital transformation project is about creating systems that are mandatory business process management, let us say SAP. You have no way other than using SAP to do your things. For the project that we did here, the automatic reservoir production reporting, annual reservoir performance reporting. This is a business process management tool that people will use. That was a success. Of course, there is no way that you will not succeed because everyone is forced to do it.
Strategy Leadership	P5	There is definitely a lot of value on implementing the AI algorithms. The challenge is in making sure that people embrace the technology. So, the people actually use it, create some trust around it, and get used to it.
Strategy Leadership	P6	And also doing awareness session, training workshops to keep people like updated about the project.
Strategy Leadership	P6	So, people will know the project before even develop the definitive version of the software or the tool. They will be already like technology champion. So, they know about the project. They evaluated themselves, they validate the pilot. And then when the project is completed, they will be more than happy to use it because they know the tool from the beginning.

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
Strategy Leadership	P6	So, who will be doing this training if we like to give this to consulting companies' Different companies.
Strategy Leadership	P7	Challenges in terms of people, process, and technology, what will be people? Uh, not only for artificial intelligence, always persistent to adapt to new, uh, system, new tools, new.
Strategy Leadership	P7	Challenges, I will say the change of management.
Strategy Leadership	P7	What could be changed or modified in the future when implementing ai? I think, uh, we need to have, um, a lot of awareness sessions.
Strategy Leadership	P8	During employee execution is always good to have the end user. It does not need to be as, it is not as critical as at the beginning of the project, but it is good as part of the mechanism or the process to develop the competency and the familiarity of the end user with the system that is going to be put in place.
Strategy Leadership	P8	It is also good to create a sense of, uh, owner. Of the end user. So, the end user needs to feel that the system is their system. It is not a system that is being defined by a project team that is not related to them.
Strategy Leadership	P8	during execution on an AI project. Well, it varies. Every project, uh, has to have, has to have good project management. Okay. There is no doubt about that. And AI projects is the same. I mean, you have to have good, good, good project management. But I think AI, pro AI projects have an additional degree of, uh, complexity, if you want to call it that way, that, uh, as you review the data and, uh, analyze the.
Strategy Leadership	P8	preferred governance model for project execution?
Strategy Leadership	P8	r AI projects, although I am not a fan of, uh, agile development, I am a fan of more, more, uh, structure execution. I think because of the, the nature of AI projects a, a mix of a structure execution approach with milestones and, and, and a very well-defined schedule will a mechanism of agile development.
Strategy Leadership	P8	That will allow the project team to, if necessary, modify the execution approach, modify the objectives, modify the way to get the objectives in throughout the project would be the preferred governance model based on my experience.
Strategy Leadership	P8	to be successful in the rollout you need to do, like in any, any other project, the change management issues and to make sure the end user will own the system or solution are especially important on an AI project in particular.
Strategy Leadership	P8	within the context of the people, process, and technology to me is the same.
Strategy Leadership	P8	AI does is not any different to any other project where we are implementing advanced technology.
Strategy Leadership	P8	the project cannot be driven by the technology. It has to be driven by the need of the people. And the need of the people is very well, very much related to the process in place. Now, the technology is not only about adoption of the technology to match the needs of the personnel, but it is also improvements on the process as a result of the capabilities of the technology.
Strategy Leadership	P8	You had a, a, a, a defined for your project. So, I think from execution, that that will be the most important thing that I, I actually would like to highlight now the challenges that are faced.
Strategy Leadership	P9	There has to be an obvious way to transition from the existing mode of operation to a different one. Let us say that you know, you as an organisation adopt, AI models to perform something, let us say wellbore images. But at the same time, your SMEs want to keep using the old software that they were used to.
Strategy Leadership	P9	So, it is a waste of money for you, right? Because you are using both and you are not realizing double the value, you are realizing the value of one, right? So then, to implement an AI strategy and sustain the creation of value and organisational performance, you need to have a clear plan for, listen guys, we are not goanna be using this software anymore.
Strategy Leadership	P9	You have three, four months to train on this new one. And you, have the opportunity to customize it. You have the opportunity to give feedback to the developers, and then after that period, three, four months, which is it. You only have the new solution, not the old. This is just an example, right?

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
Strategy Leadership	P9	There must be a clear plan, and the value has to be very clearly. Because let us say that there is a clear plan and then suddenly there is another project that your team sees, and management thinks that it adds more value, then they are going to reduce the priority level of the existing project, right? Yes. So, if the value is already clear from the beginning and plan is made, then you are likely to implement and see it through from beginning the end.
Strategy Leadership	P10	Because people started to understand the concept and the value, because once you have the first success story been accomplished other would love to be part of journey.
Strategy Leadership	P10	Change management is a crucial stage in any implementation of new disruption such Artificial intelligence, at initial stage it took us a while to ensure stakeholders understand the concept and the value of such implementation with dollar sign.
Strategy Leadership	P11	A little bit I have touched, which is integration and bringing the data in one place putting it on a proper format. And then once, once you have these models, and it comes, you have the process challenges is how do you integrate these new tools, part of existing work practices and substitute them within these new processes
Strategy Leadership	P11	There is a challenge, and the challenge is more into the adaptability and change management. The, I do not see challenges in creating these new. It is more of how to adhere and adapt to the modern technologies.
Strategy Leadership	P12	Other challenges are related that once you have finished the project, once you have your project put online, you always have the challenge to start using the product. The key consideration is that the people will need to be adapted to the new workflow.
Strategy Leadership	P13	After that, in the process side is to ensure that when you change, business process, you ensure or when you bring a new technology, but because digital transformation in AI is a transformation driven by technology is to ensure that you impact people like I mentioned before, and you impact the processes.
Strategy Leadership	P13	AI that is much more difficult to happen. If you want to be in the front of digital transformation and AI implementation, we need to be a little bit more, risk taking. Of course, with the necessary risk assessment and care. but one of main challenges has been change mentalities to be a little bit more to the organisation, to be more open, to try more technologies.
Strategy Leadership	P13	And it was important to create trust in the people that is the SEMS need to first understand technology and after that understand how this technology will change their ways of work. One good example is in AGP that at this moment, the SEMS is they have a smart room. Where they can see the prediction of these predictive models and they can start to changes in maintenance plans for the major rerouting equipment based in the prediction of these models. another one is brought to the maintenance strategy, this new way to do predictive maintenance and ensure that will not conflict with what the rules of the existing processes dictate to the maintenance plan is that this has, is a project that has start already touched the three-pillar people, technologies, and process.
Strategy Leadership	P13	But you don't want the same level of knowledge in all the levels of the organisation is that, but you need to have at least awareness, is that for even for the lowest level of the organisation, people need to understand how new technologies will change the way that work cause is key.
Strategy Leadership	P13	If they see technology has a challenge, or if they see technology has a threat for their job position, they will push back any change in the way they work. If they see as opportunity, they will welcome the change
Strategy Leadership	P14	This creates a challenge of implementation of the solution when the PoC/Pilot gets completed. Making the solution rolled out and making it as part of the operating model of the asset is a challenge
Strategy Leadership	P14	This requires an effective change management plan and the enabling digital mindset so the engineers can embrace AI technology along with their traditional process of managing their wells and field.
Strategy Leadership	P15	absolutely the, the job roles and descriptions will, will, will be modified depending on what you, what you know, what your role is
Strategy Leadership	P16	Change management is a crucial stage in any implementation of new disruption such Artificial intelligence, at initial stage it took us a while to ensure stakeholders understand the concept and the value of such implementation with dollar sign, therefore identification of right stakeholders and buy-in from leadership and top management are key to succeed.

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
Strategy Leadership	P17	But you don't want the same level of knowledge in all the levels of the organisation is that, but you need to have at least awareness, is that for even for the lowest level of the organisation, people need to understand how new technologies will change the way that work because is key.
Strategy Leadership	P17	If they see technology has a challenge, or if they see technology has a threat for their job position, they will push back any change in the way they work. If they see as opportunity, they will welcome the change that all the people in the organisation in some way need to be aware of how technology and how AI can impact their way of work.
Strategy Leadership	P17	mostly is that they see the benefits and, with the awareness sessions and repeating them. So, they start to be aware and to understand more, what is exactly when we say AI, give them examples and show them some implementations.
Strategy Leadership	P17	Several awareness sessions.so for example, we did awareness session for digital factory framework. we did as well, knowledge sharing sessions for several project related to AI and digital transformation, as well, bringing proposals to the projects team is giving support and the management are also supporting these initiatives. So, we have this support from management. We have some proposals with the values with benefit.
Strategy Leadership	P17	So, the awareness and the trained people kwon, why need AI and how it will enhance the way of operating which bring us to the other challenges, the way of people thinking. So, the change management part, many people, they do not see the value of AI. They see it as only something that is nice to have and to convince them how it can support their way of working and it will transform, and it will bring so many benefits.
Strategy Leadership	P17	This was one challenge but by the time, once we start implementation of some projects, the way of thinking is shifted to accept more the AI and digital project s. What else? The thing that we are running, this from here, like the central headquarters and we have so many operating companies, so it is a bit challenging.
Strategy Leadership	P17	You need to do it to all operating companies at the same time. Same level, but because we have like a vast number Projects, many operating companies. So, it needs some time, but as the people understanding and the change management processes,
Technology implementation and Integration	P2	Even before we talk about integrated production planning, we need to consider just planning. Planning should include setting optimum targets, not just historically based targets (remember the drilling example we discussed earlier). One of the best things we can do helped by AI is understanding if the planning targets are set correctly, based on something that we don't need to have 10 experts to add the questions, but the data by itself can “talk aloud” and tell us that there are opportunities to set better targets.
Technology implementation and Integration	P2	Intelligence could be built into the planning tools such that. based on past performance data benchmark against indicators of others in the industry, sing the output of simulation models, you can get recommendations to set optimum targets for planned shutdowns and to prevent unplanned deferrals. We should be able to consider some of these techniques to get the available rate must closer to the technical rate of our fields.
Technology implementation and Integration	P2	Our innovation and adoption time is too long. With support processes to acquire technologies or new services to do our operations. Are rigid in the sense that they are all aimed towards using the same thing efficiently, not so much to innovate with modern technologies.
Technology implementation and Integration	P2	The innovation requires thinking different about the way we acquire technology. It is based upon not necessarily using technology that are ready now, but technologies that need to be accelerated beginning with low technical readiness Level and then going through trials and deployment on a fast track. for that we are sponsoring and participating the technology acceleration program for start-ups, where we are work with start-ups to help them bring the technologies faster into ADNOC so that their innovations can be piloted and deployed much faster than before.
Technology implementation and Integration	P2	It is going, it is very well crafted. We already finished the first cohort. There were a 10-participant company selected all of them through innovators. The programme is focused on de-carbonization and the transition to the new energy, digital, and also takes upon some of the petroleum engineering solutions. we are partnering with BP and Equinor to lead this program as strategic partners. I am particularly involved on that, and it has been a wonderful experience so far. We are going to go for two more years for two more cohorts. And our objective is to bring more of these innovations to address opportunities and gaps within ADNOC

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
Technology implementation and Integration	P2	It is going, it is very well crafted. We already finished the first cohort. There were a 10-participant company selected all of them through innovators. The programme is focused on de-carbonization and the transition to the new energy, digital, and also takes upon some of the petroleum engineering solutions. we are partnering with BP and Equinor to lead this program as strategic partners. I am particularly involved on that, and it has been a wonderful experience so far. We are going to go for two more years for two more cohorts. And our objective is to bring more of these innovations to address opportunities and gaps within ADNOC
Technology implementation and Integration	P3	users' involvement during the project execution is particularly important to make sure to this agile mindset because we start by scope, features they want and by user's feedback and sometimes it can be important They give you one or two ideas and the accuracy increase by 10%. Amazingly simple to implement by the way they think, for example in this situation, look, if you have this sensor here and this sensor there means you very quickly increase your accuracy.
Technology implementation and Integration	P3	But if we keep out the team alone without this feedback, they can spend months, months without achieving that accuracy.
Technology implementation and Integration	P3	The same challenges in terms of product development value. we have some applications, the sustainability, the same SMES and the form various experiences. In other areas it is the same. So, it is, you see the same patterns they get in themselves.
Technology implementation and Integration	P3	Oil gas is a little bit behind the other industries in terms of technology adoption. Uh, but we see after like they are first fast path, most expensive companies in terms of modern technology and AI option.
Technology implementation and Integration	P3	So, it is not only objective of the development company, but also customer production. Um, one of the aspects is important to mention is that software development, which we are doing, it is important to have agile way of developing the software, is to accept that we spend a certain amount of time with minimum value product. Minimum of features, the minimum of accuracy accepted by users and with Agile way of development. And once achieve that to go into production and you keep engaging your team, your product team, along the process in order to enhance, the product in terms of accuracy, features and so on, uh, to maximize the value valuation and the engagement of users.
Technology implementation and Integration	P5	companies like Shell, for example, they also apply this and everything. So, some projects are for this size, and this is deep learning, convolutional neural networks, and a lot of complicated stuff. The generalized adversarial networks are very advanced and heavily well applicable to all this subsurface modelling domain.
Technology implementation and Integration	P5	For the operational domain, it is just a collection of a lot of small models. So, Shell has got like 30,000 machine learning models for surveillance of valves running in a platform called C3.ai and then you have similar things, you know, some other companies with Cognite and it is a scale running a lot of simple models. So, in this different approach everything depends on how your organisation is and depends on what kind of monster you are trying to solve. What are its characteristics, and the shape of the beast?
Technology implementation and Integration	P5	in my little domain of surveillance optimisation, our approach is dividing and conquer. Make many, many models, many small models, and orchestrate them all together. So, it is all about orchestrating many models. Each one of those bubbles, they can actually be created by a petroleum engineer with some basic understanding of how this AI works. But then once you go to the reservoir management domain or for example, geoscience, and you want to create an AI model to depict the falls in the seismic queue, now this is a complex math project.
Technology implementation and Integration	P5	In terms of the implementation of the AI strategy, okay, so this is not about the projects and services, but more about the strategy. Having a good strategy ensures that you put the right focus where you need to put. What we have seen around is that there is like a lot of focus on AI. You see AI everywhere and just because that is the more attractive thing for the moment. Once you dig into the things, it turns out that most of the projects do not need AI. You need to create the foundation. So having the right strategy of how to embed this AI, you have to check if it deals well with the foundation, it will facilitate so many things.

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
Technology implementation and Integration	P5	In terms of the implementation of the AI strategy, okay, so this is not about the projects and services, but more about the strategy. Having a good strategy ensures that you put the right focus where you need to put. What we have seen around is that there is like a lot of focus on AI. You see AI everywhere and just because that is the more attractive thing for the moment. Once you dig into the things, it turns out that most of the projects do not need AI. You need to create the foundation. So having the right strategy of how to embed this AI, you have to check if it deals well with the foundation, it will facilitate so many things. So, you think that you can apply AI to a certain process, for example, maintenance, the monitoring of rotating equipment, you may have a half a million instrument tags, no organisation in a historian. It is lacking the real-time data model which is part of data engineering is missing. Before you do data science, you need to do data engineering. So having an AI strategy should, you know, if it involves also mapping out, what are the building blocks that you need to get to the cherry on the pie, which is the actual AI, it is extremely useful. So, this is how I see.
Technology implementation and Integration	P6	I think for the SMEs expert, we need to have multidisciplinary expert in to be part of this digital Transformation.
Technology implementation and Integration	P6	You need to align with different partners. You need to develop the project chart, get different approvals, go to the legal, develop the contract and all this work like you take time and sometimes you spend one year to prepare a contract for two- or three-month project.
Technology implementation and Integration	P6	Actually, there is new techniques, the artificial intelligent model can be improved. It is the response and cause in each technology. So, we try to explain to our end user or our stakeholders that okay, there is some kind of lose in accuracy, but we will have like much faster, much smarter tools.
Technology implementation and Integration	P6	And the process is sometimes bit heavy. If you go to the legal to BMO and to Management approvals for this kind of project. It may take six months to one year to get the approval. And for this kind of technology the world is changing amazingly fast. So, if you wait one year to start a project, it may be obsolete.
Technology implementation and Integration	P6	But if we see from R and D part that artificial intelligence and machine learning are the best tool to solve this problem. It would be easier to explain to them. So again, if we start from the problem, try to find a solution it is better than to come with the project ready try to convince them to use it.
Technology implementation and Integration	P6	for artificial intelligence and this kind of new techniques and modern technology, we need to find a kind of fast track of project for this kind of technology because technology is changing amazingly fast.
Technology implementation and Integration	P6	If we got to a place where we have sensors the ability to actuate and optimize the system autonomously. So, without people influencing it or having to make changes, there's tremendous value in that because right now it is, you are only optimized as frequently as the information you are getting
Technology implementation and Integration	P6	Last year, the technology provider came with a project about quantum computing. This is a genuinely nice topic, but when we saw the maturity of the technology and our challenges, we could not map this technology with one of challenges.
Technology implementation and Integration	P6	So, we fail to implement this one. So again, it is, uh, it is good to have the innovative technologies, but again, we need to mark them with the business to see how it can be, can serve outlook. So, our role is to, to consider for sure these innovative technologies, but see how we can maximize the value from this technology to serve better outlook.
Technology implementation and Integration	P7	If we have opener, uh, platforms where the people can customize their workflows and do the, their own, uh, dashboards and interpretation. Um, not, I mean, it is difficult to find today someone that is, uh, having some background in it, that science plus
Technology implementation and Integration	P7	from technology point of view, um, we will say that, that the disruption because, uh, a lot of technologies, uh, coming at the same time.
Technology implementation and Integration	P7	normally I am collaborating with it because, uh, also you need to have an architecture where to plug in those, uh, applications. And, um, there is, is, uh, always challenging because it has their own project, and we have our own project.

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
Technology implementation and Integration	P7	people know anyone. No. Has to be people that they like to innovate. They like, uh, to, to think out of the box. Yes. Because, uh, this is something that, um, people have to have those skills, right? Uh, to be part of this. Plus, they have a solid technical background plus the computing, uh, skills. Um, I think, uh, we can create a profile yes.
Technology implementation and Integration	P8	So ready to be applied out of the box? No, there are some tools out there that will help on implement., but it will require certain effort of the in, in the part of the person who is actually going to use those tools in eh, item D eh, how much AI knowledge required to defend and embrace AI results?
Technology implementation and Integration	P8	So ready to be applied out of the box? No, there are some tools out there that will help on implement., but it will require certain effort of the in, in the part of the person who is actually going to use those tools in eh, item D eh, how much AI knowledge required to defend and embrace AI results?
Technology implementation and Integration	P8	within the context of the people, process, and technology to me is the same.
Technology implementation and Integration	P8	AI does is not any different to any other project where we are implementing advanced technology.
Technology implementation and Integration	P8	the project cannot be driven by the technology. It has to be driven by the need of the people. And the need of the people is very well, very much related to the process in place. Now, the technology is not only about adoption of the technology to match the needs of the personnel, but it is also improvements on the process as a result of the capabilities of the technology.
Technology implementation and Integration	P9	Historically, you would have other companies come in, take your Data. Build models and sell it to you and sell it to others, and they would be valuable. So, I want it to be made in ADNOC. It contributes to the UAE GDP that is why, the organisations would be anyone who would be using other people's products, they should be working together to create their own through AIQ.
Technology implementation and Integration	P9	I think if it is the same steps from beginning to end, you know, you start with the math and then eventually you think about, you know, your engineering, the data you are building, the software. All of these are steps that are repetitive. If there is a way to consolidate these, automate you click a button, all of that is done. That would be amazing for a specific data source. So, what could be changed or modified in the future? automate a lot of the steps. If you have the math done, I think this should get you most of the way right now. It does not get you most of most of the way is in the design and other things that are very manual.
Technology implementation and Integration	P9	It is planning because in AI. like the brain of any solution is the algorithm. It is a set of rules in math, you know what data input you need, and you also know what the output would be. But now how do you package it to be used by, you know, process engineers, by management, by decision makers?
Technology implementation and Integration	P10	AI is actually the forefront and the last layer of software solution connected to data and sensors and simplify people day to day job and management to accelerate their decision making,
Technology implementation and Integration	P11	job descriptions will change or reflect the new, the, even our recruitment processes will change. We will demand for these skills increasingly similar to innovation. So today, part of the interviewing process, you will see an assessment on. Innovative thinking the person is carrying with him, especially if he is in a profile where he needs to think out of the box or go beyond the norms, then they are looking for this type of skillset.
Technology implementation and Integration	P11	The digital twin concept will continue to grow. The definition of it will continue to grow. I think if we take an example that people see or hear about around them like it, a fully developed digital twin is like the metaverse and you go into this virtual environment.
Technology implementation and Integration	P11	You see a full simulation of everything around you and you take instant actions, and these actions are replicated into a real role. So, we will reach, so today we are talking about much simplified thing. It is more of a representation of your asset and the digital form. And then there could be some of your time data linked to it.

Phase I Interview Results after Coding		
Area	**Who?**	**Interview Response**
Technology implementation and Integration	P11	whole purpose is for this. Once the people have knowledge of digital and ai, they will appreciate what we are doing, and they will demand for this because people, when they fear something, there is a tendency of resistance. They will push back. But when they will understand it and they see the opportunity in front of them, they will embrace it.
Technology implementation and Integration	P12	One important aspect is that AI will create a large volume of results that require interpretation, both from technical and AI matters. Then, any user having knowledge around his/her technical background and a little bit of AI, then such people will have a better way to defend the results and embrace the new tools.
Technology implementation and Integration	P12	in terms of technology I would say the most important challenges a has been about having the right technology within the corporate environment of ADNOC you know we know that in many cases IT does not support many of the that a less secure infrastructure so you require to have like an enterprise a friendly infrastructure so and but having that for a tool that needs to be built sometimes is difficult so you need to combine both the issue that there is not a finished tool but that but you also need to make it as part of a corporate enterprise architecture that may be very strict sometimes.
Technology implementation and Integration	P12	We can create a small let's say more POC or visualization dashboards or tools that they use are start feeling what the final product will look like and they can provide feedback on a continuous basis the other sort of involvement will be to have many UAT user acceptance test when they are signing off end of the different functionalities that the tool has been used how have you word used their assistance in the project
Technology implementation and Integration	P13	what we have done here in digital technology group, we have developing 2020, project that was or framework that is a digital transformation or digital factory framework. It is a framework that sets the requirement for the implementation of AI, and part of that focal points have been identified in all the operating companies that exist technology or digital transformation drivers, in all operating companies to help us to start to change mentalities.
Technology implementation and Integration	P15	? So, you need to have, um, all the technical capabilities to deploy stuff. Uh, these technologies subsurface surface.
Technology implementation and Integration	P15	be able to link all that data-to-data historians that then feed into, uh, the required digital platforms to process the information.
Technology implementation and Integration	P15	the digital oil fields. Um, in terms of technology, it is having all the different, um, well, the sensors. You need to have all the right sensors calibrated. We need to have maintenance crews to make sure that is, that is working properly. Um, and you need to make sure that you have all the right inputs. PV T
Technology implementation and Integration	P16	Because we have technology team, but we have other, I would say mini technology teams across the group. So that causes a little bit of duplication effort sometimes. So, alignment is, a challenge for sure. legal process is also a big challenge. IT approvals, you know, we are super confidential. I mean, when it comes to data that are sharing the process takes a lot of time because of all of the approvals that are needed. And, yes, these are the main challenges that we have.
Technology implementation and Integration	P16	A digital factory framework which we did before, but having, AI leaders from across the group, and we train them for them to lead the digital transformation in their companies would be a particularly clever idea to accelerate AI for this technology centre.
Technology implementation and Integration	P17	Well, AI and digital transformation tools or technologies are always involvement. In that, more than ever, we need to be updated, the same way that we have started to give training to identify people and try to give awareness for most of the people, to in the organisation, maximum people possible. It is important that in the future we have like exist here, a team dedicated to understanding technology

Phase II Interview: Maturity Model

Phase II Interview: Maturity Model (1/3)			
Area	**Strategy**	**Strategy**	**Data Readiness**
Theme	Leadership and top management influence	Understanding and communicating the value	Core data availability and quality
Question?	How does leadership influence the transformation of business models?	Do all stakeholders easily understand a genuine value of the business model transformation?	Do we have all key data (availability and quality) required for transforming the production optimisation business process?
1	**Leadership and top management do not support business model transformation using AI** and ensure sticking to status-quo models.	The **AI solution supporting the new business model does not have a clear value proposition.** Communication to potential users and decision makers is limited. There is full disagreement among various top management. AI is not considered as a tool to drive sustainability and business model transformation.	**Data is poorly available, and quality is questionable for key production optimisation domain.** Data incompleteness limits the type of workflows that can be implemented to drive business model transformation in key processes. Business model transformation is not supported by current disrupted data pipeline from wellsite to desktop. Available data is not enough to establish any AI model.
2	**Some leadership and top management directives are delivered to support business model transformation using AI, but they are not consistent.** No new vision or mission statements are established. Some capabilities are acquired or pursued (talents, AI technology), but key resources are missing. There is no written or agreed AI strategy for supporting business model transformation.	The **new business model establishes a slightly better-than-nothing value proposition**. A confusing language is used to communicate to potential users and decision makers and non-technical people how value could be generated. Evolution rather than disruption results in loss of momentum. There is lack of agreement among various top management. Company struggles to show value continuously from the application of AI.	**Data is available and of excellent quality but not consistent**; some AI workflows can be implemented to overcome the limitation of low data quality and incompleteness. Data pipeline is not consistent from wellsite to desktop.
3	**Leadership and top management support business model transformation using AI by providing unobstructed vision and reviewing mission statements**. Appropriate capabilities building by acquiring new talents, data foundation, AI technology. They lead by example. They select the right projects to be executed.	The **AI solution supporting the new business model establishes a better business case and clear value proposition.** A clear (easy-to-understand) language is used to communicate to potential users and decision makers and non-technical people. Selected examples/PoV are available. Leadership turns to AI technology as a new way to create more value and mitigate survivability risks.	**Data availability and quality is an enabler for successful AI initiative driving business model transformation.** Any AI workflows can be implemented towards business model transformation. Existence of data utilization workflows drive continuous data quality improvement.
4	In addition to level 3, **Leadership and top management deliver periodic**	In addition to level 3, **the value proposition is innovative and ranks higher than many**	In addition to level 3, **company allocate resources to close the data gaps, acquiring**

Phase II Interview: Maturity Model (1/3)			
Area	**Strategy**	**Strategy**	**Data Readiness**
Theme	Leadership and top management influence	Understanding and communicating the value	Core data availability and quality
	messages about the importance of AI and new business models for the corporation ability to survive in the energy transition. Top notch skills are acquired and used to guide the strategy. There is a written and agreed digitisation and AI strategy.	**other initiatives in the management board**. Great level of communication and awareness is available across all stakeholders. Project owners have excellent marketing skills. Disruption rather than evolution creates momentum. There is full agreement among various top management.	**new data** (e.g., paying for third party data, installing new hardware, etc.) or establishing internal data governance processes are key to develop a new reality and transform the business.
5	In addition to level 4, L**eadership and top management reward behaviours and results regarding the intended strategy.**	In addition to level 4, **key project owners are able to explain tangible (real) examples of the AI algorithm behind without too many technicalities.** Value tracking shows continuous improving profitability (P&L) results. Company outstands its peers because of the best and **consistent application of AI for influencing business model transformation and have a significant competitive advantage.**	In addition to level 4, **high data availability and quality is achieved through continuous improvement process**; data is a promoter and influential factor for AI initiatives driving continuous business model transformation. Existence of data utilization workflows drive further collaboration across organisation.

Phase II Interview: Maturity Model (2/3)			
Area	**People**	**People**	**Process**
Theme	Skilled people and multidisciplinary teams	User engagement and attitude towards new ways of working	Significant simplification of previous business process
Question?	Do we have the right skilled people and synergies across multidisciplinary teams required for transforming the production optimisation business process?	What is the level of user engagement and attitude in the adoption of fresh solutions?	How does the new AI solution simplify previous business process?
1	**All key stakeholders (SME's, IT, data management and AI disciplines) work in siloes** and they seldom meet to define the needs and validate the outputs of AI models. Individual skills are unknown, some of them	**Users and managers are not engaged during AI solution build.** Users and managers are detractors of the new solution and processes. Lack of change management plan. End-user lack of	The new **AI solution does not simplify previous business process**. User interface and usability are terrible. Lack of digital project management

	are insufficient to meet work AI projects demands. SME's (G&G, PE & RE) lack of digital and AI skills.	engagement with new developed solutions.	foundation. Projects lacked a dedicated project (product) manager.
2	All **key stakeholders (SME's, IT, data management and AI disciplines) work as team during project defined tasks**. They vaguely review and validate the needs, outputs of AI models. Individual skills are known, but not available, some of them are insufficient to meet work demands.	**Users and managers are engaged at key stages of the AI solution building but not enough.** Users and managers support but they do not embrace the new solution and processes. Poor attitude towards new ways of working. Weak change management plan.	The new **AI solution simplify a little bit the previous business process.** Confusing interfaces undermines new solution's value. Poor digital project management foundation. Projects lacked a competent or enough attention of a project (product) manager.
3	**SME's, IT, data management and AI disciplines work naturally as a cohesive team** with adequate interpersonal skills to review and validate the needs, outputs of AI models. Individual skills are well known and exploited. Current skills are complemented through continuous development programs or external help.	**Users and managers are engaged at every stage of the AI solution building, from design to rollout.** Users and managers support and embrace the solutions and new ways of working, and they understand what the results of the AI tool are about. Clear and consistent change management plan.	**Users enjoy a simpler business process and enhanced user experience**, of what it used to be complicated. User's minds and hearts are gained by hiding complex features of the solution. Value addition is not compromised. Human effort or cost is reduced over 30%. Solid digital project management foundation with a dedicated project manager.
4	In addition to level 3, **new innovative ideas are generated from the teamwork.** Ideas brought to life by proper prototyping and piloting. World class skills are pursued and acquired. Geologists, PE & RE and digital and AI skills are continuously complemented.	In addition to level 3, **users and managers assist in accelerating new solution features,** and promote continuous improvements towards new ways of working.	In addition to level 3, users and managers are given the **opportunity to further simplify the process**. Human effort or cost is reduced over 60%.
5	In addition to level 4, **prototypes and pilots are further enhanced through team collaboration**, productize as commercial-like solution, and continue to innovate.	In addition to level 4, **users and managers are key for innovating future releases.** End-users have full engagement in developing fresh solutions.	In addition to level 4, users and managers are given the opportunity to further simplify the process. Human effort or cost is reduced over 90%.

Phase II Interview: Maturity Model (3/3)				
Area	**Process**	**Process**	**Technology**	**Technology**
Theme	Enabling collaboration and innovation organisational environment	Embedding new ways of streamlined working	Right digital twin model availability, training, and update	Right AI Technology selection and adoption

Question?	How do collaborations and innovation enable transformation of business model?	How new ways of working embedded in the new business model?	Has the right digital twin model been built, trained, and updated to support the new business model?	Has the right AI Technology been selected and adopted to support the new business model?
1	**Ad-Hoc or no collaboration.** Users perform workflows and run AI models in silos and individual knowledge. AI solution analysis results are disseminated vaguely to various users.	**Previous business processes are not changed**. There is difference and no value perceived from the new business process. No intention or wiliness to embed new AI tools into existing processes.	**There are no specific physical process models to address key business process through AI use cases**. AI models are not trained enough, or they are unreliable. Lack of continuous data and model update.	**AI algorithms selected do not properly support current business model transformation**. AI models are not used for production optimisation. No intention or wiliness to adopt new AI technologies. There is no technology adoption cycle.
2	**AI solution workflows driving analysis and visualization are clearly defined.** There is some limited collaboration between visualization users. Decision-makers partially depend on ad-hoc analysis and visualization.	**New ways of working are vaguely embedded** in the business processes. Previous processes are slightly changed. It is not well understood the difference and value of the new process. Good AI initiatives are not embedded into existing processes. AI- solution rollout is not consistent across whole body of users.	**AI models are built for narrow business process cases**. AI models easily break as new data arrives or field condition changes. AI models are trained with a narrow data set and do not match history properly in all areas. There is no strategy to keep AI models updated.	**AI algorithms selected somehow support current business model transformation**. AI models are used for production optimisation, but they do not solve all challenges. Misuse of AI tools or Use of incorrect AI tools. Technology adoption cycle is lengthy.
3	**AI solution workflows driving collaboration and innovations are encouraged following written processes.** Analysis tools address the needs of multiple disciplines. Users collaborate on some process areas.	**New ways of working are embedded easily** in the system and new business model. Previous processes are changed with little or no disruption. It is well understood the difference and value of the new AI-driven process. AI- solution rollout is consistent across whole body of users.	Adequate, **fit-for-purpose, AI models (reservoir, well and facilities) are built for general steady-state key business process** cases. AI models can be considered digital twins of the physical system. AI models are trained with sufficient quality data. A strategy to keep these models updated is in place.	**Proper AI algorithms and data platform support business model transformation correctly**. Machine learning fit-for-purpose models are used successfully for production optimisation. There is a seamless adoption of new and key AI technologies.
4	There is a **permanent collaborative AI solution workflows and innovation environment designed to conduct business model transformation monitoring**. Some users are involved with specific roles and collaboration responsibilities.	In addition to level 3, **new ways of working are guided through established governance processes** (KPI's, value tracking, RACI, and governance committees).	In addition to level 3, AI models can represent the **physical reality with high fidelity and for various use cases ranging daily to yearly** business process decision making. AI models' parameters are automatically updated.	In addition to level 3, **apply successfully deep learning, reinforcement learning, recommending systems** and many more AI tools for the benefit of the production optimisation business model.
5	**AI solution workflows driving analysis and visualization are governed through Business Process Automation and formal participation of required people to make decisions**. Designated	In addition to level 4, **new ways of working are continuously improved and streamlined**.	In addition to level 4, **AI models' structure and capabilities evolve as new infrastructure is added to the asset** and they are considered in all key business processes.	In addition to level 4, **AI provides new insights that can help them innovate and develops new business models** as they continue to compete in an increasingly competitive environment

	collaboration leader. Results from decisions are measured for continuous business model transformation improvement			

Phase II Interview Results: Maturity Model for Project Manager 1

Area	Theme	Before Solution	At Design Stage	During Product Development	At Rollout Stage	Vision After Rollout
Strategy	Leadership and top management influence	2	2	3	**4**	5
	Understanding and communicating the value	2	2	2	**3**	3
Data Readiness	Core data availability and quality	1	1	2	**3**	4
People	Skilled people and multidisciplinary teams	2	2	3	**3**	4
	User engagement and attitude towards new ways of working	2	2	3	**3**	3
Process	Significant simplification of previous business process	2	2	2	**3**	4
	Enabling collaboration and innovation organizational environment	2	2	2	**4**	5
	Embedding new ways of streamlined working	2	3	3	**3**	4
Technology	Right digital twin model availability, training, and update	1	1	3	**3**	4

Phase II Interview Results: Maturity Model for Project Manager 2

Area	Theme	Before Solution	At Design Stage	During Product Development	At Rollout Stage	Vision After Rollout
Strategy	Leadership and top management influence	2	2	2	**3**	4
	Understanding and communicating the value	2	2	3	**3**	4
Data Readiness	Core data availability and quality	2	2	2	**3**	4
People	Skilled people and multidisciplinary teams	1	1	2	**3**	3
	User engagement and attitude towards new ways of working	2	2	2	**2**	3
Process	Significant simplification of previous business process	1	2	3	**3**	3
	Enabling collaboration and innovation organizational environment	1	1	2	**4**	5
	Embedding new ways of streamlined working	N/A	2	3	**3**	3
Technology	Right digital twin model availability, training, and update	2	2	2	**3**	4

Phase II Interview Results: Maturity Model for Project Manager 3

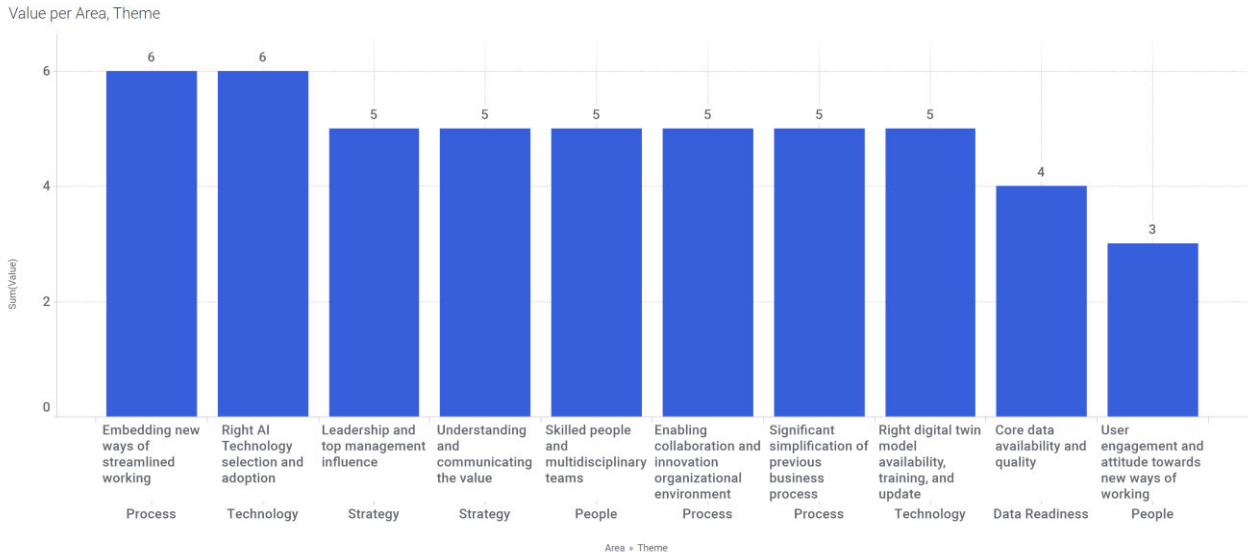
Area	Theme	Before Solution	At Design Stage	During Product Development	At Rollout Stage	Vision After Rollout
Strategy	Leadership and top management influence	2	2	2	**3**	4
	Understanding and communicating the value	2	2	2	**3**	4
Data Readiness	Core data availability and quality	1	2	3	**4**	5
People	Skilled people and multidisciplinary teams	1	2	2	**2**	4
	User engagement and attitude towards new ways of working	2	2	3	**4**	5
Process	Significant simplification of previous business process	2	2	3	**4**	5
	Enabling collaboration and innovation organizational environment	2	2	3	**3**	5
	Embedding new ways of streamlined working	1	1	2	**4**	5
Technology	Right digital twin model availability, training, and update	2	2	3	**4**	5

Phase II Interview Results: Maturity Model for Project Manager 4

Area	Theme	Before Solution	At Design Stage	During Product Development	At Rollout Stage	Vision After Rollout
Strategy	Leadership and top management influence	2	2	2	**3**	4
	Understanding and communicating the value	1	3	3	**3**	3
Data Readiness	Core data availability and quality	2	2	2	**2**	3
People	Skilled people and multidisciplinary teams	2	2	2	**2**	3
	User engagement and attitude towards new ways of working	1	1	1	**1**	3
Process	Significant simplification of previous business process	2	2	2	**2**	3
	Enabling collaboration and innovation organizational environment	2	2	2	**2**	3
	Embedding new ways of streamlined working	2	2	2	**2**	3
Technology	Right digital twin model availability, training, and update	1	1	2	**2**	3

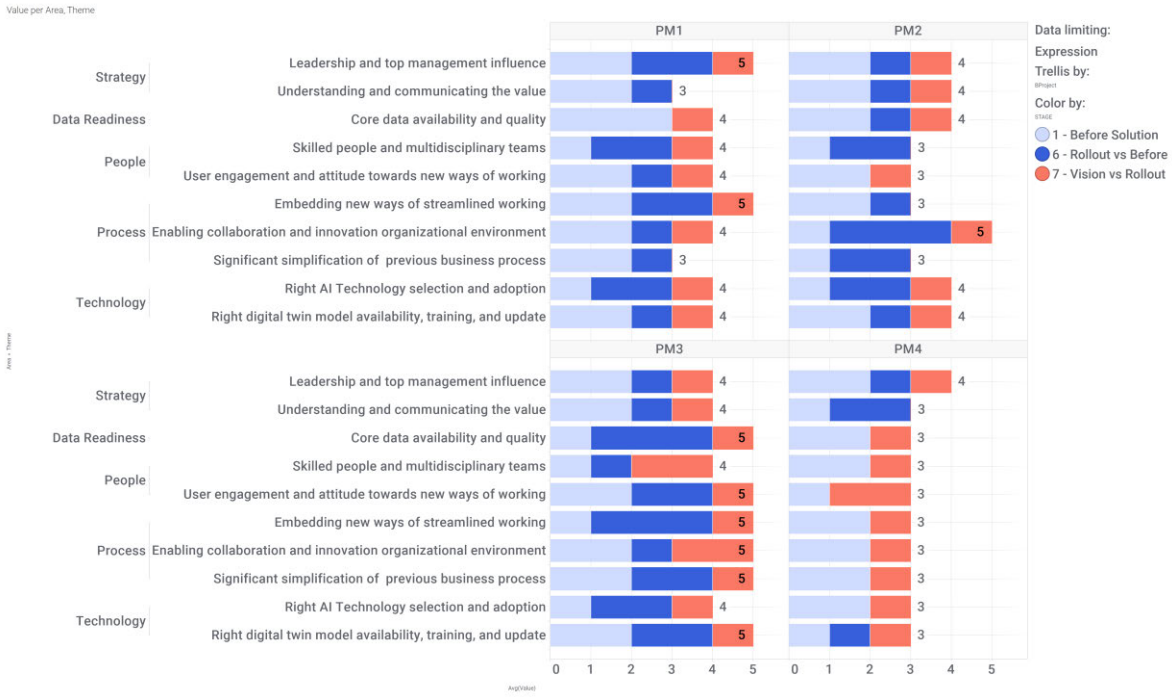
Appendix C Phase II Summary Results

C.1 Major Contribution Across All Projects



C.2 Phase II Major Gaps Across All Projects

C.3 Value Added (Dark blue) and Gaps (red) by Area/Theme by Project



C.4 Added-Value Areas by Project