Adoption Model for Digital Technologies: Case Study of Petroleum Development Oman

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Abstract

As Petroleum Development Oman (PDO) embarked in using digital technologies to address operational challenges, it was ill prepared regarding the approach the company needs to take. This thesis proposes an adoption model that PDO can use to adopt digital technologies.

During the process of problem analysis, three research objectives were identified. These are; understand digital adoption, investigate factors influencing digital adoption and developing a model for digital adoption. In order to address these research objectives using action research over several cycles, mixed methods were utilised. The research was conducted over a period of almost one year from April 2020 to Jan 2021. The research contributed to identifying two main actions for PDO. PDO embarked in the implementation of a PDO wide digital strategy and kick started the talent development program as a result of this research.

The literature review identified key areas to investigate in order to develop an adoption model for digital technologies. These include identifying the digital drivers, the organizational readiness, the required capabilities, leadership and change. As a result of the literature review, the theoretical framework was based on those five pillars. These formed the five research stages of this action research, including debriefing sessions with PDO management after each stage to ensure continuous alignment. The population sample included all staff involved in contributing to the experimentation of digital pilots within PDO.

A digital adoption model for PDO emerged with seven key pillars: digital strategy and vision (focusing on building a coherent digital strategy for PDO), digital leadership (focusing in building the required skills for PDO leadership), digital talent development (focusing on skilling PDO resources to implement digital projects), digital capabilities (focusing on key business capabilities to drive digital), business model innovation (focusing in creating a digital mindset to drive future business development), digital governance (focusing on building faster decision making capabilities), and digital change management (focusing on managing the transition to a higher digital maturity).

The proposed adoption model was partially implemented by PDO through the development of PDO-wide digital strategy and developing the digital skills within. Finally, the research identified the potential to generalize the model to other organizations and identified key limitations. The limitation includes the use of a particular population sample, conducting the study during COVID19 pandemic and the use of descriptive analysis to analyse the results.

This study provided empirical evidence supporting the drivers to adopt digital technologies In addition, the survey developed to measure the digital capabilities provided empirical insights into the digital capabilities needed for organizations planning to adopt digital technologies. Finally, the study outcome was an adoption model (based on evidence collected during this action research).that could guide organizations embarking on similar journey to adopt digital technologies .

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Chapter 1 - Introduction

Digital transformation — that is, the use of technology to radically improve the performance of an enterprise (Westerman et al., 2011) — is rapidly emerging and gaining traction and wide adoption globally. As a result, many organisations are under pressure to harness digital technologies and transform how they work through major initiatives to improve current business processes and introduce new business models (Westerman, et al., 2011). On the other hand, driving successful digital transformation is challenging and risky if implemented improperly (Kane, et al., 2015). Furthermore, industries are not equally mature in adopting digital transformation initiatives, and certain industries (e.g., energy) are considered laggards in comparison with customer-facing industries such as banking (Fæste, et al., 2015). Such variation in maturity and adoption, alongside pressure for organisational improvement through digital technologies, has resulted in digital initiatives becoming perplexing for organisations in diverse industries. This study will focus on the digital adoption within Petroleum Development Oman (PDO), for which such pressure is mounting. In addition, the company would like to utilize digital technologies to excel its business, yet there is no clear path for how such adoption of digital technologies should take place. Taking an action research approach, this study explores drivers and state of readiness and offers a set of recommendations to the senior management of PDO.

The thesis divides into seven chapters. The first chapter introduces the primary

topics under investigation, including digital technologies, the hype of digital transformation, key digital adoption challenges and the importance of adopting digital technologies in MENA and the oil and gas industry (please refer to section 2.3). It then examines action research and discusses its importance, its aim and objectives, and the methodology employed. The second chapter reviews the literature to identify relevant contemporary and new research in the field of digital adoption, in alignment with the research questions and objectives. The third chapter discusses the research methodology, including the research design and the analysis techniques employed in this study. The fourth chapter presents the research findings and the iterative cycles where the action is reviewed with PDO management before it gets actioned. The fifth chapter discusses the findings and contrasts them with the literature review and provides a deep evaluation of the study outcomes and proposes different paths to digital adoption. The sixth chapter presents the main recommendations from the study and discusses in detail the proposed adoption model. The final chapter examines the study's limitations and practical implications. **Figure 1.1** displays the structure of the study.
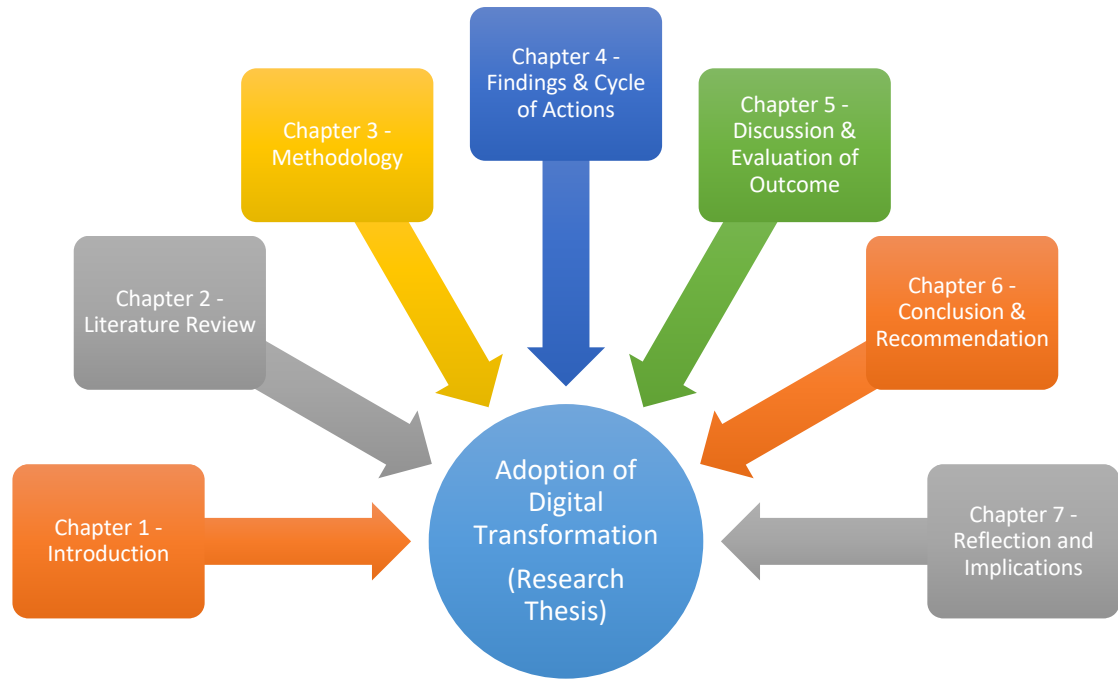
Figure 1.1. Structure of the Thesis

1.1 Introduction

According to Gartner, the term "digitalization" is often associated with how companies can use digital technologies to change their business model or how they conduct business (Gartner, 2017). How companies use such technologies necessitate the need for such technologies to be adopted by the users within the organizations. Prior to understanding how such adoption should take place, it is important to understand what constitutes a digital technology as this very much varies among the literature. McDonald and Rowsell-Jones (2012) argue that technologies such as Big Data, predictive analytics, visualisation, and advanced algorithms are considered digital technologies. Furthermore, as Uhl and Gollenia (2016) identify, disruptive technologies such as Big Data, social media, cloud

computing, 3D printing and mobility comprise the digital technologies that will change future business models. Gartner defines digital technologies as part of a hype cycle featuring technologies such as digital twins, blockchain, and the Internet of Things (IoT). Beyond the inconsistency in how digital technologies are conceived, such technologies are continuously evolving and maturing. According to the World Economic Forum (WEFORUM, 2017), seven technologies are anticipated to reshape business and society in the coming years: artificial intelligence, autonomous vehicles, Big Data analytics and cloud computing, custom manufacturing and 3D printing, the IoT and connected devices, robots and drones, and social media. Although some of these technologies (e.g., Big Data; Spelman et al., 2017) are familiar to the oil and gas industry, others have entered only recently or have yet to be introduced. **Table 1.1** illustrates the different definitions of what constitutes "digital technologies".

Literature Source	Definition of Digital Technologies
McDonald & Rowsell-Jones (2012)	Big Data, predictive analytics, visualisation and advanced algorithms
Uhl & Gollenia (2016)	Big Data, social media, cloud computing, 3D printing and mobility
Gartner	Digital twins, blockchain, and Internet of Things (IoT)
World Economic Forum	Artificial intelligence, autonomous vehicles, Big Data analytics and cloud computing, custom manufacturing and 3D printing, the IoT and connected devices, robots and drones, and social media

Table 1.1. Definitions of Digital Technologies

Why should a company like PDO operating in the upstream oil and gas industry be bothered about such digital technologies? The literature provides evidence that

digital technologies can variously impact the oil and gas industry in ways related to current themes and challenges within it. More precisely, according to Spelman et al. (2017), four trends are affecting the oil and gas industry.

The first trend is the volatility of oil prices, disrupting supply and demand. This disruption will sustain pressure on hydrocarbon prices, driving oil and gas companies to become more efficient in their investment choices and operations. Thus, *adopting digital technologies could improve and optimise operational costs*.

The second trend affecting the oil and gas industry is the decline of conventional methods of oil extraction and the growth in unconventional methods. Consequently, the unconventional methods require technological advancement to drive corporate investment in innovative technologies and lower the overall cost of production. In Oman, most oil exploration uses unconventional methods such as enhanced oil recovery (EOR). The extraction of hydrocarbons by both conventional and unconventional methods is likely to be the preferred way to address global oil demands for the next 50 years (Zitha, et al., 2019). According to Spelman et al (2017), the US is becoming a producer of light oil and overtaking Middle Eastern countries as swing producers. *With the use of digital technologies and advancement in artificial intelligence models, the oil and gas operators will arguably have faster time to market* (Spelman et al, 2017).

The third trend relates to asset maturity within the MENA region. Including Oman, many companies within Gulf Cooperation Council (GCC, comprising Bahrain, Kuwait, Qatar, Saudi Arabia, Sultanate of Oman, and United Arab Emirates) have mature oil infrastructure and assets, as oil was discovered more than 50 years ago in some places. The PDO's operations include such established infrastructure. The

ageing infrastructure presents a constant and growing challenge. In general, asset integrity degrades with age, which can result in oil deferments (loss of oil) and, in the worst cases, safety incidents. Maintaining asset integrity is essential to ensure a safe, reliable, and efficient industry, and therefore a sustainable one. *This type of maintenance can be enabled through digital technologies such as sensors and the IoT* (internet of Things).

The fourth trend is "crew change" as the oil and gas industry often experiences losses of professional and experienced workers. On the people and knowledge management side, the professional workforce in the hydrocarbon industry is aging, and many in today's workforce will retire within the next decade. Meanwhile, producing oil and gas fields are maturing, and new fields are more complex to locate and develop. This transition from an aging workforce to a younger workforce — often referred to as "The Great Crew Change" (Coton, 2011) — is perhaps the largest challenge the industry faces in MENA, GCC including Oman, because of the many people leaving the platforms and refineries, the vast practical knowledge of the industry they possess, and the difficulty of retaining this workforce knowledge due to the verbal culture of the oil and gas industry. *Digital technologies can help in capturing such knowledge through technologies such as big data, advanced analytics and expert systems.*

With the different challenges facing the oil and gas industry and the promise of digital technologies, PDO seems ill prepared to adopt and utilise digital technologies and adopt them within. This research examines PDO as a case study of the oil and gas industry, and how adopting digital technologies are expected to considerably influence the company and potentially the oil and gas industry.

According to Spelman et al. (2017), the oil and gas industry faces disruptive technological advancement such as hydraulic fracturing, resulting in oversupply of oil and driving further volatility in oil prices. In addition, operating costs and competition are rising. Spelman et al. (2017) has argued that adopting digital technologies will help the industry to remain competitive in two ways:

1) They will shift the operating cost from the traditional expensive model into a subscription-based and pay-as-you-go model. This shift will reduce operating expenses.

2) They will enable cross-functional multidiscipline collaboration that will drive effective decision making.

The importance of adopting digital technologies has been attested also by Kane et al. (2015) in the work done through the Massachusetts Institute of Technology (MIT) survey. The survey conducted by MIT Sloan Management Review and Deloitte highlighted that more than 70% of global executives who participated stated that digital technologies are important to their organisation (Kane, et al., 2015). The significance of digital technologies has also been discussed by various consultancy firms such as Accenture, who in 2016 conducted an Upstream Oil and Gas Digital Trends Survey (Spelman, et al., 2017). The findings from the Accenture survey illustrated that global companies in the oil and gas industry are planning to invest heavily in implementing digital technologies within their organisations. In the next three to five years, the top three digital technologies (in terms of investment) are expected to be in the areas of mobility, Big Data analytics, and the IoT. In addition, as digitalisation initiatives are implemented in other industries, and as other organisations within oil and gas industry are transformed through

digitalisation, the adoption becomes a question of survival: either evolve or die (Raskino & Waller, 2015).

On the other hand, organizations attempting to adopt and implement digital technologies find themselves in dilemma. How should such adoption be driven? Should it grow organically within the organization using its current practices or should an external party help and support such digital adoption? How such adoption should be manifested within the organisation and what are the different elements needed?

1.2 Research Background

As PDO started to experiment with different digital technologies, the approach taken prior to 2018 was fragmented and does not provide the aspired business benefits as stated by Spelman, et al. (2017). In 2018, a new Chief Information and Digitalization Officer was appointed to optimise the company digital investment and to drive the digital adoption within PDO. The new CIDO formed a team called the Digital Center of Excellence (DCoE) -which I was a member- to evaluate the different approaches of digital adoption. The engagement (myself, CIDO and members of the DCoE) in 2018 with multiple consultancy firms suggests that they have used various methods and frameworks to support organisations pursuing digital adoption. These consultancy firms created adoption models that were generic, however, and PDO management viewed them as both biased and lacking regard for the business interests of PDO. I was motivated to create an adoption model for PDO through the use of action research as part of the Doctorate in Business Administration (DBA) program. I discussed the idea with CIDO, who thought that these consulting firm's frameworks seem to adopt a one-size-fits-all

approach; this consideration prompted her in April 2018 to support this research study. With her support, I started the process of gaining approvals to initiate this action research. Unfortunately, due to the delays encountered in obtaining the necessary approvals from University of Liverpool, CIDO suggested the need to hire an external consultant (named digital partner) to support PDO while I continue my research in developing an adoption model. By doing so, CIDO managed to reduce the pressure from the top management who wanted to see an immediate results, yet provided me an opportunity to contribute to the success of the company in adopting digital.

1.2.1 The Researcher's Role

I work for PDO, which is the largest oil and gas company in Oman (see **Appendix C** for my position within the organisation in 2020 and **Appendix B** for my biography). I play a vital role within the organisation, especially in translating the company's business demands into information technology (IT) products and services and advising the organisation on long-term technology adoption and choices. My role as a chief architect comprises the following three main activities:

(a) translating the company's business needs into IT-related activities and technologies;

(b) building a five-year roadmap for how IT projects can help support business objectives; and

(c) mapping the different IT vendors' offerings and managing the overall IT landscape.

I will play two main roles in the present research:

(a) deciding which digital technologies will bring the most value to the organisation and

(b) developing a methodology for adopting such technologies within the organisation.

Notably, digitalisation is not itself a business objective for the organisation. Rather, digitalisation enables business processes; this is the real reason organisations are undertaking digitalisation strategies. Examples of such impact can be seen in multiple oil and gas companies utilising sensor technologies to aid the drilling process (Spelman, et al., 2017, p. 9). To allow me to architect the digitalisation roadmap, it is essential to understand how each of the digital technologies will impact the organisation. Furthermore, I am playing an active role already in identifying the digital agenda for the organisation and views this research as a useful tool to investigate the connection between theory and practice. The digital partner (in this case Boston Consulting Group [BCG]) is aimed at speeding up the learning curve of digital adoption by bringing external expertise from other organisations who have already embarked on the journey of digital transformation.

Furthermore, there is always an underlying assumption that as an insider researcher, I will have easy access to information and thus support the research process. However, the journey was more complex than that. To overcome potential difficulties posed by insider research, Schein (2010) proposed that the basis for any research inquiry is to build trust and relationships and to collaborate within a team. Since the DCoE was a newly formed team in 2018, I anticipate positive engagement and cooperative interactions among participants (**Figure 1.2**

shows the membership of DCoE and how it spans PDO). The DCoE consists of three types of members:

1) Digital advisors who are experts in data science and digital technologies,
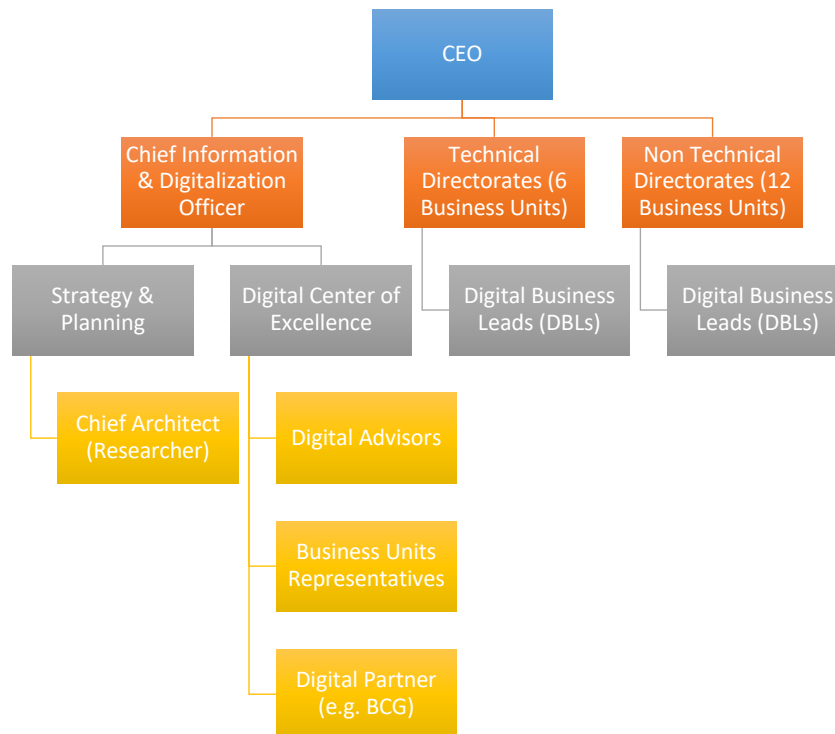
Figure 1.2. Information & Digitalisation Organisation Chart

digital architects (where I am providing my expertise), and experts on PDO business processes.

2) The business units' representatives are mainly the digital business leads (DBLs) from technical directorates and nontechnical directorates. Technical directorates include petroleum engineering and operation engineering. There are 6 business units under the technical directorates category. On the other hand, nontechnical

directorates consist of 12 business units, including finance and human resources. All DBL participated in the different stages of this study.

3) The digital partner is BCG who were used to craft the digital ambition for PDO and support PDO to initiate certain digital projects, such as the use of artificial intelligence in drilling.

While I am an insider to the organisation, the exposure associated with the research entailed collaboration among different sections and business units within the company. The fact that I work for PDO ensured that organisational jargon and informal culture were considered during this research. This familiarity helped in breaking barriers to accepting me as part of the same social unit but also helped participants to relate to the different topics discussed. As I was part of the fabric of PDO, I can draw from my experience and knowledge of the organisation when interviewing and asking questions. I therefore built credibility and trust in the research.

1.3 The Research Problem & Justification

PDO embarked on a journey to adopt digital technologies. Adopting digital technologies involves understanding key drivers, readiness, capabilities, current practices, etc. Navigating through this can be very challenging given the fact that its first attempt for PDO to adopt digital and the undergoing challenges the oil and gas industry is facing in terms of its existence and sustainability. The challenge is compounded by two main attributes.

The first is that there is no standard approach or adoption model for companies to follow when it comes to adopting digital technologies. Multiple sources from

academia and industry provide a list of technologies categorised as digital technologies but offer no clear methodology on how each organisation should prepare for adopting digital technologies. Some of these digital technologies are available for use within the oil and gas industry while others are still emerging. Given the limitations in resources and funds that confront every organization, it is key to decide not only which of these technologies can drive the business objectives and offer the most value to the organisation, but also the approach of how to adopt them. The latter is the focus of this research. If one could understand the different parameters needed for digital adoption, then determining which approach to adopt becomes a subsequent step.

Secondly, Uhl and Gollenia (2016) describe digital technologies as disruptive, since they challenged the status quo by doing things differently. For example, in the oil and gas industry, the use of artificial intelligence to support the drilling process can remove human error and reduce drilling time, disrupting the traditional drilling business. As these technologies increasingly change the oil and gas industry, it becomes imperative to understand how such technologies should be adopted by PDO. Understanding of technology is necessary to design and implement the overall solution, but knowledge is also required concerning readiness, operation, and lifecycle management. Thus, organisations must have holistic comprehension of their path when embarking on digital journey, including not only the technology, but also the people, process, culture, and organisation's readiness to adopt digital.

Based on the above two challenges, the workplace context is driven to address how PDO should go about adopting digital technologies. The workplace problem

that is the focus of this research is the current uncertainty as to which of the approaches to digital adoption, as discussed in the literature or modelled in practice, are most applicable to be used within PDO. Other oil and gas companies have used mostly different consultancy firms such as McKinsey, Accenture, the Boston Consulting Group (BCG), PricewaterhouseCoopers (PwC), and others to help them shape their digital adoption practices. PDO conducted several meetings with these companies, and each approaches digitalisation differently, further complicating PDO's pursuit of digital adoption.

From the perspective of a researcher–practitioner, the obvious approach is to merge theory with practice. Although PDO has faced the difficulty determining which practitioner's approach is suitable, this research was approved based on the strength of combining scholarly practitioner approaches (i.e. a juxtaposition of practice and literature). In this action research, I will use knowledge from the literature to inform practice, and vice versa. The fact that there are no one-size-fits-all organisations pursuing digital adoption makes this research important to PDO. I utilised an evidence-based approach for data collected to arrive at certain conclusions related to how PDO should engage in digital adoption.

1.4 Aim, Objectives & Research Questions

During the process of problem analysis, it was found that PDO was ill prepared to adopt digital technologies and as a result needed guidance in how to go about adopting digital technologies and utilise them effectively to address the different challenges the industry and the organization face. Subsequently, three main objectives and various research questions were identified. While the main aim of

this research is to develop a model or a framework for PDO's adoption of digital technologies, there are three different objectives this research thereby pursues. The first objective is to understand the different terminologies associated with digital adoption. The second objective is to investigate key debates within the literature and practice around digital adoption. The third objective is to develop paths to digital adoption and how the PDO adoption model should look like. Within each of these objectives, there are goals and research questions.

Objective 1: Understand digital adoption and what does it constitutes of.

Goal: Identify the determinants of digital adoption and their relations to frameworks, such as diffusion of innovation (DOI) or technology, organisation, and environment (TOE) framework.

Research Questions

1.a. What are the determinants of digital adoption?

1.b. What are the current adoption models used for technologies within PDO? How are they related to diffusion of innovation (DOI) or technology, organisation, and environment (TOE) framework?

1.c. Can any of the currently adoption models be used for digital adoption? What enables or prevents this adoption?

1.c. How are these drivers related to the DOI and TOE frameworks?

Potential Actions

While many business units within PDO have experimented with digital

technologies, each has its own methodology and approach. Gathering such information and understating the literature surrounding digital adoption could help understand the approach suited for PDO to pursue.

Objective 2: Investigate key debates within the literature and practice around digital adoption.

Goal: Understand how digital adoption is perceived within the literature and practice and investigate key components identified in aim 1.

Research Questions

2.a. What are the internal and external drivers compelling the organisation (PDO) to pursue digital transformation initiatives?

2.b. How is organisational readiness connected to an organisation's adoption of digital technologies?

2.c. Which business capabilities can be addressed through digital adoption?

Potential Actions

Understanding the current state of the organisation in terms of readiness to adopt digital, determining the key drivers and understanding the key digital capabilities needed for digital adoption. This will allow for an accurate test of whether the organisation has a meaningful appetite for digital adoption.

Objective 3: develop paths to digital adoption and how the PDO adoption model should look like.

Goal: Review previous adoption methods used for technology adoption, assess its

applicability and draw from the evidence collected paths to digital adoption.

Research Questions

3.a. How to assess the applicability of current practices to digital adoption?

3.b. Is there different paths to digital adoption within PDO? What are the pros and cons of each?

3.c. How to develop a model for digital adoption and what does it constitute of?

Potential Actions

A review of previous technology adoption within PDO presents a number of lessons for digital adoption. These lessons were considered during model development in addition to the evidence acquired during this research study.

Figure 1.3 illustrate the research aim, objectives and research questions.
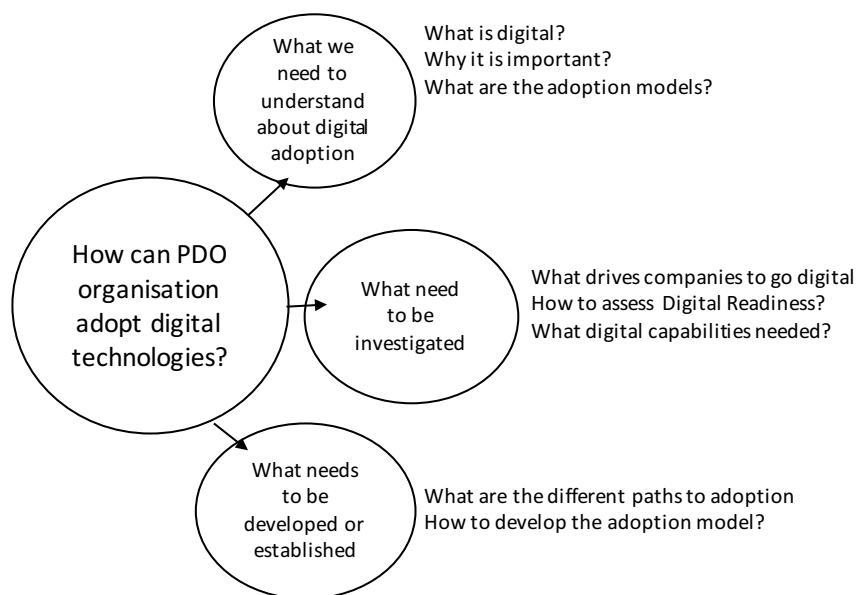
Figure 1.3 Research Aim, Objectives and Questions

1.5 Research Methodology

The research was conducted in the oil and gas industry using PDO as a case study (the reason for selecting case study approach can be found in Chapter 3). Since the number of employees within the company exceeds 8,000, it was decided to focus the research on the business units that experimented with digital technologies (e.g., Exploration, Petroleum Engineering and Operation Engineering business units) along with the DCoE (which has representation from the other business units that did not experiment with digital technologies along with digital advisors and BCG) and the IT organisation supporting these digital initiatives. This is mainly because these business units will be able to articulate their experience and exposure, as well as how they view the importance of digital technologies within PDO, as compared to other staff members who are not exposed.

Since this study followed a methodology of action research, it was crucial to design suitable research methods and apply the appropriate intervention to change the status quo, with theory informing practice and vice versa (Brydon-Miller, et al., 2003). This study began by setting research aims and objectives. I investigated each aim and objective and selected data collection tools with either qualitative or quantitative methods, depending on the nature of the research objective. While the study applied mixed methods (i.e., qualitative, quantitative, and action-based), the method of inquiry was driven by the existence of tools (e.g., surveys) within the literature and the areas in which further research was needed. Notably, my epistemological and ontological stands on action research impacted my interpretations of the inquiry outcomes. For instance, I took an evidence-based approach to developing the digital adoption model. As such, if the evidence was

not sought during the inquiry outcomes, then it is not included as part of the model. Following the inquiry into each objective, certain other actions were taken to inform PDO management of results during the research, and attempts were made to interpret these results based on either the literature or similar studies from practice. Some of these outcomes went into iterations (e.g., understanding the drivers for PDO to pursue digital technologies), as action research aims to produce practical knowledge. On the other hand, it was important to see how such knowledge could be linked with existing initiatives on which PDO is currently embarking to support their journey of digital transformation. The consolidation of this practical knowledge supported me in developing an adoption model that can be applied in PDO, with potential applications for other organisations. **Figure 1.4** illustrates the research timeline.

| April 2018 | Oct 2019 | Jan 2020 | Dec 2020 | April 2021 |
| Proposal for conducting Research endorsed by CIDO | Proposal and draft of first 3 Chapters completed | Ethical Approval received to kick start the research | Completion of Data Gathering & Analysis | Final Thesis Draft after 2nd Supervisor Review |
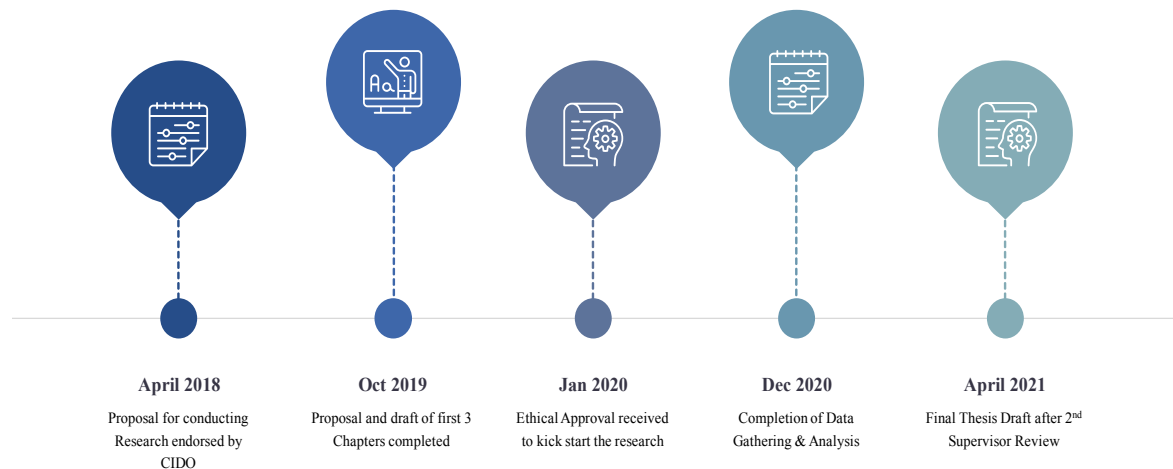
Figure 1.4. Research Timeline: April 2018–April 2021

1.6 Action Research

According to Coughlan and Coghlan (2002), action research should be used when inquiring into an "unfolding series of actions over time". As PDO embarks on a

digital journey, many actions are already unfolding. This research began in 2019 after a series of discussions with different consultancy firms to select the digital partner. The aim at that time was for the digital partner to support the newly formed DCoE to develop the digital ambition for PDO and to experiment with digital technologies that can demonstrate the value of digitalisation. The digital partner work was elected to be BCG near the end of 2019. As BCG started their work in early 2020, this study was taking place. Members of the DCoE (including DBLs from different business units) were among the research participants, in addition to IT staff who supported the different experimentation of digital projects. For instance, during the first stage of the research, the focus group discussions centred on identifying digital drivers. While BCG did not start with identifying those drivers, this research did so through iterations of two different focus groups discussion (each focus group had eight members). The consolidated findings from the different drivers were checked against the literature (mainly Lammers et al., 2018) and later presented to PDO management for verification. For each research stage, a combination of participatory inquiries took place (where I engaged with the different participants who consented to participate in the research), along with a review of the findings from literature and PDO management. Chapter 3 details the research methodology, but some of the outcomes from this research were already under implementation when this research was written (April 2021).

1.7 Chapter Synopsis

This chapter has presented a general definition of the digital technologies and their importance was introduced. Digital technologies are variously defined in the

literature. A detailed review of the definition of digitalisation will be offered in Chapter 2, the literature review. While understanding the different definitions of digital technologies was important, it was equally important to explore the challenges facing the oil and gas industry. Four challenges have been identified in the oil and gas industry, reviewed in relation to how digital technologies can improve organisational performance. The research context and its importance to PDO has also been introduced, including the research questions and the aims and objectives they serve. In addition, the chapter reviewed my role and motivations in pursuing the study. The research inquiry methods were briefly introduced, as these are explained in Chapter 3. Finally, a brief introduction to the use of action research and the cycles of actions was given.

As discussed previously, this research is divided into six chapters. In the next chapter, a review of the literature will be critically analysed.

Chapter 2 – Literature Review

2.1 Introduction

Digital adoption is gaining momentum in terms of research studies. The literature coverage of digital adoption yielded over 3,000 articles at the time when this research was conducted, yet what it takes to understand digital adoption within organizations is made discrete and not integrated within the literature. This literature review aims to gain insights on the different components surrounding digital adoption and attempt to argue the need for an integrated approach to study digital adoption. Since this research is using PDO as a case study, it was important to review digital adoption not only in different industries, but primarily in the oil and gas industry. Acknowledging the challenges facing the oil and gas industry in general and PDO specifically makes the literature review important pillar to understand key adoption concepts.

This chapter discusses the methods by which relevant literature was selected for review. It discusses the concepts from the literature as relevant to the research questions. The first section reviews the current landscape within the region and identify the different challenges the oil and gas industry is facing. A literature review of what defines digital adoption was then discussed and key debates were surfaced. Then a deep

dive of the different components of adoption is reviewed, debated and discussed. The review included four main components such as understanding the drivers to digital, assessing the organisational readiness for digital, understanding the digital capabilities needed for digital adoption, and reviewing change and leadership aspects of digital adoption. Finally, a review and critique of some of the available frameworks within the literature to explain the adoption process within organisations is discussed and analysed.

2.2 Literature Review Method

2.2.1 Search Strategy

In order to analyse the literature on the topic under research, it was important to identify the search strategy. Many criteria were used in the search strategy. The first criterion was to base the search on the key terms in each research aim or question. For example, the second aim of the research is to investigate certain concepts within the literature regarding the "*drivers* for *digital adoption*". There are three key words here, and it was important when the search was done to include all of them. In addition, there were other filters used such as the existence of these articles in MENA, Gulf or Oman and the relevance of the articles to the oil and gas industry. The second criterion was to use Google Scholar as a search engine, in addition to the Liverpool Online Library. I used Google Scholar first, followed by Liverpool Online Library. This two-step procedure was done to

ensure that a large number of articles were reviewed for relevance before obtaining a copy from the Liverpool Online Library as the Liverpool Online Library tends to have limited coverage. The third criterion was to use peer-reviewed articles where possible. In addition, the literature review began in 2018 during the proposal stage and continued until the thesis write-up in 2021. As a result, the above criteria generated a number of articles, and it was important to complete the analysis of these articles on an ongoing basis and to identify key themes within the literature.

2.2.2 Article Analysis

The starting point of the literature review was to analyse which articles were relevant to the research. To achieve this goal, I started to map the different research questions with the articles from the literature. This exercise involved reviewing articles and assessing their relevance to this research based on two criteria:

(a) Theoretical positioning: If the article provided theoretical background or grounding theory that is relevant to adoption of technology, then it was included.

(b) Contribution to practice: Since DBA research centres mainly on practitioner research to solve a business problem, articles that provide practical insights are also included. In addition, empirical research was included and considered.

These articles are then analysed and used to inform the different sections of the literature review. **Table 2.1.** provides a mapping between the articles reviewed and their association with the research questions. Although the exposure to the literature was not limited to the articles listed in the table, during the course of the research study, I reviewed additional articles and utilised in the different parts of the research. I used these articles mainly to support certain argument or provide a better understanding of certain concepts.

Table 2.1. Mapping between Research Questions and Reviewed Articles Conceptual Framework for the

Literature Review

Article Title	Author Name	Journal Name	Research Industry/Focus	Research Question
Technology Adoption in the Presence of Network Externalities	(Katz & Shapiro, 1986)	Journal of Political Economy	Cross Industry	Adoption Determinants/Factors
Organizational Innovation: The Influence of Individual, Organizational and Contextual Factors on Hospital Adoption of Technological and Administrative Innovations	(Kimberly & Evanisko, 1981)	Academy of Management Journal	Health Care	Adoption Determinants/Factors
Digital Transformation Initiative: Oil & Gas Industry	(Spelman, et al., 2017)	World Economic Forum	Oil & Gas	Different Research Questions
Digital Enterprise Transformation: A Business-Driven Approach to Leveraging Innovative IT	(Uhl & Gollenia, 2016)	Book	Cross Industry	Different Research Questions

Development of an instrument to measure the perceptions of adopting an IT innovation	(Moore & Benbasat, 1991)	Information Systems Research	Cross Industry	Digital Adoption
Literature Review of IT Adoption Models at Firm Level	(Oliveira & Martins, 2011)	The Electronic Journal Information Systems Evaluation	Cross Industry	Digital Adoption
Diffusion of Innovations	Rogers, Everrett (2003)	Book	Cross Industry	Digital Adoption
Innovation Diffusion in Global Contexts: Determinants of Postadoption Digital Transformation of European Companies	(Zhu, et al., 2006)	European Journal of Information Systems	Cross Industry	Digital Adoption
Building Dynamic Capabilities for Digital Transformation: An Ongoing Process of Strategic Renewal	Warner & Wäger (2019)	Long Range Planning Journal	Cross Industry	Digital Capabilities
The Future of Jobs Report 2018	(Leopold, et al., 2018)	World Economic Forum	Cross Industry	Digital Capabilities/ Digital Importance
Grand Challenges Facing the E&P Industry	(Zitha, et al., 2019).	Society of Petroleum Engineering Journal	Oil & Gas	Digital Challenges
The Digital Edge: Exploiting Information and Technology for Business Advantage	(McDonald & Rowsell-Jones, 2012)	Book	Cross Industry	Digital Definition

What "digital" really means	(Dörner & Edelman, 2015)	McKinsey Insights	Cross Industry	Digital Definition
Digital to the Core	(Raskino & Waller, 2015)	Book	Cross Industry	Digital Definition
What Causes Companies to Transform Digitally? An Overview of Drivers for Key Australian Industries	(Lammers, et al., 2018)	IEEE	Cross Industry	Digital Drivers
Drivers and Barriers for Industry 4.0 Readiness and Practice: A SME Perspective with Empirical Evidence	(Stentoft, et al., 2019)	Proceedings of the 52nd Hawaii International Conference on System Sciences	Mostly Manufacturing	Digital Drivers
Creating a Better Future: Four Scenarios for How Digital Technologies Could Change the World	(Pollitzer, 2018)	Journal of International Affair	Cross Industry	Digital Importance
Digital Transformation: A Roadmap for Billion-Dollar Organizations	(Westerman, et al., 2011)	MIT Centre for Digital Business and Capgemini Consulting	Cross Industry	Digital Importance
The Digital Advantage: How Digital Leaders Outperform Their Peers in Every Industry	(Westerman, et al., 2012)	MIT Centre for Digital Business and Capgemini Consulting	Cross Industry	Digital Importance

Is Your Business Ready for a Digital Future?	(Kane, et al., 2015)	MIT Sloan Management Review	Cross Industry	Digital Maturity and Readiness
Strategy, Not technology, Drives Digital Transformation: Becoming a Digitally Mature Enterprise	(Kane, et al., 2015)	MIT Sloan Management Review	Cross Industry	Digital Maturity and Readiness
Achieving Digital Maturity	(Kane, et al., 2017)	MIT Sloan Management Review	Cross Industry	Digital Maturity and Readiness
Think Act Industry 4.0	(Dujinne, et al., 2014)	Roland Berger Strategy Consultants	Mostly Manufacturing	Digital Technologies
Digital Darwinism and the Need for a Digital Transformation	(Kreutzer, 2014)	Annual International Conference on Business Strategy & Organizational Behaviour	Cross Industry	Importance of Digital
SMEs' Adoption of Enterprise Applications: A Technology-Organisation-Environment Model	(Ramdani, et al., 2013)	Journal of Small Business and Enterprise Development	Cross Industry	TOE Framework

2.2.3 Conceptual Framework

Based on the articles analysis, there were number of concepts that emerged to inform this research study. Some articles were used as the basis for the study, while others are used as supporting the arguments made. Thus, this formed the conceptual framework of the research. The first concept that emerged from the article analysis is related to the Oil and Gas landscape in MENA and how digital technologies can influence the change within the industry. The main paper discussing such analysis is Spelman et al. (2017). The second concept was related to organizational readiness for digital. There were two main resources used, namely; Kane et al (2015) and Uhl & Gollenia (2016). The third concept is related to the drivers for digital and what makes organizations consider going digital. The main resource was the research done by Lammers et al. (2018). The fourth concept from the article analysis was around digital adoption. While the literature did not have specific theories around digital adoption as per say, technology adoption theories such as Diffusion of Innovation Theory by Rogers (2003) and TOE Framework by Tornatzky and Fleischer (1990) were used as the main resources. Finally, the concept of digital capabilities emerged as a result of the article analysis and the main resource used was the research done by Warner & Wäger (2019). Table 2.2 shows the different concepts and their base theory following the literature review and article analysis.

Research Analysis	Theory in use	Logic for using such research
Digital Importance	(Spelman et al., 2017)	Oil & Gas specific
Digital Readiness	(KANE, et al., 2015) Uhl & Gollenia (2016)	Tool for survey readiness How to classify Readiness
Digital Drivers	Lammers et al. (2018)	Mining industry targeting drivers
Digital Adoption	DOI by Rogers 2003 TOE Framework by Tornatzky and Fleischer (1990)	How technology is diffused
Digital	Warner &	Different types

Capabilities	Wäger (2019)	of capabilities required for digital

Table 2.2 Conceptual Framework

2.3 The Oil & Gas Landscape in MENA

Since this action research takes PDO as the organisation under study, and since PDO operates in the oil and gas industry, it is key to understand the oil and gas industry and its challenges. Although Spelman et al. (2017) argue that the oil and gas industry had been using digital technologies such as Industrial IoT and Big Data since the 1980s, one would argue that as the digital technologies evolved over time, the industry did not take advantage of these changes. Hence, this could explain why the adoption of digital technologies within oil and gas was generally slow (Spelman, et al., 2017). This sluggishness may explain why the oil and gas industry remained behind other industries, such as media and telecommunications (Gandhi, et al., 2016). Although there could be multiple factors attributing to this slowness, one would argue that this slow adoption of the digital technologies can be attributed to the relatively high price of oil, which caused companies to focus their resources on producing more rather than making operational efficiencies or transforming digitally. Following the downturn in oil prices in 2016, the oil and gas industry began to consider the use of digital

technologies to enhance their operations (Spelman et al., 2017); however, the industry now faces challenges that could influence the uptake of these technologies.

Two primary challenges are the US becoming a major producer of oil and competing with Middle Eastern countries in addition to the shift in global demand away from fossil fuel such as oil and gas to cleaner forms of energy (Spelman, et al., 2017). This difficulty is compounded by the recent COVID-19 pandemic, which has caused oil prices to slump and exhibit turbulence. While such price volatility existed prior to COVID-19 pandemic, climate change regulations and the shift to renewables are among other challenges. PDO is not immune to these challenges, and as a result, they will significantly impact PDO's digital ambition. Nevertheless, Spelman et al. (2017) have claimed that the value generated from digital transformation can reach up to USD 1.6 trillion. This value is a combination of cost saving and cost avoidance by using digital technologies. While this is a global statistic of the value generated, since PDO is operating within the oil and gas industry, arguably it will receive a portion of that value. On the other hand, Oman geography is unique compared to other neighbouring countries. Investing in digital technologies could eventually increase its cost per barrel given that the cost per barrel is higher in Oman due to its subsurface characteristics (Anon, 2016). In addition, PDO is the backbone of Oman's economy and as such, there is an expectation from its employees and the

government that the company should drive digital within the country. This was evident during the focus group discussion that took place as part of this research. Hence adopting digital is no longer an organisational objective only but also a national one.

2.4 Defining "Digital Adoption"

As stated in the research objectives, there are few terminologies and concepts that need to be understood from the literature review. The first concept is how to define digital adoption or adoption of digital technologies. Assuming digital technologies is a form of innovations, Rogers (1995) differentiates between adoption and diffusion in terms of the process versus the decision. While diffusion is concerned with the process by which an adoption of innovation takes place, adoption focuses on the different elements needed to implement an innovation (Rogers, 1995). Therefore, one could argue that before diffusing an innovation a decision needs to take place, thus adoption. While adoption is concerned with how digital technologies need to be implemented, the literature provides many terminologies that explain the purpose behind digital adoption. Many terminologies such as digitalisation, digital enablement, digital optimisation or digital transfomation are used interchageably to refer to adoption of digital technologies within organizations. However, each of these terms has its own meaning. Digitalization is widely used to refer to

the use of digital technologies (Gartner, 2017) while digital enablement is used to refer to adopting digital technologies to enhance the technology landscape in order for the business to start innovating. Digital optimization on the other hand is concerned with adopting digital technologies for the purpose of enhancing the existing business processes. Westerman et al. (2011) define digital transformation as "the use of technology to radically improve performance or reach of enterprises". I would argue that the radical nature of digital transformation is driven from the fact that the purpose behind adopting digital technologies is to transform the business model. In addition, while digital transformation is concerned mainly with change management (Uhl & Gollenia, 2016), adoption of digital technologies is concerned with multiple components including but not limited to change management. Figure 2.1 illustrates the differences among the various terminologies.

Which of the different types of digitalisation should PDO go for? The approach to implementing digital initiatives within oil and gas industry is debatable. For instance, Spelman et al. (2017) claim that the implementation of digital technologies within oil and gas must follow an incremental rather than radical approach. This ultimately means that the purpose of digital within oil and gas should remain on the enablement and optimization of business processes. I would argue that such statement will depend on the maturity of the organization and its appetite for change.

Thus what will determine the pace and coverage of digital adoption is not the type of industry rather the organisational maturity. Furthermore many organisations are trying to go digital by simply using digital technologies and not truly adopting. Dörner and Edelman (2015) argue that digitalisation is not about the technology but about how the technology is used to drive value and build foundational capabilities through a process of digital adoption (Dörner & Edelman, 2015). This insight was evident from this research as participants linked the drivers to adopt digital technologies to the company's business objectives and how digital can drive value. If the company objective is to reduce cost through digital adoption, then digital technologies should provide such capability. If a digital technology can enable a reduction of cost by at least 10%, this is a significant amount of money saved, considering that the cost of drilling offshore exploration rig can reach up to 200 million USD (Raskino & Waller, 2015).

Although the literature provided good insight on the different definitions of "digital adoption", it becomes evident from the outcomes of this research study (as one will see in Chapter 4) that the definition depends greatly on organisational maturity. While this insight was not apparent from the explored literature, it was obvious from the findings of this study.

2.5 The Importance of Digital Technologies

Why it is important to consider adoption of digital technologies? The oil and

gas industry confronts disruptive technological advancement especially in the areas of oil exploration and production. Technologies such as hydraulic fracturing now enable more energy companies from more places to produce oil at competitive prices, which will result in oversupply of oil affecting the overall demand and driving costs down (Spelman, et al., 2017).

For the industry to remain competitive, Spelman et al. (2017) claim, digital technologies can offer support in two ways: The first is to shift costs from a traditional expensive model into a more subscription-based and pay-as-you-go model. This shift will lower operating costs and raise margins. I would argue that the importance of this shift to PDO is in its ability to reduce the cost of per barrel of oil. The second claim is to enable cross-functional multidiscipline collaboration that will drive effective decision making. Faster decision making will enable better reaction to changing circumstances, especially in such a volatile industry. However, I would argue that this is dependent on the organizational culture and its ability to change.

Thus, while the Spelman et al. (2017) argument is driven mainly by cost reduction and increase in collaboration, one could argue that the oil and gas industry remains a laggard in the adoption of digital technologies: Adopting digital technologies can take years, so cost efficiencies cannot be immediately realised. In addition, while the oil and gas industry is prone to price fluctuations, cross-functional collaboration is perhaps a necessity not

for digital adoption but for the continued existence of the company.

On the other hand, the survey conducted by MIT Sloan Management Review and Deloitte highlighted that more than 70% of participants of global executives stated that digital technologies are important to their organisations (Kane, et al., 2015). According to Kane et al (2015), the importance of digital technologies lies in driving faster decision making and introducing efficiencies through innovation which makes organization keen to adopt digital technologies. However, Kane et al (2015) acknowledges that only 29% of the companies surveyed are having a high digital maturity. Thus, I would argue that such benefits of adopting digital will take time. In addition, importance of digital adoption has also been discussed by a number of consultancy firms, such as Accenture, who conducted a 2016 an Upstream Oil and Gas Digital Trends Survey (Spelman, et al., 2017). The findings from the Accenture survey illustrate that global companies in the oil and gas industry are planning to invest heavily in implementing digital technologies within their organisations. Although this plan is driven mainly by cost reduction and increase in collaboration (Spelman, et al., 2017), the peer pressure it generates could cause companies to pursue such technology adoption.

Although the oil and gas industry lags in its adoption of digital technology, given the industry challenges the sense of urgency to act now becomes prevalent. Given the volatility of the oil prices and potential demand

changes, many industries, including oil and gas, will need to evolve or die, thus digitalisation becomes imperative (Raskino & Waller, 2015). However, this evolution, as described by Spelman et al. (2017), must involve the development of new business models and new digital capabilities and need to be strategically agreed and aligned. Nevertheless, the adoption of digital technologies is not an aim in itself; rather, an organisation must grow and optimise its operations through the adoption of digital technologies. Therefore, while different organisations may have various drivers to adopt digital technologies, such drivers will vary from one company to another. In addition, what drives a company in the oil and gas sector could differ from an organisation operating in other industries, such as logistics, banking, or media. Therefore, it is key to explore the different drivers of digital transformation and attempt to identify whether such drivers are linked to the type of industry in which the company operates.

2.6 Determinants for Digital Adoption

In the previous sections, a review of the current landscape in oil and gas industry offered a good insight on the industry challenges both locally and regionally. While it is important to understand the definition of digital adoption and its importance to organizations, it is important to understand the elements of digital adoption. Assuming digital technologies is a form of innovations, Kimberly and Evanisko (1981) posit three predictors of organisational adoption of innovations: the "characteristics of

organizational leaders, characteristics of organizations themselves, and characteristics of their contexts" (Kimberly & Evanisko, 1981, p. 695). I would argue that by understanding these three elements one would be able to understand how adoption can be implemented within organizations. Although this study was conducted mainly in hospitals, its generalisation to other sectors should be cautiously analysed. According to Kimberly and Evanisko (1981), the adoption of technological innovation tends to be effective when an organisation has four characteristics: large size, specialisation, functionally differentiation, and decentralisation. Organisations with these four characteristics are better equipped to adopt technological innovations (Kimberly & Evanisko, 1981). PDO arguably has these characteristics, and thus, PDO's outlook for innovation adoption is positive. It is large (more than 8,000 employees), and it is specialised in upstream oil and gas production with different functionalities spread across multiple areas within the country, making its operations decentralised. Nevertheless, since the study done by Kimberly and Evanisko (1981) aimed at specialised hospitals, I would argue that not all elements can be used to describe adoption in oil and gas company. In addition, a more recent study done by DeStefano et al. (2017) confirms similar findings to those of Kimberly and Evanisko (1981), who found firm characteristics such as size, human capital, age and headquarters to be important determinants in digital usage. Thus, it is important to understand such organizational context prior to adoption. The context of PDO (will be described in chapter

3) within Oman and within the regional oil and gas industry, position the company to be ready for digital adoption. Thus understanding the organisational readiness is one element of digital adoption

In addition to the organisational context, Katz and Shapiro (1986) supported the need for organisational leaders to sponsor digital initiatives, asserting drives technological innovation is the existence of such sponsorship. In their analysis of videocassette recording (VCR), Katz and Shapiro (1986) concluded that when a technology has sponsorship, it receives wider adoption even if it is inferior. Although Katz and Shapiro's (1986) study is outdated and focussed on one technology, it highlights the need for sponsorship, which has been the norm in PDO, where so many major projects currently have a sponsor or a champion. A good example of such sponsorship PDO's deployment of the SAP blueprint within the company to be the main enterprise resource management platform. The sponsor for this activity was the deputy managing director (second position from the top). This support afforded the blueprint enough significance for successful adoption. Thus, another determinant of successful technological adoption is leadership to drive the change required for digital adoption.

According to Rogers (2003), five main variables determine the rate of adoption of innovations: the perceived attributes of innovations, type of innovation-decision, communication channels, nature of the social system, and extent of change agents (Rogers, 2003). While the DOI may provide

wider coverage of innovation adoption determinants, it focusses mainly on the speed of the adoption rather than the adoption itself. Thus, while the DOI could be used to explain how adoption is carried out within this research, its relevance to the process of digital adoption is arguably in the governance and change management aspects. Furthermore, I would argue that the process of digital adoption needs multiple capabilities to drive the end game.

It is evident from the literature review that there are five elements that help in shaping the digital adoption within organizations. These elements are the organizational context, the organisational readiness, the drivers to digital, the digital capabilities needed, and the leadership and change. Apart from the organizational context, the following sections provide a more detailed analysis of each element.

2.7 Drivers of Digital Adoption

Digital technologies are impacting many organisations and disrupting business models all over the world. On the other hand, organisations must understand the foremost drivers of digital adoption to manage this transition and its impact on operations within their industries. Lammers et al. (2018) studied the key drivers of digital adoption that emerged from their literature review of five key Australian industries. These drivers and their associated industries are summarised in **Table 2.3**.

		Drivers							
		Customer focus & value differentiation	Cost efficiency - process efficiency	Environmental sustainability	Workers safety	Productivity	Market focus / globalization	Decision-making support	Idiosyncrasies of the industry
Services	Financial Services	11	5	1					
Services	Healthcare	11	9						
	Mining		10	4	7	17			
	Construction			3		6	2		37
	Manufacturing	3	3	2		3	3		
	Agriculture			3		9		9	

The table shows the number of sources mentioning the ==drivers== *for each industry*

Table 2.3. The Drivers of Digital Transformation (adapted from Lammers et al., 2018)

Lammers et al.'s (2018) review of papers published in international journals and Australian journals, in addition to published reports, focussed on drivers in mainly Australian industries. Eight drivers were identified, and their relevance to each Australian industry is listed in the above table. While Lammers et al. (2018) have reported that these drivers may vary in importance depending on industry, their study was limited to the Australian industry. However, similar drivers could also apply to the other countries and industries. Furthermore, Westerman et al. (2011) have stated number of drivers for organisations to pursue digitalisation including cost

leadership, optimising investment, and growing market share. Although Lammers et al. (2018) did not highlight the main drivers for oil and gas, per se, drivers associated with mining industry may resemble those of the oil and gas industry to a certain degree, given that both industries form a part of the energy production sector. Given this assumption, four main drivers can be identified for oil and gas industry: cost efficiencies, environmental sustainability, worker safety, and productivity (Lammers et al., 2018). The investigation of PDO drivers to digital adoption resulted in digital enabling multiple business objectives such as increase production, enhance business processes, enhance staff & asset efficiency and drive talent and capability building. It is worth noting that digital drivers are mainly triggers to achieve business objectives.

Although the above drivers relate to Australian firms, since such firms operate within global industries, such drivers could also be applied in other industries and countries. Furthermore, Stentoft et al.'s (2019) analysis of the drivers of Industry 4.0 within the literature classifies them into four categories (regardless of industry):

(1) *Legislation-related.* In this category, the legislator either fast-tracks certain legislation as a result of technological advancement or requires certain improvements to be introduced through the use of digital technologies. In both cases, legislation became a driver for companies to think about adopting digital technologies. In a comparison of this driver to

that of environmental sustainability in Lammers et al.'s (2018) study, adhering to regulatory bodies could be one of the drivers to adopt digital technologies. For instance, to monitor gas flaring, the industrial IoT could be used in combination with data analytics to provide insights into the amount of gas flared, which in turn helping the company report such figures to regulatory bodies.

(2) *Strategy-driven.* Kane et al. (2015) conducted a study of digital business covering 129 countries and 27 industries. The study highlights not only the importance of strategy in driving digital transformation but also that a talented workforce will likely work for digital leaders. Acquiring such talent will mean that organisations must strategize and think digital. In addition, organisations within the manufacturing industry who would like to reduce costs and stay competitive will need to strategize and start using digital technologies such as robotics and the IoT (Dujinne et al., 2014). Countries such as Germany and China have already initiated long-term strategies for exploiting Industry 4.0 technologies. Such initiatives will motivate companies within these countries to initiate digital adoption. Within Oman, baby steps are being taken to discuss digital technologies and the impact of Industry 4.0. Eventually, a strategy for Industry 4.0 will need to be established for Oman as well. On the other hand, Stentoft et al. (2019) list strategy-oriented categories of drivers to include customer requirements, cost reduction, speed to market, and competitors practice of the Industry

4.0. Some of these categories are similar to the drivers listed by Lammers et al. (2018). This similarity suggests that the drivers listed by Lammers et al. (2018) can apply to countries outside of Australia.

(3) *Workforce-driven*: The recent *Future of Jobs Report* by the world economic forum estimates an average of 40% of jobs globally will be automated by 2022 (Leopold, et al., 2018). Although the report attributed such automation to digital technologies, the rate of adoption among industries and countries will vary. In addition, while workforce automation could be viewed as both an opportunity and a barrier to digital adoption (Stentoft, et al., 2019), the lack of a talented workforce may motivate the fast-tracking of the adoption of digital technologies to recruit talent early in order to prepare for future talent disruptions. Lammers et al. (2018) indicate such drivers to be under the market focus/globalisation driver, where companies use innovation and automation to speed up time to market.

From the previous discussion, the drivers presented by Lammers et al. (2018) and Stentoft et al. (2019) seem to indicate a number of drivers towards digitalisation that can be generalised to other industries. Since this research is oriented mainly towards digital adoption within oil and gas, the closest industry in Lammers et al.'s (2018) study is mining industry. According to Lammers et al. (2018), the mining industry must consider four main drivers to go digital: cost efficiency/process efficiency,

environmental sustainability, worker safety, and productivity.

While Stentoft et al. (2019) attribute the drivers to digitalisation as part of the Industrial 4.0 context, Pollitzer (2018) states that drivers of digital technologies can be associated with two major contrasting visions of the future. The first vision relates to the Fourth Industrial Revolution or Industry 4.0, and the second relates to the United Nations Sustainable Development agenda for 2030. While the first trend is to drive organisations to consider exploiting emerging digital technologies as an approach to achieve their goals, the second trend is to focus on how digital technologies can be utilised for the social good, for instance in connection with gender equality and educational quality (Pollitzer, 2018). Although organisations are typically driven by financial gains, Westerman et al. (2012) argue that organisations that mature in the use of digital technologies outperform industry peers in terms of financial performance. Thus, the adoption of digital technologies will drive not only organisational performance but also financial performance. Therefore, organisations digitally mature.

On the other hand, for organisations to be a Digitari (mature in adopting digital technologies), they must excel in both digital intensity and digital adoption capabilities (Westerman, et al., 2012). While exceling in both may be the aspiration of many organisations, the key challenge is likely instead to be in transformation management, as it will involve changes in the leadership capabilities required to make digital adoption a reality. I would

also argue that the type of digital drivers will evolve over time and it is not static. This evolution could be either attributed to shifts in organizational priorities or arguably an evolution into a more digitally mature organization. Therefore, it is important to understand what is digital maturity and how it will influence digital adoption.

2.8 Digital Maturity

The second element related to digital adoption from the literature review is digital readiness or maturity. Organisations differ in their appetite to adopt digital technologies. To assess the digital capabilities of any organisation, there is a need to understand its digital maturity or readiness for digital adoption. Although readiness and maturity are often used interchangeably, they differ, as described by Schumacher et al. (2016, p. 162): "readiness assessment takes place before engaging in the maturing process whereas maturity assessment aims for capturing the as-it-is state whilst maturing the process". As the maturity of the organisation grows, its readiness for the adoption of digital technologies grows as well. An evaluation of digital maturity can provide insight into organisational readiness for digitalisation. However, the question remains as to the best approach by which to assess such readiness or maturity. There are primarily three models for digital maturity: That proposed by Uhl and Gollenia (2016) measures the digitalisation level of an organisation through across different levels. Each level describes the digital maturity of the organisation in

reference to certain key characteristics:

(1) ad-hoc — no clear direction on how digital technologies are exploited to serve company's objectives;

(2) reactive — digital principles on the use of digital technologies are established but there is no strategy in place to guide a wider implementation process;

(3) defined — all projects are aligned with the strategy and customisation is allowed;

(4) managed — a digital transformation strategy is in place and serves the current company's objectives; and

(5) excellent — the digital transformation strategy is moving towards business model transformation and creating new opportunities with digital technologies. **Figure 2.1** illustrates Uhl and Gollenia's readiness model.
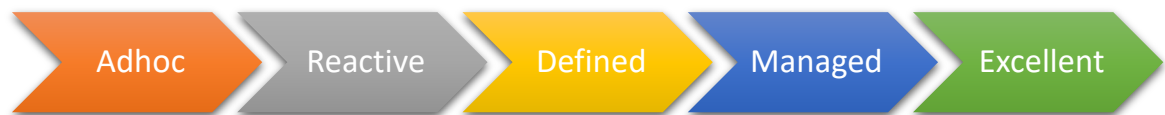
Figure 2.1. Digital Readiness Maturity Continuum (Uhl & Gollenia, 2016)

By contrast, Westerman et al.'s (2011) maturity model describes digital maturity in a 2×2 matrix measuring digital intensity and transformation

intensity. This model classifies organisations into four different levels of maturity. The first stage regards the BEGINNERS maturity, capturing organisations with low digital intensity and low transformation intensity. Organisations at this level have immature digital cultures, and they carry out digital experimentation but are sceptical about the value of digital technologies. Compared to the levels of maturity model of Uhl and Gollenia (2016), the BEGINNERS level is similar to the ad-hoc level. The second stage in maturity model by Westerman et al. (2011), FASHIONISTAS, describes the scenario in which digital intensity increases while digital transformation intensity remains low. This stage is characterised by advanced experimentation with digitalisation, but there is no overarching vision, and the digital culture is siloed. **Figure 2.2** shows the digital maturity matrix and describes each of the four maturity levels. Compared to the levels of the maturity model of Uhl and Gollenia (2016), the FASHIONISTAS stages is similar to reactive stage in Westerman et al. (2011). This stage is marked by increasing digital transformation intensity but low digital intensity: CONSERVATIVES. This stage is similar to that defined stage in the digital maturity model by Uhl and Gollenia (2016). This stage is characterised by the creation of a digital vision that is not well understood, yet with the implementation of digital initiatives being carefully controlled. The fourth stage in Westerman et al.'s (2011) consists of high digital intensity and high digital transformation intensity. This stage, DIGIRATI, is characterised by a clear overarching digital vision and strong governance, along with many

digital initiatives delivering the anticipated value.
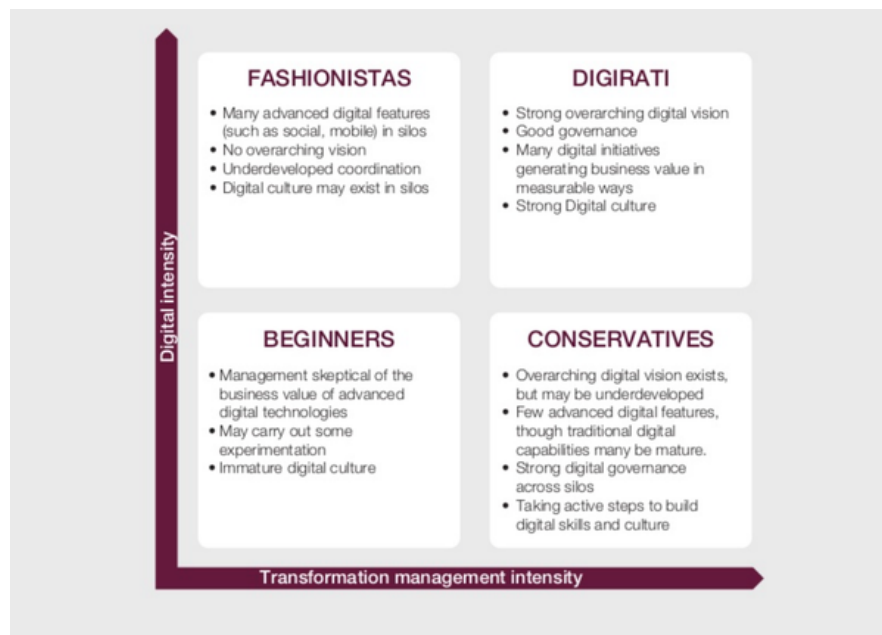
Figure 2.2. Digital Maturity Matrix by (Westerman, et al., 2011,p.4)

The third maturity model is more of a practitioner model developed by the MIT Sloan School of Business in association with Deloitte (Kane, et al., 2017). The model is based on a list of questions to measure organisational readiness for digitalisation. This model classifies digital maturity into three different levels: early, developing, and maturing. Depending on the response to each of the questions in the survey, each answer corresponds to a particular maturity level (Chapter 3 will discuss the model in details). Based on the collective responses to the survey questions, one can state the level of the digital maturity of the organisation or the company under investigation.

Unlike the digital maturity models of Uhl and Gollenia (2016) and Westerman et al. (2011), this maturity model has a related tool for data collection (i.e., the list of questions within the survey). Therefore, it was viewed as more pragmatic to use as the basis for measuring digital readiness within PDO. Furthermore, the model developed by Kane et al. (2017) measures digital maturity using a multifaceted scale, considering multiple dimensions (Chapter 3 details the dimensions), while the other two models focus primarily on one or two dimensions only. Although this model was also used internationally by Kane et al. (2017) to investigate digital maturity in 14 countries spanning North America, Europe, South America, and Asia, no Arab or Middle Eastern countries were included. However, since the questions within this survey focussed on organisational culture and since PDO is a multinational organisation, it is plausibly suitable for PDO. This was also evident from the findings of the assessment where PDO scores compared to international ones and found similarities and differences. Detailed discussion on the comparative analysis between the results from PDO readiness and the one conducted by Kane et al. (2015) can be found in Chapter 4 and 5.

2.9 Digital Capabilities

The third element that could influence digital adoption is the digital capabilities needed for any organisation considering digital adoption. Business capabilities are defined as "capacities or abilities within a firm,

which can be linked together as business processes, in order to enable a specific purpose or outcome" (Beimborn et al., 2005). While Beimborn et al. (2005) have linked business capabilities to the specific purpose or outcome a business wants to achieve, being digital is arguably not a business capability; rather, the outcome it generates is. Hence, it is important when trying to identify business capabilities for digitalisation to understand the underlying outcomes that the business seeks. Warner and Wäger (2019) have illustrated that for an organisation to adopt digital technology, it must build dynamic capabilities that will lead to strategic renewal of the organisation's business model, its collaborative approach, and its culture. Those dynamic capabilities can be classified into three categories: sensing capabilities, seizing capabilities, and transforming capabilities (Warner & Wäger, 2019). **Figure 2.3** below adapted from Warner & Wäger (2019) illustrates the different capabilities. Although Warner and Wäger's (2019) model has external triggers that lead to the acquisition of such dynamic capabilities, the existence of external triggers (e.g., changing consumer behaviours and disruptive digital technologies) are among the main drivers for organisations to adopt such capabilities. Hence, the scope of the drivers will likely determine the kind of capabilities the organization wants to acquire. On the other hand, the adoption of such capabilities is a key factor in sustainable digital adoption. In the case of PDO and due to its low digital readiness, more focus was seen on the sensing capabilities especially the ones related to crafting a digital mindset. While

the Warner & Wager (2019) did not specifically associate the organization digital maturity with the digital capabilities, it was evident from this research that such linkage exists. I will also argue that Warner & Wager (2019) emphasized more on the talent and resource maturity rather than taking the whole organizational maturity into consideration.
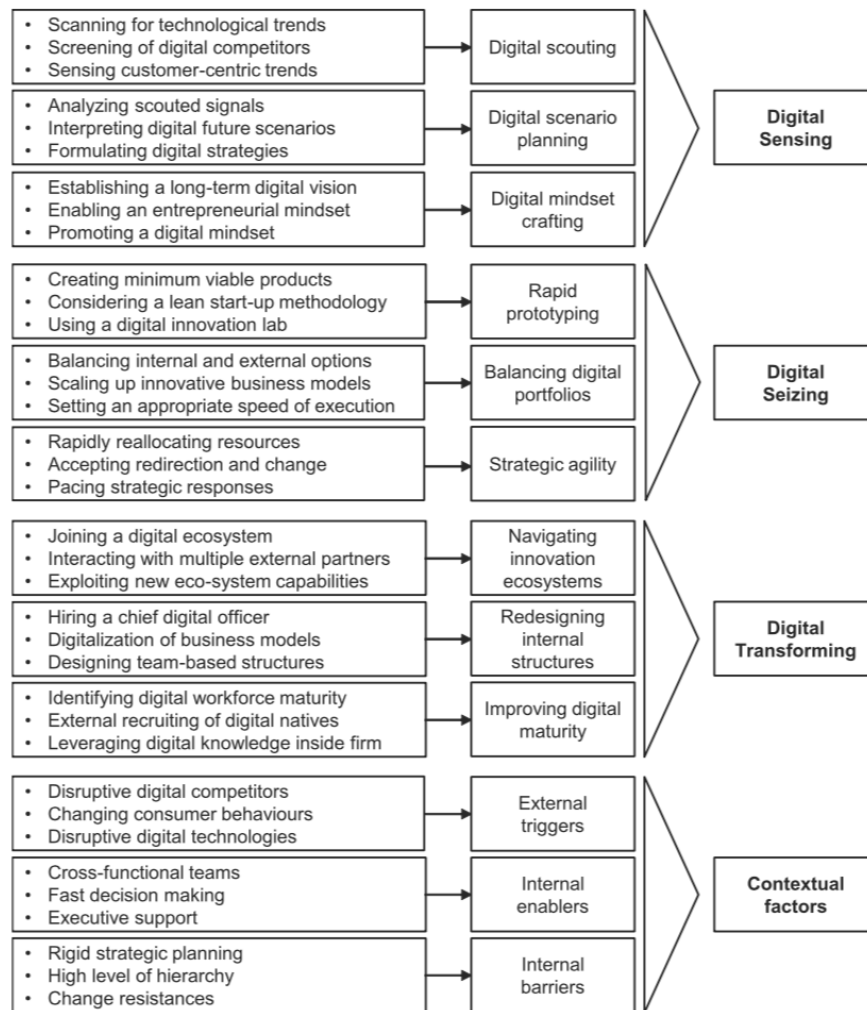
Figure 2.3. Illustration of Dynamic Capabilities (Warner & Wäger, 2019)

Another digital capability featuring in multiple articles within literature is the establishment of digital strategy. As discussed in the maturity model of

Uhl and Gollenia (2016), the existence and integration of digital strategy is a strong determinant of an organisation's digital maturity and readiness. Digital strategy is also attested by Warner and Wager (2019) as one of the components that enable digital adoption. In addition, navigating through the different challenges the oil and gas industry facing and the digital disruption through the convergence of the different digital technologies will require clear strategy (Raskino and Waller, 2015). While strategy seems to be vital in driving digital adoption and maturity, according to Kane et al. (2015) it is key to note that the focus of the digital strategy shifts from operational focus (at low maturity) to achieving strategic goals (with maturity). Arguably, the main determinant of the strategic focus will be distilled mainly from organisational goals and objectives. Thus, organisations seeking operational excellence might direct digital initiatives to focus on operations rather than strategic ends. Such a focus does not indicate flawed strategy. I would argue that having a digital strategy alone is not sufficient if such strategy cannot be realised. While what defines a good strategy varies among organisations, Uhl and Gollenia (2016) contend that strategy is only one component of what organisations need to succeed in their digital transformation. Uhl and Gollenia (2016) have discussed the need for what they call a "digital capability framework" that includes digital strategy, digital capabilities, digital use cases and digital transformation roadmap. In the context of this study, the dimension of digital strategy will be investigated through the use of the instrument

developed by the MIT Sloan Management Review and Deloitte. Kane et al. (2015) found that companies cited lack of digital strategy as a key barrier to the adoption of digital technologies.

2.10 Leadership & Change Management

The fourth element that is important to understand with regards to digital adoption is the leadership and change. As digital adoption variously affects organisations (e.g., their processes, technology, and people), its success depends on management through a shift in the mindset of company leadership (Bongiorno, et al., 2018). According to Bongiorno et al. (2018), leadership's role in digital transformation is principally to bridge business needs and align aspirations and ambitions to create business value. While this role is traditionally performed by leadership, bridging becomes more important within digital transformation, due to the need for multidisciplinary teams and heightened collaboration. Furthermore, adopting digital technologies requires a change in the way organisation work and, as a result, the role of leadership evolves becomes to inject change and drive new ways of working (Duscher, et.al., 2017). The role of leadership within digitalisation has also been discussed by Obwegeser et al. (2020) and Brunetti et al. (2020). While Obwegeser et al. (2020) focus the role of leadership within digital transformation on gaining momentum through removing potential obstacles and scaling digital initiatives, Brunetti et al. (2020) contend that digital transformation demands new

types of skills and cultural changes. One of the new skills needed for digital leaders a shift in leadership mindset away from traditional risk aversion into embracing a fail-fast mode as the norm for digitalisation (Kane, et al., 2015). The need for a culture of risk taking has also been argued by Fæste et al. (2015) to be a primary driver of digital transformation. While leadership is vital organisations' digital agendas, scholars diverge in describing the nature of the role. Nevertheless, many scholars posit that digital transformation requires trust to motivate collaboration and to enable information sharing culture (Obwegeser et al., 2020) (Duscher et al.,2017). Thus, in addition to the traditional leadership role, a new set of skills is needed specifically to facilitate digital transformation within organisations (e.g., risk taking and intensive collaboration).

Digital transformation requires a new set of leadership skills, which may mean departure from traditional leadership. Traditionally much of the literature's categorisation of leadership has been based on leadership behaviours, styles, or traits (Graen and Uhl-Bien, 1995). However, digital transformation (with its demand for intensive collaboration) mandates that trust be built among the different participants (Obwegeser et al., 2020). To nurture such trust, the focus must shift from the individual leader to the relationship between the leader and followers (Graen and Uhl-Bien, 1995). While this shift in perspective is necessary to articulate the leadership role within digital transformation, modern organisational development theories

promote such discourse through new sets of organisational development practices (Marshal and Grant, 2008). Those practices will enable successful digital transformation, as leadership is a core element of the organisational dimensions required for digital transformation (Sainger, 2018). Another important leadership aspect within digitalisation is the need for consistent leadership to drive change (Sainger, 2018). In other words, leaders must not only walk the talk but also exhibit consistent values-driven leadership. Although this leadership style is not something attributable only to digital transformation, discrepancy between espoused and enacted values can lead to a leadership crisis (Heifetz, 1994) that inhibits the organisational changes required to drive successful digitalisation.

While leadership's role is evolving within the context of digital transformation, the need for a stronger change management practices is growing sharply. Digital adoption is often challenged by various barriers ranging, from technological and organisational to psychological barriers (Ramilon and Embi, 2014). Successful digital transformation requires leaders to address each of these barriers and create a positive attitude towards the adoption of new technologies (Brunetti et al., 2020). While traditional change management strategies can be employed throughout digital adoption, one must acknowledge the need for continuous and sustainable change to create a suitable culture for digital adoption (Brunetti et al., 2020).

2.11 Technology Adoption Frameworks

Although in the previous sections, I attempted to analyse the literature in terms of what digital adoption should cover, the literature is full of technology adoption models examples, each with its own merit. In explaining how technology adoption works, the most common theories are the technology acceptance model (TAM; Davis 1986, Davis 1989, Davis et al. 1989), theory of planned behaviour (TPB; Ajzen 1985, Ajzen 1991), the unified theory of acceptance and use of technology (UTAUT; Venkatesh et al. 2003), the DOI framework (Rogers 1995), and the TOE framework (Tornatzky and Fleischer 1990). This research will focus on PDO's adoption of technology, and only two frameworks deal with such adoption at the organisation level: the DOI and TOE frameworks. Therefore, the two models are examined in details in this section.

2.11.1 Diffusion of Innovation

Although the DOI theory was introduced in 1995 (Rogers, 2003), it remains the most widely used theory to explain technology adoption. The theory explains how, why, and at what rate new innovations are accepted through organisational cultures. The theory identifies five main elements that converge and determine whether innovation adoption succeeds: the perceived attributes of innovations, type of innovation-decision, communication channels, nature of the social system, and extent of change agents (Rogers, 2003). The main argument of the DOI theory is that

innovations are spread through very specific channels over time and that the acceptance of such innovation varies on the basis of individual degrees of willingness to adopt such innovations. While the DOI theory depends on the individual perception and uptake of each new idea, Lundblad (2003) argues that individual adoption can differ from organisational adoption, and thus innovation adoption within organisations requires a different set of parameters.

By contrast, since organisations are small social system by themselves, what drives innovation within an organisation is arguably the individuals who work within that social system. In addition, while the DOI theory assumes that the full population will eventually adopt the technology over time in a normally distributed curve (Rogers, 2003), organisations may not necessarily exhibit this pattern, especially when management mandates the use a particular system for doing the work. While the DOI theory segments individuals into five categories of willingness to adopt technologies from first to last adopters according to Rogers (2003), Tiago Oliveira (2011) have argued that the DOI's assumptions about adopting such technologies are biased towards the individual person perception of the technology. This bias is evident in organisations who might choose to select early adopters based on their role rather than their perception of the technological benefits. Thus technological attractiveness is not a strong consideration of the DOI. For instance, the initial uptake of the new iPhone

upon release cannot be explained through DOI, as the curve is skewed towards early adopters (Tiago Oliveira, 2011).

In addition, while the theory addresses internal organisational structure, it lacks clarity on the role of management sponsorship and political climate within the company. Thus, I would also argue that the environment in which the organisation operates plays a vital role in shaping its innovation process. If the environment is competitive, the rate of adoption of new technology will be higher than if the environment is not as competitive. Nevertheless, DOI theory remains a strong starting point from which to analyse adoption of innovation; thus, its use within this research is based on a careful analysis of its strengths and the value it provides to the study objectives.

Furthermore, while Rogers' (1995) DOI theory emphasises various independent variables — such as the leader characteristics, the internal organisational structure, and external characteristics of the organisation — leadership and change needs further investigation to better explain its role in innovation diffusion within PDO and similar companies. In addition, while DOI can provide good starting point froing which to understand innovation diffusion, a holistic approach for adoption must consider the operating environment in addition to individual and organisational characteristics.

2.11.2 Technology, Organisation, & Environment Framework

According to the TOE framework by Tornatzky and Fleischer (1990), the process of adopting new technologies can be explained with reference to

three main elements: technological context, organisational context, and environmental context. While the DOI theory focusses on the individual context, the TOE framework does not consider individual attitudes towards change. On the other hand, the TOE framework provides a concrete theoretical basis along with reliable empirical support (Oliveira & Martins, 2011) regarding technology adoption through the use of technological, organisational, and environmental contextual factors. Therefore, it is a framework widely used for explaining the adoption of innovations within information systems, due to its coverage of the above three contexts.

In addition, the TOE framework includes two components unavailable within the DOI theory: technology and operating environment. As stated previously, understanding the characteristics of the technology will help the organisation assess its impact and thereby motivate its adoption. Furthermore, the operating environment provides both opportunities and constraints regarding how technology is adopted. In the case of the oil and gas industry, especially for national oil and gas companies, regulation related to data sovereignty can impact the rate of technology adoption. While the combination of the DOI and TOE frameworks foster comprehension of the overall adoption process within PDO, the literature did not provide evidence of the usage of both frameworks to explain this adoption. In fact, the literature has more coverage of the DOI framework than it does the TOE framework. Since this research aims to understand the

adoption of digital technologies, and since the focus is primarily on adoption, I decided to use the DOI framework where applicable (for further discussion, see Chapter 3).

2.12 Summary

The literature review has revealed that the oil and gas industry faces disruptive upcoming changes with the use of digital technologies. These digital technologies can enhance the exploration and production of hydrocarbons, yet their use within oil and gas is underdeveloped. The literature also provides five dimensions that can influence digital adoption within organizations; namely organizational context, the organisational readiness, the drivers to digital, the digital capabilities needed, and the leadership and change. PDO experimented with digital technologies yet they could not scale such initiatives as the adoption process did not take off. While different industries vary in their motivations for adopting digital technologies (Lammers et al., 2018), every industry gains common benefits from applying digital technologies to improve their business. On the other hand, organisations vary in their use of different digital technologies, depending on the nature of the business and the drivers of digitalisation. Therefore, it is important to investigate what drives PDO to adopt digital technologies, as it will have consequences for which digital technologies they use.

Although the importance of digital technologies is evident from the

literature review, the maturity of each industry and company varies. Companies whose integration of digital technologies has matured are better positioned to succeed and to lead in their respective industries. Hence, assessing the maturity of a company prior to digital adoption is an important step in understanding organisational readiness to adopt digital technologies. Multiple maturity models are available in the literature, but the model developed by Kane et al. (2017) features an associated practical tool that can be used to assess PDO's readiness for digitalisation. Understanding the digital capabilities needed for digital adoption is key element to the success of the adoption. In addition, leadership and change are essential to the process of digital adoption.

Chapter 3 - Research Methodology

3.1 Introduction

This research attempts to develop a digital adoption model that will help PDO to successfully adopt digital technologies by providing individual business units an adoption template. Since the model is based on existing frameworks applied to position a digital transformation framework for PDO, it is in this sense that the goal is to *develop* an adoption model. The theoretical and practical importance of this research is in establishing a methodology to be followed by the different business units within PDO to successfully adopt digital technologies. The model is developed specifically for PDO and uses PDO business units as a case study, and its applicability to other organisation within the oil and gas industry is outside the scope of this research and thus must be investigated and assessed separately. A number of objectives were considered in framing the problem statement for this research. These objectives represent key areas within the digital transformation strategy. Each objective was investigated through the use of a specific research methodology (either qualitative, quantitative, or both). Hence, overall, this research utilised mixed methods to investigate the different aims, key areas, and factors associated with digital adoption at PDO.

As discussed in the literature review chapter, there are multiple dimensions

that influence digital adoption within organization. Thus, the development of a digital adoption model for PDO requires a structured approach to investigate such elements. The approach I took was start investigating each element through using multiple research methods ranging from discussion groups to surveys. The first element I investigated was the main drivers motivating PDO to pursue digital adoption. During this investigation, both internal and external factors were considered. Once those factors were known, the second stage was to assess organisational readiness for digital adoption. The readiness of the organisation was used as input to the model development, dictating the pace of execution. The third stage was to investigate the business capabilities required for digital adoption. Business capabilities are important in determining the extent of change required, especially with respect to the company's competency and proficiency with digital technologies. In addition, the level of change was used as an input for model development in the fifth stage. In the fourth stage, I assessed previous experience within PDO of technology adoptions with the aim of encapsulating lessons into model development in the final stage. The final stage was to analyse the output from the previous four stages and develop a digital adoption model for PDO, including change management and how to deploy such model. During each of the research stages, a discussion with PDO management was held to review their perspective and gain guidance on the research stages under investigation or the next one. I expected that while these stages may seem to form a sequential process, in reality and in

view of utilising action research, such stages were iterative in nature. **Figure 3.1** illustrates the different stages of the research.
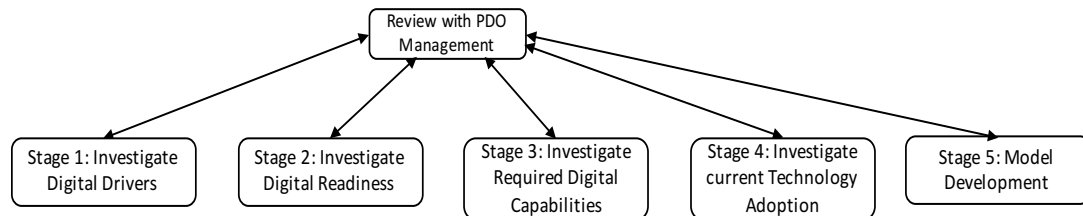
Figure 3.1. Research Stages

The chapter is structured in four main components. Section 3.2 discusses the research context and its impact on the research design. Section 3.3 focusses on the research approach including the five stages described in Figure 3.1, the research methods, and the research strategy and design. Section 3.4 centres on analysis techniques and ensuring the validity and the reliability of the research.

3.2 The Research Context

As discussed, the operating environment within the oil and gas industry is difficult. While the volatility of oil prices challenges every oil and gas company, other factors also create operational problems. The exploration and production in Oman has moved from producing the easy oil, namely conventional drilling and production, to unconventional methods, such as EOR, where technologies such as steam and gas injection are employed to extract oil. As the largest oil and gas company in Oman, PDO has inherited these industry challenges (**Appendix A**

illustrate PDO profile), including the increase of the cost to produce one barrel of oil to more than US$20, as compared to neighbouring countries in which the cost of producing a barrel of oil is less than US$10 (Anon, 2016). In addition, oil production in Oman began in 1967, and PDO has mature assets in need of refurbishment. As these assets reach the end of their lifecycles, they impose both operational costs and safety risks. Furthermore, company experts are approaching retirement, with a younger workforce joining the company. This employee turnover is reducing operational knowledge and efficiency within the company.

To address these challenges, PDO has strategically emphasised the exploitation of new technologies (see **Appendix D**1 for the company strategy map, where all similar priorities are illustrated). Hence, multiple sections within the company experimented with digital technologies such as drones (in Exploration Directorate), analytics (Petroleum Directorate), wearable technologies (Operation Directorate), and mobile devices (Operation Directorate). Although such experimentation has provided some insight into the organisation's options, these efforts have also produced challenges. The duplication of effort due to lack of coordination among the different initiatives, eroding efficiency. The multiple investment funds being used by different departments within the same organisation, resulting in cost inefficiencies. The lack of technical support during experimentation due to staff lack of readiness, leading to more technical problems being generated than business problems being solved; and lack of clarity on how these digital initiatives will help the company achieve its strategic objectives (see **Appendix D1** for the company strategy map, where the key strategic themes are listed; although the details of these initiatives are confidential, during data

collection section it will become clearer how these strategic objectives can be operationalised).

To address the above challenges, on 15 January 2018, the Company CEO appointed a chief information and digitalisation officer (CIDO) to lead a consolidated approach for digital adoption. On 3 May 2018, the CIDO created a federated multidisciplinary team called the Digital Centre of Excellence (DCoE) reporting under CIDO, comprising members from 18 business units. I am also part of this virtual team. Through this team, an approach to adopting digital technologies that suits PDO ambition will be crafted. As I was included in this virtual multidisciplinary team, I recognised the prospect of conducting action research on digital technologies to support PDO. This action research presents the opportunity to focus the development of a digital adoption model to support digital transformation initiatives

3.3 Research Approach

As illustrated in Figure 3.1, there are five stages of this research with an overarching stage to consult with PDO management after each stage. The research approach I took was to investigate each of the five dimensions and use the action generated from the discussion with PDO management to inform and progress this research. In this section, I will discuss the approach I took for each stage and the input received from PDO management that resulted in shaping the research findings.

3.3.1 Stage 1: Identifying Digital Transformation Drivers

The first stage of this research is to identify what drives PDO to adopt digital technologies. The literature review identified multiple factors that motivate companies to pursue digital transformation initiatives. Although different views of these drivers were cited in the literature (Lammers, et al., 2018), (Stentoft, et al., 2019), (Pollitzer, 2018), and (Westerman, et al., 2011), the drivers identified by Lammers et al. (2018) especially in the mining industry seems more relevant to be used in this research. A qualitative research approach was adopted for this purpose, mainly because even though different business units may have articulated their own drivers, a combined list of drivers for PDO must be constructed. The approach comprised two focus group discussions (mainly to understand internal and external drivers of digitalisation by different set of participants), followed by one workshop to consolidate the overall drivers for PDO. During each focus group discussion, the group was exposed to some of the drivers from the mining industry based on the work done by Lammers et al. (2018). The focus group was then asked to brainstorm internal and external drivers for PDO to go digital and the reasoning behind them. Following the outcome from the two focus groups, a workshop was conducted with PDO management to showcase outcomes and consolidate drivers for PDO. The workshop presented the different drivers generated during the two focus group discussions. PDO management felt that the number of drivers were too much and need to be limited to the top 3 or 4 drivers. As a result, a follow up focus group discussion was conducted with

the same people to prioritise the drivers. To structure these discussions, the drivers were prioritised based on a 2×2 matrix of business impact and generated value. The aim was to understand which of those drivers will generate the greatest business impact and the most value. The outcome from this workshop formed the action part of the first stage.

3.3.2 Stage 2: Assessing Organisational Readiness and Maturity

The second stage of this research aims to assess organisational readiness for PDO to adopt digital. The main question this stage aims to answer is whether the company (PDO) is actually ready to digitalise and the organisation's maturity. Since digital maturity is a well-known and established phenomena, utilising a quantitative approach to assess organisational readiness was as most appropriate in this case. While the literature provided multiple perspectives on digital maturity, it was difficult to find an instrument to assess organisational maturity in digitalisation. In pursuit of a digital maturity quantitative instrument, I decided to review the consulting firms' digital initiatives. The research included the work of consultancy firms such as Accenture, Deloitte, and Cap Gemini. A global survey done by MIT Sloan Management Review and Deloitte has focussed on understanding how different companies compare on the digital maturity scale (Kane, et al., 2015). The scale divides into three stages: early, developing, and maturing. Since the original survey is done across various companies and various countries, this survey was

modified to reflect the research's objectives. Thus, the survey was modified to include only questions related to assessing readiness. Furthermore, the questions were also modified to reflect the business unit's aspiration rather than that of the whole company. The modified MIT Sloan survey can be found in **Appendix G**. Furthermore, the questions within the survey were grouped to form distinct dimensions. The collection of these questions were then used as the basis of the analysis. **Table 3.5** illustrates the associated questions with the dimensions covered as part of the survey.

Dimension	Questions
Demographics	Q1-4
Digital Business & Strategy	Q5-11,14, 19, 20
Technology Choices	Q15, Q16
Digital Readiness	Q12-13,17,18, 22-24
Resources & Talent	Q21, 25-33, 38
Talent Retention	Q34-37, 39-41
Leadership	Q42-45

Table 3.5. The Dimensions Covered by the MIT Survey

The MIT Survey questionnaire includes questions measured on a 5-point Likert scale in addition to multiple-choice questions. Each of the above dimensions (apart from demographic data) has a mix of these two types of questions. During the analysis, the 5-point Likert scale was used to assess PDO level in that dimension, while the multiple-choice questions were used to gain more insight and reflection on why such a level in Likert scale is obtained. Following the outcome of the maturity assessment, a second workshop was conducted with PDO management to verify the applicability of the findings.

3.3.3 Stage 3: Defining Business Capabilities

Following the identification of the digital maturity, PDO must identify the necessary business capabilities for adopting digital technology.

To identify such capabilities, I designed an instrument as a survey based on the business capabilities relevant to digital adoption, as discussed by Warner and Wäger (2019): digital sensing, digital seizing, and digital transforming. Under each of these three capabilities, there were nine sub-capabilities associated for each capability. All were included in the survey and the participants were asked to assess the relevance and importance of each sub-capability based on a 5-point Likert scale. **Appendix H** shows the Digital Capabilities Survey. Since the contextual factors identified by Warner and Wäger (2019) are not business capabilities as per the definition by Beimborn et al. (2005) and already covered as part of the research

context, they were not used for the survey design. These contextual factors was discussed during the interviews and focus groups relating to the identification of digital drivers.. I used deductive reasoning to analyse the output from the survey and identify the different capabilities needed for PDO Digital journey. Since Warner and Wäger's (2019) research has a wide coverage of seven different industries, one can argue that it can be generalised to include the oil and gas industry. Following the outcome of the capability assessment, a third workshop was conducted with PDO management to reflect on the identified capabilities. Whilst the participants response were mainly driven towards sensing capabilities, PDO management expected more capabilities in the seizing.

3.3.4 Stage 4: Investigating Existing Technology Adoption

One of the aims of this research is to learn from a previous technology adoption model that exists within PDO. At this stage, I carried out an identification and analysis of previous adoption methods used for technology adoption within PDO. PDO has had a rich history of technology adoption since its inception in 1957. While the word "technology" is often associated with IT, it is critical at this stage to differentiates between technologies related to the exploration and production of oil and gas and technologies related to IT. Since this study centres on digital technologies, its empirical research focussed on the adoption of technologies related to IT, with the aim of understanding the current adoption models. The focus

on IT projects mainly due to the fact that digital technologies are IT-based and often software-driven.

Technology	Description	Implementation Duration	Main Usage of Technology	Importance	Complexity	Impact	Completion Year
High-Performance Computing (i.e., Comprehensive Data Interpretation System (CIDIS))	Introducing server-based computing and storage technologies for processing seismic data to speed up the exploration processes	2 years	Time liberation	Reduced the interpretation process from 9 months to 6 months	Medium level	Improved the exploration timeline	2015
Skype for Business Implementation	Introducing Microsoft Skype for business tool to enable better collaboration	1.5 years	Collaboration	Provided means for employee to communicate and collaborate with each other	Medium level of complexity and integration	Improved communication and collaboration	2018
Windows 7	Introducing Windows 7 as the main platform for user community	3 years	Productivity	Enhanced employee productivity and provided enhanced access to company resources	Medium with application compatibility being the main challenge	Enhanced employee productivity	2010
Windows 10	Introducing Windows 10 as the main platform for user community	3 years	Productivity	Enhanced employee productivity and provided enhanced access to company resources	Medium with application compatibility being the main challenge	Enhanced employee productivity	To be completed by 2022

Table 3.1. Main IT Technology Adoption Examples

I identified four recent major technology disruptions that occurred within the company within the last 20 years: the introduction of server-based computing for seismic processing, the introduction of Skype for Business, the introduction of Windows 7, and the introduction of Windows 10 for user-based computing. These four technology adoptions instances were selected due to their strategic importance, complexity, and impact in my organisation (see **Table 3.1)**.

The selection of the above four technology projects was influenced by the

availability of the documentation and people to interview. The research method was qualitative, where many interviews were conducted with the people involved in these projects. In addition to the interviews, a review of the documentation for different projects provided was carried out as a form of secondary data input. A special workshop was conducted with the project managers of the above projects to verify the understanding of the adoption models used and confirm their applicability to digital. The findings from this stage were communicated back to PDO management and they supported the need for clear governance and change management practices to lead digital adoption.

3.3.5 Stage 5: Developing an Adoption Model

At this stage, it was important first to assess the applicability of the DOI and TOE framework to digital adoption within PDO. As discussed in Chapter 2, many frameworks describe technological adoption within organisations. Therefore, building on the work of Oliveira and Martins (2011), this research assessed the applicability of these two frameworks to the adoption of digital technologies within my organisation. To assess such applicability, I analysed whether the four technology projects conducted in PDO (Table 3.1) used any of the two adoption frameworks. Since the implementation of the above four technology programs was driven mainly by companies such as IBM and Microsoft, it was evident from the previous stage analysis that a technology adoption model is vendor-biased rather than driven by

DOI or TOE models. When attempting to map these vendors based models to either DOI or TOE, there is no one size fit all can be derived and each program has its own specifics. Returning back to the literature, it was important to understand how a model should be developed. It was clear that if we reflect on the different maturity assessment models, this could provide a path to how the model should be developed. When the different paths to digital adoption was presented to PDO management, they initially thought that could be an infinite number of paths to be taken. However, it was agreed that an evidence based approach should be considered when selecting those paths to digital adoption. Hence, three paths were analysed and one was selected.

3.3.6 Review with PDO Management

Since this is an action research, it is important to identify the type of action generated from each stage of the research. An overarching step was introduced where the result from each research stage was verified with PDO management before proceeding to the next stage. This provided legitimacy to the research findings. The review stage is used to reflect and guide the development of the digital adoption model. The PDO management team comprised of CIDO and DCOE members. In some cases other members from the leadership team joined the discussion to challenge the thinking process.

3.4 Research Methods

This research employed mixed methods (quantitative, qualitative, and action research). These methods are integrated together in the analysis stage in pursuit of developing the digital adoption model. The following sections explore each method and its relevancy to this research.

3.4.1 Quantitative Method

Although Creswell (2013) argues that quantitative research is premised on collecting numerical values, in this research, I used quantitative instruments, as a result of the literature review, from which I identified two main instruments as part of the quantitative method. The first instrument is based on the Digital Maturity Survey by Kane et al. (2017). This instrument was used to understand PDO's readiness for digitalisation and thus to determine PDO's digital maturity. The second instrument was developed based on Warner and Wäger's (2019) digital capabilities, and each capability was assessed based on its relevance and importance to PDO.

3.4.2 Qualitative Method

To conduct qualitative research, it is important to identify a potential approach (or approaches) that can be applicable to this research topic. Creswell (2013) identifies five approaches to qualitative inquiry, based on

which an analysis of the different approaches was completed in relation to their applicability to PDO. **Table 3.2** demonstrates the advantages and disadvantages of each qualitative research approach in the context of this research study.

Table 3.2. Advantages and Limitations of the Five Main Approaches to Qualitative Research for PDO (adapted from Creswell, 2013)

	Narrative Research	Phenomenological Research	Grounded Theory	Ethnographic Research	Case Study Research
Advantage	• Focuses on individual identity • Resulting data can be analysed using thematic, structural, and dialogic analysis	• Captures significant statements (textural) • Interpretation to meaning units	• Can be used to develop a theory of how digitalisation can be adopted within PDO	• Focusses the researcher on reporting facts "Realist Ethnographer" • Helps to understand the perception of digitalisation within PDO	• In-depth understanding of the case • Model can be developed for different themes
Limitations	• Potential cultural conflict if the organisation doesn't have a uniform culture	• Digitalisation is new, so has not yet been experienced by all units within PDO	• Too focussed on generating theory and not on finding solutions	• The time required to collect data is extensive	• Identifying research boundaries can be challenging

Since this research comprises an action-based study completed by a scholar-practitioner, grounded theory approach was discounted. The use of ethnographic research would require extensive time and, as a result, was also discounted. Phenomenological research aims to describe the essence of a phenomena. Given the research stages, this type of approach was not suited for investigation of the lived experiences of digitalisation, especially in areas of the business that had not yet initiated digitalisation. Therefore, this approach was also discounted. Narrative research is useful for cultural investigation and could be used to assess the digital culture. PDO is in its early stages of digital adoption, though, and this approach carries the potential for subjectivity which was against the evidence based approach promised to use within this research, so it was dismissed.

By process of elimination, the case study approach was selected as most applicable for this research, since case studies are rigorous and can be generalised.

3.4.3 Participatory Action Research

Participatory action research (PAR) involves stakeholders, either as individuals or groups. Stakeholders are meant to act as equal partners in the research process. In PDO's case, they are highly concerned about the internal issues at the organisation. They also help inform the organisation about external business trends, so their participation is critical. The aim of

PAR is to strengthen the company's position in the external environment by having action researchers and participants actively participate in business operations and create social changes to enhance the company's long-term value. Stakeholders are not involved at the outset of the research, but after the company seeks their help, they become active early in the process. They then collaborate in studying the action plan and in finding ways to implement it (Berg & Lune, 2004).

Collaborative research is essential to action research. It provides employees, employers, and stakeholders with the means to step forward and take systematic and regular action to resolve significant problems. Collaborative research is democratic, as it invites all team members to participate in the process and conceives their decisions and ideas as valuable. The involvement of employees and stakeholders makes the research participatory. PAR encourages employees and stakeholders to generate explanations of their actions and then develop plans to best resolve the problem (Berg & Lune, 2004). In addition, PAR has a number of key goals, such as generating practical knowledge that can be used to solve problems under investigation through the involvement of different people and the inclusion of different perspectives (Schneider, 2012).

The current study employed PAR by involving key stakeholders from different levels of PDO. The discussion of the sample used will be detailed in the next section; however, each stage of this research involves

participants from the DCoE in addition to other members who engage with digital projects across PDO. PDO management were used normally to vet and verify the applicability of the knowledge created for PDO. This verification was done iteratively through different workshops and engagements from different members of my organisation.

3.5 Research Strategy & Design

As discussed previously, research aims to develop a digital adoption model for PDO. I identified five main aims for this research, each of which was investigated through various research methods. In this section, number of components will be discussed, including the study population, sampling procedures, data collection, and type of instrumentation to be used in the study.

3.5.1 Sample Population

Since PDO has over 8,000 employees, it is important to design the population sample correctly. While it is impossible to run the study with all of the employees, identifying the right population sample for this research becomes important. Since the study focusses primarily on digital adoption, it is important to identify an appropriate sample population for the study. Based on PDO's organisational structure, many digital initiatives have been introduced within the different business units. Staff who worked on these initiatives gained great knowledge of such digital technologies through

experimentation. To determine eligibility for participation in the study, it was agreed that participants should be part of the team tasked to select and implement digital technologies initiatives within PDO. This team is called the DCoE. Since the creation of the DCoE in PDO, many who experimented with digital technologies became part of it as DBLs. Hence, they represent and help their business unit in pursuing digital technologies. In addition, many of the IT staff are also part of the DCoE working as advisors, architect, business analysts, among other roles as well.

The DCoE exhibits the following features:

• The business members of the DCoE represent their business unit's aspiration and act as owners of all digital initiatives for their respective business units. Business members are therefore referred to as DBLs.

• The IT members of the DCoE are actively involved in the experimentation and execution of the technology aspect of digitalisation. These members include digital advisors, architects, portfolio consultants, and technical staff.

Thus, the population of this group is between 30-40 people, and this was the population sample used in this study. I determined the appropriate number to be 30-40 mainly based upon the expansion of business units who wanted to go digital. At the start of the research design in 2019, 30 were people identified. Due to the dynamic nature of business, the number

increased to 40 by 2020. Therefore, as new members emerged, they were invited to join and to consent to this research study. As part of this sample group, individuals were invited to take part in interviews and focus groups and to complete a survey. The nature of action research requires an individual to participate more than once. **Table 3.3** displays the different samples for each of the research stages.

Stage	Type of Research Method	Targeted Sample
Stage 1: Identifying Digital Drivers	Focus group discussion	16 (13 DBLs and DCoE)
Stage 2: Digital Maturity Assessment	Survey	30-40
Stage 3: Digital Capabilities Assessment	Survey	30-40
Stage 4: Previous Projects Assessment	One-on-one Interview	8 (2 individuals from each of the identified projects)

Table 3.3. Research Sample Population

3.5.1 Sampling Method

The population sample was identified based on their digital expertise and as members of the DCoE team; hence, the sampling strategy was purposive and not random. It was based on a specific and identified population sample. Given the scope of digital adoption within PDO in 2019 (when I designed the research methods), few primary data sources could be used in this study. Digital projects were sparse, and the number of business units experimenting with digitalisation was also low. In addition, the DCoE team had been newly formed, and the digital partner (i.e., BCG) had just begun

the work. Hence, purposive sampling was the most appropriate sample method for this research. On the other hand, the use of purposive sampling faces certain limitations, such as researcher's bias on sample selection. This is augmented, as the identified sample was a fixed number of people, either part of the DCoE or working on digital projects. Each participant had to sign a consent form before participating. As a result, the number of participants varied for each stage.

In addition, during the quantitative research methods, such as questionnaires, all willing participants were expected to respond to survey questions. The qualitative approach included the use of interviews, focus group discussions, and workshops. While it is important to conduct such interviews and discussions, it is equally important to identify adequate participation. As stated previously, the sample population for this research was based on the members of the DCoE in addition to DBLs, representing each business unit and responsible for driving the business unit's digital agenda, and business unit portfolio consultants, responsible for demand management of IT services, including digital. The total number of people identified varied from 30-40 people.

The sampling process was also influenced by the willingness of people to participate in the different stages of the study. For instance, people who consented to participate in the research were sent the invitation to participate in the two surveys, yet the number of responses differed and it

was based on the willingness of people to participate. Thus, while the surveys targeted all of the 30-40 people who consented to participate, the response was based on the motivation of these staff to participate. For the one-on-one interviews (used in Stage 4) and the focus group discussion (used in the first stage) of the research, willingness to participate was partially achieved.

In the case of the focus group discussion to derive the drivers for digitalisation, the target was to design the sample correctly. In order to do so, it was important for the focus group discussion to have fewer participants for two reasons. First, larger groups are difficult to control, and the discussion can drift to irrelevant topics (Lavrakas, 2008). Thus, focussed discussion occurs more readily in a small group of participants. For better time management and to provide each participant an opportunity to share their insights and observations, the group was designed to have no less than five and no more than eight members (Lavrakas, 2008). The second reason is relevance of the participants to the study as systematic sampling was used in focus groups for better insights. The selection of the participants within the focus group was limited to DCoE members, including the DBLs. This was done mainly to engage the different business units on their drive and aspiration for digital adoption.

For all the research methods used, an invitation to participate (in English) was sent to all identified members to participate. The surveys or focus

group discussions took place only after obtaining the participants' consent and willingness to participate. A sample of the consent forms can be found in **Appendix E**.

3.5.4 Data Collection Procedure and Process

All data collection, as part of this research, was carried out provided two conditions. The first was that all participants read and understood the Participant Information Sheet, which was shared with them (a copy of the Participant Information Sheet can be found in **Appendix F**). The second condition is that participants agree to an informed consent form (a sample of the consent forms can found in **Appendix E**). The consent form was provided to all participants who were part of the selected sample population for this research. The form details what participation means and how the collected data will be used. As discussed previously, various methods were used for data collection. **Table 3.4** describes each of these methods and the type of data to be collected.

Following each stage of data collection and analysis, actionable knowledge was generated through workshops with PDO management. These workshops were mainly held to achieve two objectives. The first was to ensure that the analysis and the findings from each stage would be vetted and affirmed by PDO management to avoid potential conflict. The second objective was to ensure this action research would generate value to PDO and help the

organisation to accelerate its digital adoption. These workshops were also part of the support provided by CIDO and my commitment to this research study.

During these workshops, certain key actionable knowledge was generated through discussion and dialogue. The workshops had no particular format. I presented the results and their interpretation, and the discussion with PDO management took place to agree on the next steps.

Research Stage	Data to be Collected	Contribution to Actionable Knowledge	When Data was Collected
Stage 1: Identifying Digital Transformation Drivers	Business unit drivers	Debriefing workshop with PDO management to review the consolidated digital drivers for PDO	**Apr-20**
	Type of drivers		
	Perception of PDO-wide drivers		
Stage 2: Assess Organisational Readiness	Current maturity state	Debriefing Workshop with PDO management to reflect on current maturity and discuss the gaps identified	**May to June 2020**
	Organisation's aspiration		
	Current challenges		
Stage 3: Identify Business Capabilities	Capabilities types	Debriefing Workshop with PDO Management was conducted to discuss the findings and consider the required future digital capabilities	**July to August 2020**
	Required digital capabilities		
Stage 4: Assess Existing Technology Adoption	Existing adoption models with PDO	Key findings for successful technology adoption (from the analysis of the associated projects) discussed with PDO management and confirmed the findings	**August to September 2020**
	Their applicability of previous models to digital adoption		
Stage 5: Develop Adoption Model	How PDO should go about adopting Digital?	Consolidation workshop with DCoE to agree the adoption model suitable for PDO	**Jan-2021**
	Criteria for selecting adoption models		
	Methods for testing the model		

Table 3.4. Data Collection Methods

3.6 Analysis Techniques

Since the research will use mixed methods, the analysis techniques will differ based on the research method used. For quantitative analysis, the identified software was the Statistical Package for the Social Sciences (SPSS) as a primary tool with a MANOVA design. Notably, the MANOVA analysis in SPSS is the best evaluation tool for the two aims identified to use quantitative methods of research. Data collection was done through Survey Monkey (online), and the raw data was imported for analysis in the SPSS tool. In SPSS, I performed descriptive statistical analysis to measure the central tendency for each statement within the surveys.

For the qualitative analysis, two software; Nvivo and Dedoose were used for the analysis. Both pieces of software can analyse text-based input such as interviews and focus group discussions transcripts in addition to secondary data such as documents and project files. Since the qualitative analysis were done in two stages, each stage had its own analysis technique. In Stage 1 (where the aim was to identify digital drivers), the thematic analysis focussed on two main components. The first component of the analysis was done in Dedoose software, where word frequency and mind map for the common text was produced. This analysis was completed to arrive at the potential codes used. The second component was aimed at using the codes generated in Dedoose to see which of them could be classified as general terms used to describe the digital drivers. For instance,

Dedoose identified the word "production" as a common word used in the transcripts. The word was checked in Nvivo against the same transcripts to determine that phrases such as "increase production" or "sustain production" were quoted by the different interviewees. Thus, coding of the transcripts for the two focus group discussions was done in Nvivo. I completed the coding in two steps mainly because of the different capabilities made available by the two different pieces of software: While Dedoose has a simpler and easier graphical interface to highlight common words, Nvivo has better coding capabilities. Once the codes were matched between the two software, the result was further analysed. The result of the coding exercise was a long list of codes that were later consolidated into themes. These themes became the digital drivers for PDO. While the codes were generated from the interviewees' own words, I developed the themes.

3.7 Research Methodologies Limitations

There are multiple limitations to the research methodologies employed in this action research. The first limitation is that contextual factors related were not investigated as part of this research. As per the literature review, there were five different dimensions that influenced the digital adoption within organization. The research, thus, focused on investigating four of those dimensions assuming that contextual factors are important to understand but not to be investigated in the form of a survey or interview.

This might have limited the research exposure on cultural elements. Whilst this might be the case, some of the contextual factors such as use of multidisciplinary teams and geographic disperse teams were investigated using the digital readiness assessment tool.

The second limitation is distilled from my ontological and epistemological stands. This research aimed at investigating four dimensions that influences digital adoption. Since there are multiple perspectives and views with regards to each of these four dimensions, I took a realist approach through employing mixed methods which influenced the choice of which method to be used to investigate a particular dimension.

3.8 Research Quality & Validity

One of the most important elements to consider in any research is its quality and validity. When researchers use quantitative methods, the discussion around quality and validity is pressing than with the use of qualitative methods. Although the literature has focussed upon the need to create alternative criteria upon which to judge the quality and validity of qualitative research (Lincoln & Guba, 1985), Bryman (2006) has argued that the mere use of mixed methods warrants the need for such criteria. Such criteria for mixed methods do not exist, although Marshall and Rossman (2011) have discussed criteria of soundness by which both quantitative and qualitative studies have their own criteria for evaluating the quality of the

research.

Since this research utilised a mixed-methods approach, the question of how to evaluate research quality and validity became noteworthy. On the other hand, since this research uses quantitative methods to answer research questions that differ from those addressed by qualitative methods, the issue of integration between the two methods makes it difficult to create a common criteria to judge both (Bryman, 2006). In order not to divert the focus of this research and to follow the debate within the literature, I based the quality and validity of this research on two main rudiments. The first is the quality of the research process, including the use of mixed methods in the overall research study. The second is the criteria outlined by Lincoln and Guba (1985): credibility, dependability, confirmability, and transferability.

The research design, the data collection methods, and the sampling strategy were discussed in the previous sections. Although the research design does not differ from those of other case study research, there are several risks associated with the quality of some of research design components. The first component is the sampling strategy. The sampling strategy was based on the identified population sample (i.e. DCoE team including the representation of the different DBLs). In addition, staff involved in digital projects were also included in the sample. This might cause a reliability issue, given that there might be a bias to select these

individuals only. However, I did not select these individuals per se; rather, they were already identified as part of the organisational structure, thus eliminating any researcher bias in the selection process.

Further risks associated with the sampling strategy include the validity of the participants' input. From one side, the sample is purposely selected to provide an opinion about digital within PDO; however, since these individuals are heavily involved in the situation, their opinions are biased in a specific direction. Fortunately, this bias is mitigated by the use of different methods by which to engage the population sample, leading to the creation of multiple perspectives that were later triangulated to arrive at a sound interpretation. Another risk to the validity of the research is the anonymity of the individuals participating in it. While methods such as surveys protect the anonymity of participants, interviews and group discussion do not. To mitigate this risk, I ensured the confidentiality of the data collected and that individuals' names would not be revealed. Thus, the collected data were used for research purposes only.

As discussed previously, since this research used mixed methods, and since there is no specific criteria to assess the quality or trustworthiness of such research, the criteria outlined by Lincoln and Guba (1985) were used. This research underwent number of challenges from the first and second supervisors when designing the research methods to ensure standard action research methods were used. To improve the credibility of this research,

debriefing sessions took place with PDO management following each research stage to ensure data collection and that the analysis performed were meeting the objective of this research. Some of these sessions produced more insights that supported the research in the results interpretation stage.

Another criterion considered during the research is dependability. As all data collection took place in 2020, during the COVID-19 pandemic, the surveys, interviews, focus group discussions, workshops, and debriefing sessions were all done online using Skype for Business. In addition, data collection was completed after BCG finalised their first digital pilot. During each stage of data collection, the information collected, along with my views, were shared with my first supervisor in order to produce an audit trail. All this information was loaded in the University of Liverpool discussion portal. Finally, another criterion to consider was the transferability or the generalisability of this research. Although this action research was designed for PDO to produce a digital adoption model, there are certain limitations to be considered before it can be generalised. Although Chapter 6 details these limitations, the selected population sample, the specific setting of online meetings, and the fact that this action research was completed after the BCG engagement could limit its generalisability.

3.9 Ethical Considerations

Prior to conducting this action research study, I had to complete an ethical application form and seek approval from University of Liverpool Research Ethics committee. Multiple ethical considerations were identified and will be discussed in this section.

The first consideration is informed consent before participation. Before participating in this action research, each member of the identified population sample was asked to sign a form indicating consent to participate. The form stated clearly that the participant's participation would be voluntary, and as a result, they were free to withdraw at any time. Certain participants contacted me for more clarification with regard to gaining approval from PDO before conducting this researched. The approval letter was shared and communicated with those who raised such concerns. In addition, participants were assured that their data would remain confidential and that their names would be mentioned neither during the debriefing sessions with PDO management nor during the thesis write-up. This assurance provided them more confidence to participate.

However, a considerable challenge for me was linking this study to the work of the BCG with regards to digitalisation. Although the study objectives were clearly articulated, there seem to be a confusion on the mind of participants about what the BCG is supposed to deliver as compared to this study. Participants voiced this confusion during the interviews and focus

group discussions, and it was often resolved by my brief introductions to these sessions. In addition, it was interesting to notice that participants were excited to use these discussions as a forum to air their opinions. Participants were engaged during these sessions and appreciated and valued the study and its approach. While there was no mechanism to measure participant enthusiasm during the surveys, the response rate was a good example of the willingness to participate.

Another ethical consideration was my dual role as researcher and employee, including the potential for conflict of interest. As stated previously, the population sample for this study was DCoE and individuals who participated in digital projects. While I am part of the virtual team forming the DCoE, I have no direct reports participating in this study at the time when the data collection took place. Therefore, the risk of harm to participants was minimal. In addition, the first supervisor was invited to the different interviews and focus group discussions to ensure participants were neither coerced nor harmed in anyway. The participants seemed content to have found a forum in which to air their opinions about PDO's digital journey. In other words, they seemed to feel included.

Although their willingness and enthusiasm to participate in this study was witnessed during this action research study, certain political issues were encountered. Because the data collection for this study was conducted after BCG engagement, many individuals (including members from business

units who participated in the study) within PDO felt that this study should have instead been done first. As a result, two schools of thought emerged. Certain individuals heavily involved with the BCG engagement defended the importance of BCG's approach, as opposed to the second school of individuals who were supported this action research and its approach. This division was evident in the participation rate of the survey, although less so during the focus group discussions and interviews.

These two schools of thought converged eventually after the debriefing sessions with PDO management, as the results and analysis of the findings became applicable in PDO's journey to digitalisation. This action research and BCG engagement in fact complemented each other, as they addressed different aspects of the digital spectrum. While BCG engagement was concerned with building and proving the value of digital technologies, this action research was concerned with their adoption and how to scale digital projects across PDO.

3.9 Summary

This chapter has detailed this study's stages and how each addressed the different research questions and, as a result, ground this action research. While the overall research used mixed methods (both quantitative and qualitative), each method was used to investigate a particular dimension related to the digital adoption within organisations. My ontological and epistemological stands were also examined and discussed. The fact that I

based my research on multiple stages and I used multiple paradigms ranging from relativist to positivist/social constructivist paradigms, this influenced the research design by employing different methods and different data collection techniques. This is mainly done to gain and compare different perspectives. In addition, since this is an action research study, PAR was used present in the research design through the use of multiple debriefing workshops to arrive at meaningful action. This action was complemented by the analysis techniques carried out over the different research stages using either quantitative analysis tools (e.g., SPSS) or qualitative analysis tools (e.g., Nvivo and Dedoose) to arrive at the adoption model.

While the selection of research methods for this action research was influenced by the research questions and by my ontological and epistemological stances, two methodological conclusions can be drawn. The first relates to the quality and validity of the research methods used. While the literature did not provide specific criteria by which to evaluate the trustworthiness of mixed methods, criteria developed by Lincoln and Guba (1985) were used to consider them. The second relates to the actionable knowledge produced by the study. The perception that action means actual change in the environment is fallacious. Each of the tools used, such as surveys, interviews, and focus groups, addressed different parts of the research questions and generate new actionable knowledge. For instance, the fact that an agreement reached with regards to what

drivers PDO to go digital can be quantified as actionable knowledge.

There were some key lessons from the research design process. The first is that the duality of my role was viewed by many participants as a good mechanism by which to feel included and to voice their opinion with regard to PDO's digital journey. Such feedback from participants were often given verbally or in a written format after the interviews/surveys. In addition, it was essential to remind the participants what hat I wear when conducting the research. The second lesson was that the research journal (mainly my physical notes) and tracking the development of the research design were important tools to capture feedback from the first supervisor.

The third lesson was that political challenges emerged as a result of who is supposed to drive digital adoption within PDO: BCG or this research study? Due to the delays encountered in obtaining approval for this research study, BCG started and completed their work before this study. Hence, questions were even raised regarding the importance and validity of the study. These questions were seen as an opportunity to introduce the research to PDO management. Thus, I conducted multiple clarification sessions with PDO management to identify the boundaries of each party (i.e., BCG and me). These sessions improved the situation, but there was always a need to articulate the distinction between BCG and this research during interviews and focus group discussions.

Chapter 4 – Research Findings and Story of Cycles of Action

4.1 Introduction

As discussed previously, this research attempts to develop a digital adoption model that will help PDO to successfully adopt digital technologies. The previous chapter discussed the research design, research approach, research strategy, and ethical considerations. As per the research approach, there were four stages (related to each of the four dimensions that influence digital adoption within organizations) of this research. The first aimed to investigate the digital drivers. The second stage is aimed to assess PDO's digital maturity and readiness. The third is aimed at determining the digital capabilities needed for PDO to adopt digital. The fourth stage is aimed at investigating current adoption models and their applicability in the digital era.

This chapter presents the key findings of each stage and the results of communicating the fieldwork findings to the PDO management team. The structure of this chapter will be to present the findings from each stage and the feedback received from PDO management and how it was incorporated in the study. Chapter 5 will discuss the details of the findings and reflect on how such findings informed literature or vice versa.

4.2 Stage I: Identifying Digital Drivers

4.2.1 Key Findings

The objective of this stage is to investigate what drives PDO to pursue adoption of digital technologies. There were two focused groups and both were tasked with identifying internal and external drivers for digital adoption. The following are the main findings:

1. For the internal drivers, it was noticeable that the composition of the two groups influenced the type of drivers generated. While the first group composition was oil and gas related business units such as exploration, gas and operation, the second group included supporting functions such as business planning, finance and data management. The drivers identified by the first group related to efficiencies in the production and operation of oil and gas fields while the second group focused mainly on collaboration, innovations and building new business frontier.

2. While the group composition influenced the internal drivers, it did not influence the external drivers as the two groups reported similar drivers.

4.2.2 Cycle of Action

After stage one, a meeting was held with PDO management to report the different drivers for PDO to adopt digital technologies. There were a total of 13 drivers (internal and external) identified by the two focused groups.

PDO management felt that 13 drivers are too many and requested to reduce them to the top 3. Following the steer from PDO management, a prioritisation exercise was carried out to identify the top drivers. The different drivers were assessed based on their impact to business and value they generate. In addition, a frequency check was carried our in Nvivo to identify the top drivers mentioned by the two focused groups. Surprisingly both groups agree that increase production is the top driver. Although digital technologies will not necessarily increase production, it will contribute to this goal. Thus, the business goal from adopting digital technologies is one of the strategic objectives of the company. Compared to the eight drivers identified by Lammers et al. (2018), this is not one of them as the oil and gas industry is different than mining.

4.3 Stage II: Digital Readiness & Maturity

4.3.1 Key Findings

In this stage, the tool developed by Kane, et al. (2017) was used to assess the company readines to adopt digital. The result generated from the tool provided insights not only on the organisational readiness but also in other elements the tool investigated. The following are the main findings:

1. Although the 50% of respondents stated their business unit has some form of strategy for experimenting with digital, 90% of them agreed the need for a coherent company strategy for digital. Whilst this survey was done after

the BCG engagement and the publication of the digital ambition, it provided an evidence on the need for a PDO digital strategy emphasising the importance of this research.

2. 62% of respondents stated that top management dictates the digital agenda and respondents have little say on where digital technologies should be used. While this response can be argued to represent an authoritarian organizational culture, I would argue that it is due to the focused digital ambition agenda developed by BCG which was mainly driven towards exploration and well engineering.

3. Respondents ranked leadership as the top factor influencing the success of digital initiative. The second factor is the availability of digital strategy followed by investment and commitment.

4. It was a surprise for me to learn that 71% of the survey respondents quoted the same list of digital technologies impacting PDO now and in three years time. This could be attributed to the uncertainty surrounding oil and gas industry during the COVID-19 pandemic.

5. The overall readiness of PDO to adopt digital technologies is low. Although the survey evaluated 7 elements related to digital adoption readiness, not all elements scored high in the likert scale. It was noticeable that business units who experimented with digital reported successful trials, improved risk tolerance, and these business units are becoming agile

as a result. However, other business units remained low in their readiness and they represent the majority. In addition, 90% of respondents stated that PDO took a specific approach rather than a holistic approach to digital implementation, making them early in their readiness. Furthermore, 62% stated that digital is not an integral part of the business strategy and as a result digital is not seen as a strategic choice for the whole company justifying the low maturity.

6. It was interesting to see 60% of the survey respondents citing that the organisational structure interfere with the collaboration and ability to engage in digital business. On the other hand, 52% confirmed that collaboration across team are often rewarded and recognised. While collaboration is embraced, the organisational structure can impact full scale adoption of digital.

7. There are two main issues revealed with the readiness survey, namely; utilising existing talents in digital and digital talent availability within PDO. 62% of survey respondents recognised the need for digital talents and 86% stated the need to develop that locally through a company driven program. In addition, 76% of respondents stated that the overall program should develop analytical skills followed by technical skills.

8. It was noticable that 67% of survey respondents recognised the impact digital will have on their jobs yet 38% only stated that they will shift to another company. This was a surprising finding and can be attributed to

the strong believe that PDO is capable of leading digital nationally as 85% of the respondents wanted to work for a digital leader.

9. There is also a strong believe on the current PDO leadership to lead digital with 62% of respondents citing strong confidence on current leadership. However, two differentiating traits the respondents expecting the leadership to have, namely; experimentation mindset and risk taking attitude through coaching existing leaders.

4.3.2 Cycle of Action

Although it was evident from the readiness survey that PDO is low in ts readiness and as a result number of improvements needs to be done, other views emberged when presenting the findings to PDO management. Firstly, PDO management did not believe that 90% of respondents stated the lack of cohesive digital strategy. Their underlying assumption was that the BCG work on digital ambition was a sufficient digital strategy for PDO. In addition, PDO management questioned if the survey participants demonstrate a good coverage of all PDO business. When the demographics results were shared and 11 out of 13 business units were included, PDO management agreed the need for digital strategy to be included in the adoption model following a long debate. In addition, PDO management agreed that since PDO just started the digital journey, its matruity level will be low. Secondly, PDO management did not agree that organisational

structure inhibit collaboration. They strongly believed that any organisational structure will work as long as there are clear roles and responsibilities defined. Thus, the organisational structure was not considered as part of the adoption model. Thirdly, PDO management were pleased to see the recognition and trust on the current leadership practices. However, they debated the need to upskill leadership team with digital leadership skills such as experimentation and risk taking citing such skills are not limited to digital but key part of any oil and gas operation. However, PDO management acknowledge that leadership is an important part of any digital program. Finally, PDO management recognised the challenges on talent and agreed to include the company digital program as part of the adoption model.

4.4 Stage III: Digital Capabilities

4.4.1 Key Findings

In order to assess the digital capability needed for digital adoption, I developed a survey based on Warner & Wäger (2019) to assess the importance and relevance of the different digital capabilities. There were 3 main capabilities (i.e. sensing, seizing and transforming) and 9 subcapabailities for each main capability. The following are the key findings:

1) In the sensing capability, 78% of respondents stated the importance of

establishing long term digital strategy and promoting digital mindset within PDO. This is further emphasising the importance of digital startegy as demonstrated in stage II of this research.

2) In the seizing capability, 61% of respondents emphasided the need to scaling up innovative business models, 56% of them highlighted the need for setting the appropriate speed of execution and 50% stated the need to accept redirection and change. This is clearly demonstrate the desire for PDO to move from experimentation to scaling and demonstrating value from these digital initiatives.

3) In the transforming capability, 83% of respondents stated the need to leverage existing digital knowledge within the organisation compared to 22% who stated the need to hire experienced digital transformation expert. This demonstrate the tendency to develop resources in-house to take on digital projects.

4.4.2 Cycle of Action

The presentation of the findings of these capabilities to PDO management did not receive many challenges. This could be because all of the findings in this stage had similarities to the previous one. However, PDO management acknowledged the need to include these capabilities in the future adoption model.

4.5 Stage IV: Previous Projects Analysis

4.5.1 Key Findings

At this stage, structured interviews with nine project stakholders of key technology projects were conducted with the aim to understand technology adoption models. The interviews were structured based on DOI Theory by Rogers (2003) investigating the different attributes of adoption. In addition, a review of secondary data such as project documentation was carried out to identify key elements of adoption. The following are the key findings:

1) It was evident from the investigation that the adoption of technologies in these projects did not follow any particular model. The method of adoption varied among the projects and it was mainly driven from the vendor. For example, Skype for business, Windows 7, and Windows 10 projects took the methodology from Microsoft of how they should go about adopting the two technologies while CIDIS project was driven by IBM and Shell. Whilst the adoption was mainly driven by vendors, there is evidence of some components of DOI within each adoption. For instance, in all the projects, triability and observability were two approaches done to attract and convince employees to use the tools.

2) For some of these technologies, the initial adoption rate was not as high especially (Windows7, Windows 10 and Skype for Business). However, due to COVID-19 and remote working, the adoption rate increased as a result of

the pandemic. I would argue that external factors can influence the adoption rate.

3) Strong governance, communication and change management practices influenced the adoption of these technologies. This was evident in all projects but especially in CIDIS and Windows 10 projects.

4.5.2 Cycle of Action

When the above findings were presented to PDO management, there was a challenge on the applicability of these learnings to digital adoption. The main argument was that digital technologies are not IT technologies and as such one need to be careful in drawing conclusions. However, PDO management acknowledged the need for Strong governance, communication and change management practices to be part of the adoption model. This is also inline with BCG recommendation on establishing a Digital Steering committee at a high level to govern the execution of digital projects within the company.

4.6 Summary

In this chapter, the key findings from each of the four stages of this research was presented. A cycle of action was generated following the discussion with PDO management. While PDO management debated and argued around the findings is some cases, there are other areas were they simply concurred with the findings. The next chapter will discuss in detail the

findings and compare them with the literature.

Chapter 5 −Discussion, Reflection, and Sense-Making

5.1 Introduction

This chapter discuss in detail the results obtained from each stage of the study. Since each stage of the research employed different research methods (e.g., quantitative and qualitative), the instrument used for each method is discussed along with the key findings. The chapter is structured by the four stages of the data collection. For each stage, key findings are presented and then interpreted. In the case of qualitative methods, I offer a deeper discussion of the interviews or focus group discussion. Following the interpretation of the results, a specific section on the study's contribution to actionable knowledge is included for each stage. Data analysis and interpretation was enhanced by cycles of action through the literature review and the debriefing sessions that occurred with PDO management before arriving at actionable knowledge − thus improving the overall interpretation of the results and providing meaningful insights.

5.2 Stage 1: Identifying Digital Drivers

In the first stage of the research, the objective was to investigate the main

drivers motivating PDO to pursue digital adoption. Since there was no documentation within PDO offering this information, and as per the research design, a qualitative approach was used. This investigation was conducted in the form of focus group discussion to identify both internal and external factors driving PDO to pursue digital adoption. Two focus groups were conducted, each including eight participants from the identified sample group. As stated previously, the population sample was around 40 people, of which 32 consented (in a signed form) to participate in this research. An email was sent to the members of DCoE team to participate in the two focus group (including the DBLs and those who experimented with digital projects which represents a subset of the population sample of around 20 participants). Those who accepted the invites were included in the discussions. **Table 5.1** presents the composition of the two groups.

Representation of Group 1	Representation of Group 2
Exploration Directorate (1), External Affairs Directorate (1), Operation Directorate (1), Gas Directorate (1), Logistics Business Unit (1), Data Science (1), Information Management (1) and Project Management (1)	Finance Directorate (1), Gas Operation (1), Business Planning (1), Technology Architecture (1), Data Management (1), Digital Centre of Excellence (1), and Digital Core (2)

Table 5.1. Business Units Representations

All participants provided consent by signing the consent form. The

discussion was divided into three parts. In the first part, participants were asked to identify the internal drivers applicable to PDO. In the second part, participants were asked to identify the external drivers. Finally, participants were then asked to rank drivers based on their impact to business (i.e. the amount of disruption this driver will generate) and the generated value (i.e. the amount of value it will provide to the business unit). To stimulate the discussion within the focus group, the eight drivers identified by Lammers et al. (2018) were shown to participants. These drivers included mainly customer focus and value differentiation, cost efficiency and process efficiency, environmental sustainability, workers safety and productivity, market focus and globalisation, decision making support, and idiosyncrasies of the industry. Both focus groups struggled initially, as some thought the drivers had already been identified for PDO. However, I clarified that the drivers by Lammers et al. (2018) are intended only to stimulate thinking. While the different participants mentioned different set of drivers, the more interesting discussions and debate came during the ranking of their importance. Following each focus group session, the ranking was shared with participants, and no strong feelings were voiced against it.

Due to the COVID-19 pandemic, all focus group discussions were conducted via Skype for Business. Since the company does not support recording within Skype for Business Application, an external voice recorder was used. The

recorded discussions were uploaded to a transcription application called Otter to transcribe the conversations. The researcher verified the transcripts to ensure better-quality transcriptions. These transcripts were uploaded first to Dedoose to obtain the key themes, mainly through repetition of key words. The transcripts were loaded later into Nvivo Software, where I performed coding based on the key themes obtained from Dedoose and performed further textual analysis. **Appendix D2** presents a sample analysis performed within Nvivo. The illustration in **Appendix D2** figures the text coding of the different drivers for the two transcripts from the focus group discussions. The size of each box represents the amount of discussion related to that particular driver as a portion of the overall drivers. Although the suggestion is that the driver most spoken about was operational excellence, it is important to note that this supposition is based on linking the text to a particular driver (or code). This was not the approach to determine the top driver; rather, the analysis considered the impact of such drivers in terms of the value they generate and their impact on business.

5.2.1 First Focus Group

The first focus group discussion comprised eight participants representing eight different business units: Exploration Directorate, External Affairs Directorate, Operation Directorate, Gas Directorate, Logistics Business Unit, Data Science, Information Management and Project Management. In

the first part of the discussion, the members were asked to identify the internal drivers forcing PDO to adopt digital technologies. To stimulate thinking and discussion, the internal drivers from Lammers et al. (2018) were used. Notably, while all participants agreed that the drivers identified by Lammers et al. (2018) are applicable to PDO in general, other drivers are relevant to PDO only. In addition, in the focus group discussion everyone agreed that PDO main driver for digital is to produce more oil and gas at a lower cost. However, when asked what drivers are specific to the participant's business unit, each participant highlighted different sets of drivers. These specific drivers were captured and highlighted for each business unit. **Table 5.2** summarises the list of internal drivers, classified by its applicability to the whole company (General) or to the business unit (Specific).

N	Internal Driver	General or Specific
1	Changes in business expectations	General
2	Increase production	Specific (Gas, Operation)
3	Reduce cost	General
4	Enhance staff and asset efficiency	General
5	Talent and capability building	General
6	Facilitate faster decision making	General
7	Reduce health, safety, and environmental (HSE) incidents	General
8	Automation	General
9	Reduce people and asset exposure	Specific (Operation, Logistics)
10	Enhance business processes	General

11	Reduce work complexity	Specific (Exploration)
12	Short project delivery cycles	Specific (Project Management)
13	Enhance collaboration and communication	Specific (External Affairs)

Table 5.2. Internal Drivers Identified by First Focus Group

The drivers listed in Table 5.2 are given in participants' own words. The above drivers are also not ranked in any particular order, but rather the time at which they were mentioned during the discussion. Furthermore, when I asked whether those internal drivers were known to all PDO employees, all of them agreed that only a specific group of people knew about them, but it is not well-articulated across the organisation. When participants were asked if such articulations are beneficial, all agreed that it will help derive focus and it will be a good idea to do so.

In the second part of the discussion, the participants were asked to identify the external drivers of PDO to pursue digital technologies adoption. **Table 5.3** lists all the external drivers.

N	External Driver	General or Specific
1	Competition	General
2	Digital shift	General
3	Economic situation	General
4	Geo-political situation	General
5	Leading the digitalisation front	General
6	New technology availability and affordability	General

7	Regulation	General

Table 5.3. External Drivers Identified by First Focus Group

The above drivers are not ranked in any particular order, rather the time at which they were mentioned during the discussion. During the discussions on external drivers, the participants highlighted the importance of becoming an "efficient organisation through the use of digital technologies" in order to survive competition. In addition, the participants within this focus group highlighted the importance of "using digital technologies to enhance the economic and geopolitical situation". It was noticeable that some members associated the "economic success" of certain neighbouring countries with their fast adoption of digital technologies. PDO, as the largest private employer in the country, was "expected to lead digital transformation initiatives", indicated participants. This expectation from public and government is also a major driver for the company to pursue digital adoption. Moreover, many PDO employees participated in the vision 2040 workshops; consequently, the focus group indicated that PDO must "play a role in realising the national vision", which present a driving force for digital adoption. The COVID-19 pandemic also arose in the discussion. Participants highlighted that "due to technology availability and affordability, most PDO staff were enabled to work from home". This external event (i.e. COVID-19 pandemic) was a major driver for the fast adoption of certain digital technologies. When participants were asked

about which driving force is more powerful to driver PDO digitally, they all agreed that it is a "blend of both internal and external drivers".

Following the PDO management steer to arrive at the top three drivers, I conducted a prioritisation exercise. The dialogue aimed to identify the different internal and external drivers that generate the highest value and business impact. Figure 5.1 below shows the outcome of that prioritisation exercise.
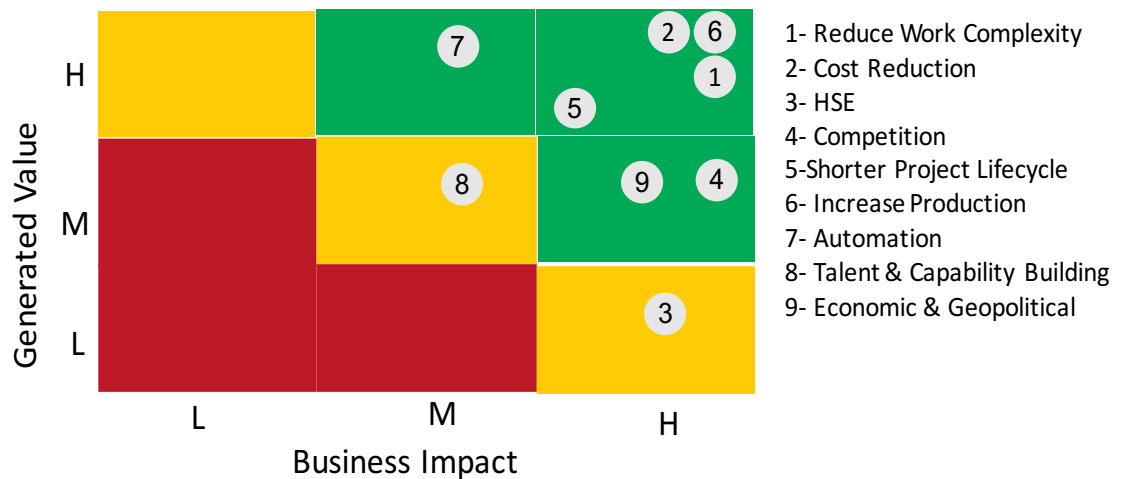
Figure 5.1. Digital Drivers Categorisation

The above figure clarifies that not all digital drivers (internal and external) were identified in the above matrix, for two reasons: Firstly, more focus was given to the drivers that generate the highest value but caused the greatest business impact. The second reason was mainly limitations of time, as people needed to go to other meetings while the discussion was not concluded. The result of the focus group discussion was shared after the

discussion with the participants, and the participants did not raise any disagreement about the final ranking.

Secondly, the top four drivers that generated the most value and created the most business disruption are increased production, cost reduction, reduction in work complexity, and shorter project lifecycles. While these drivers are given in the participants' own words, I attempted to consolidate these statements to arrive at common drivers from both focus group discussions. These drivers are, as expected, considered more important than others, as they represent the core business objectives of PDO.

Thirdly, it was noticeable that talent and capability building generates medium value and creates medium business impact. Although I expected this impact to be greater because the move to digital had just begun, this expectation could be attributed to the fact that capability acquisition and retention are costly and thus generate less overall value. Participants stated the importance of talent in statement such as "I think as part of the digital journey we must have to start competencies development to make sure that the adaptation process is supported", or "I think PDO with time is losing its attractiveness of talent or even with the retention of talent within the organisation". However, relatively speaking, talent and capability building ranks lower than other drivers, but is yet important.

5.2.2 Second Focus Group

In the second focus group discussion, participants represented eight different business units: Finance Directorate, Gas Operation, Business Planning, Technology Architecture, Data Management, DCoE, and Digital Core. In the first part of the discussion, the members identified multiple internal drivers forcing PDO to pursue the adoption of digital technologies. **Table 5.4** summarises the list of internal drivers classified by its applicability to the whole company (general) or to the business unit (specific).

N	Internal Driver	General or Specific
1	Improve data quality to aid decision making	Specific
2	Business innovation and transformation	General
3	Enhance collaboration and communication	General
4	Reduce deferments	Specific
5	Reduce downtime	Specific
6	Sustain production	Specific
7	New business frontiers	General
8	Enhance staff and asset efficiency	General
9	Enhance business processes	General
10	Reduce operating unit cost	General
11	Cost avoidance	General
12	Talent and capability building	General

Table 5.4. Internal Drivers Identified by Second Focus Group

Notably, the drivers listed in Table 4.4 are the participants own

suggestions. The above drivers are not ranked in any order, but rather by the time at which they were mentioned during the discussion. Similar to the first focus group, all participants within the second initially agreed that the drivers identified by Lammers et al. (2018); used to stimulate thinking during the focus group discussions) are applicable to PDO in general, and there are other drivers that could be specific to PDO. During this group discussion, similar drivers were identified than in the first focus group.

However, there was emphasis on new set of drivers. Firstly, unlike the first focus group, one of the identified new drivers for going digital was the "need to have a single source of truth on data". This need arises mainly because data affects all the different drivers, such as by increasing production and reducing cost. If data has quality issues, then decisions based on those data may be inaccurate. Thus, a main driver to go digital is to "improve the data quality", to consequently "improve the decision making" regarding many of the internal drivers.

The focus group discussion highlighted that "PDO has a complex subsurface" that demands use of new technologies and innovation to extract such oil and gas. As a result, two drivers were identified: the need to "sustain production and reduce deferment and downtime". Thirdly, while cost reduction was identified as a driver in both focus group discussions, in this focus group, "cost avoidance" is also identified as a potential driver of digitalisation. As with the first focus group, the participants identified

whether the driver is general or instead specific to a business unit. In addition, the second focus group highlighted an interesting point about the internal drivers. Those drivers are "personal, and different people within PDO will only state the driver that is relevant to their business unit". Some will be common; others will be specific. Furthermore, when I asked whether those internal drivers are known to all PDO employees, participants agreed that they are well articulated across the organisation. Participants also agreed that such articulation is beneficial; however, the focus might shift over time, depending on the annual set of strategic objectives.

In the second part of the discussion, the participants were asked to identify the external drivers for PDO to pursue digital technologies adoption. **Table 5.5** lists all the external drivers.

N	External Driver	General or Specific
1	Competition	General
2	Better compliance with regulation	General
3	Economic situation	General
4	Geo-political situation	General
5	Leading the digitalisation front	General
6	Reputation	General

Table 5.5. External Drivers Identified by second Focus Group

The drivers listed in Table 5.5 are the participants own suggestions. The above drivers are not ranked in any order, but rather by the time at which they were mentioned during the discussion. During the discussions of

external drivers, most of the identified external drivers were similar to those in the first focus group. However, two new drivers emerged. The first was the "amount of compliance that will be required in future" that will drive the "need to use digital technologies to monitor compliance". Examples of such technologies include the use of drones to monitor health and safety at drilling sites. The second is the need to maintain "company reputation" when it comes to using and implementing digital technologies. Although the first focus group identified this need as part of "national objective", it was interesting to see the second focus group linking this driver to "company reputation". In addition, participants highlighted the COVID-19 pandemic (as an external event) and social distancing as the new norm; consequently, participants noted a more "urgent need to fast adopt digital technologies". When participants were asked whether those external drivers are temporary or also relevant for the future, most agreed that these "external drivers will remain applicable in the future".

Following PDO management steer to identify the top drivers, I initiated a dialogue aimed to identify the different internal and external drivers that generate high value and business impact. Figure 2 below displays the outcome from that prioritisation exercise.
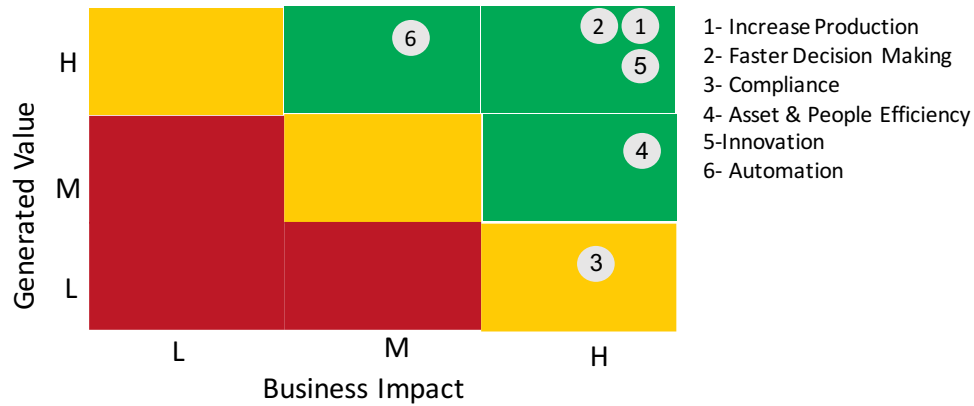
Figure 5.2. Digital Drivers Categorisation

The above figure demonstrates the following: first, similar agreement between the two focus groups on the main drivers that have high impact and that generate much value (i.e. mainly increase production and cost reduction). The second focus group viewed "innovation as disruptive but generating more value".

Secondly, PDO compliance to "increased regulation" has a high business impact but low generated value. While this result was expected, the high disruption to business is driven by PDO's prescribed conduct. Good examples of regulations include "data sovereignty" and use of "cloud services within the country" that prohibiting PDO from moving quickly to use service from cloud service providers.

Thirdly, automation has a medium business impact but high generated value. This difference could be mainly driven by the fact that PDO's business processes are highly digitised, such that automation will not have

a high business impact.

5.2.3 Consolidated Drivers

The above discussions raise multiple internal and external drivers that drive PDO to pursue the adoption of digital technologies. To consolidate drivers from both focus groups, I manually categorised the list of drivers mentioned by each focus group (based on their intent) to form new set of drivers. Then, the new set of categories was used within Nvivo to link the the drivers that were identified and placed into different categories, based on their relevance. For example, cost avoidance and reduction of operating cost are examples of cost reduction. Thus, cost reduction was placed as the primary category while the other two drivers are part of the general theme of cost reduction. **Table 5.5** consolidates the drivers from the two focus groups.

N	Title	Driver Type
1	Business innovation and transformation	Internal
1.1	Better compliance to regulation	
1.2	Changes in business expectations	
1.3	Enhance collaboration and communication	
1.4	Facilitate faster decision making	
1.5	New business frontiers (new business model)	
2	Competition	External
3	Digital shift	External
4	Economic situation	External
5	Geo-political situation	External

6	Increase production	Internal
6.1	Enhance oil recovery	
6.2	Reduce deferments	
6.3	Reduce downtime	
6.4	Sustain production	
7	Leading the digitalisation front	External
8	New technology availability and affordability	External
9	Operational excellence	Internal
9.1	Automation	
9.2	Enhance business processes	
9.3	Enhance staff and asset efficiency	
9.4	Reduce work complexity	
9.5	Short project delivery cycles	
10	Reduce cost	Internal
10.1	Cost avoidance	
10.2	Reduce operating unit cost	
11	Reduce HSE incident	Internal
11.1	Reduce people and asset exposure	
12	Regulation	External
13	Talent and capability building	Internal
13.1	Job creation	
13.2	New ways of training	
13.3	Staff retention	
13.4	Upskilling staff	

Table 5.5. Consolidated PDO Internal and External Drivers

Using Nvivo capabilities, frequency analysis of the transcripts was executed to identify the repeated mentions of the drivers in both the two focused group discussions. **Table 5.6** presents the frequency at which a particular driver was mentioned in the transcript.

The frequency check evidences four internal drivers frequently cited during the discussion: increase production, enhance business process, enhance staff and asset efficiency, talent and capability building.

While none of the above drivers come as a surprise, as studies such as Lammers et al. (2018) identified these drivers, this study provides evidence that PDO as an organisation is driven by similar set of drivers. On the other hand, a new set of drivers emerged that were specific to PDO. While a ranking of the drivers based on their business impact and generated value is valuable, the content analysis clarified the most important driver of digitalisation is competition. While competition is the only external driver, it was the most frequently cited during the focus group discussions. Its prevalence can be attributed to the fact that peer pressure (from similar organisations operating in the oil and gas sector within Oman) and the PDO's public expectation that it should be seen as leader in digitalisation.

	Focused Group 2 Transcript on digital drivers.docx	Focused Group 1 Transcript on digital drivers.docx	Totals
Business Innovation & Transformation	1	1	2
Better Compliance to regulation	1	0	1
Changes in business expectations	0	1	1
Enhance collaboration and communication	1	1	2
New Business Frontiers	1	3	4
facilitate faster Decision Making	2	1	3
Competition	0	8	8
Digital Shift	1	4	5
Economic Situation	0	1	1
Geo-political situation	0	2	2
Increase Production	2	5	7
Enhance Oil Recovery	1	1	2
Reduce Downtime	1	3	4
Sustain Production	1	0	1
reduce deferrments	1	0	1
Leading the Digitalization Front	1	5	6
New Technology Availability & Affordability	0	2	2
Operational Excellence	0	5	5
Automation	0	2	2
Enhance Business Processes	4	3	7
Enhance Staff and Asset Efficiency	3	4	7
Reduce Work Complexity	2	2	4
Short project delivery cycles	0	1	1
Reduce Cost	0	4	4
Cost Avoidance	1	0	1
Reduce operating unit cost	0	2	2
Reduce HSE incident	1	1	2
Reduce people and asset exposure	1	2	3
Regulation	0	3	3
Talent & Capaibility Building	0	7	7
Job Creation	0	1	1
New ways of training	0	1	1
Staff Retention	0	1	1
Upskilling staff	0	3	3
Totals	25	79	0

Table 5.6. Illustration of the Consolidated Drivers Analysi

5.2.4 Contribution to Action Learning

During this stage, it was important to understand the motive behind PDO's pursuit of digital transformation. Therefore, I investigated the different drivers and categorised them in an attempt to "map the terrain" for the action. While these drivers were not initially documented, they were known to the different business units experimenting with digitalisation. Even those business units that did not experiment with digital technologies attempted to identify drivers related to their business units. This series of workshops resulted not only in a documented list of drivers, but a clear motive for PDO's needs to pursue digital adoption. This contribution to knowledge was appreciated by participants of the interviews, and the list of drivers was documented and shared with PDO management during a debriefing session with them, following the completion of this stage. Thus, a clear message was delivered for why digital transformation is important for PDO.

5.3 Stage 2: Digital Readiness

5.3.1 Introduction

Following the consolidation of the digital drivers, it was evident that PDO is motivated to adopt digital technologies. The reasons were clear after the first stage of data analysis, so the analysis turned to organisational readiness for digital adoption. During this stage, I used an instrument developed by MIT Sloan (Kane et al., 2017) to assess organisational

readiness and maturity for digital technologies adoption. Although the survey was natively designed to assess maturity across multiple companies, industries, and companies, it was customised to be suitable at an organisational level. The customised survey can be found in **Appendix G**. The following sections analyse the survey results. Firstly, survey participants are analysed in terms of the demographics. Then, I discuss each of the survey's six main components: digital business and strategy, technology choices, digital maturity, resources and talent, talent retention and leadership. Each component will be analysed and discussed in detail.

5.3.2 Demographics

The MIT survey was sent to the sample identified in Chapter 3. Out of 40 staff identified as part of the sample, 32 provided their consent to participate in the different interviews and surveys. Thus, the MIT survey was sent to the 32 staff who provided their consent to participate in this research study. Of the 32 who received the survey, 21 responded. The demographic analysis indicates that the other 11 staff who did not participate were from a mix of business units, including IT. However, the participation level represents 66% of the sample who consented to participate. While the ideal mix would be all the 13 business units in addition to IT & Digitalization, participation from 10 business units affords a highly representative sample of PDO. The other three business units, which had no representation, included mainly the Oil North Directorate, Oil South Directorate, and Gas Directorate. These directorates are mainly

responsible for the operational aspect of oil and gas. While these assets did not participate in the survey, their functions Petroleum Engineering Directorate and Operation Directorate were included in the sample (where digital experimentation took place for all assets). In addition, since the purpose of the study is to develop an adoption model for digitalisation, the selected sample included those participants who were involved in digital initiatives across PDO; thus, the focus of the demographic was mainly on the perspective of the business units. The participants' demographic shows almost a 50% split between the IT and Digitalization department and the other business units. This distribution is unsurprising, as staff from the Information and Digitalization department were part of digital projects within the business. Furthermore, since its inception in 2018, the DCoE (part of Information and Digitalization department and with representation from the business units) played a major role in overseeing digital initiatives. Therefore, most of these participants are expected to be the DBLs from the business units, thus representing a good mix. **Figure 5.3** shows the different representations of the participants who responded to the survey.
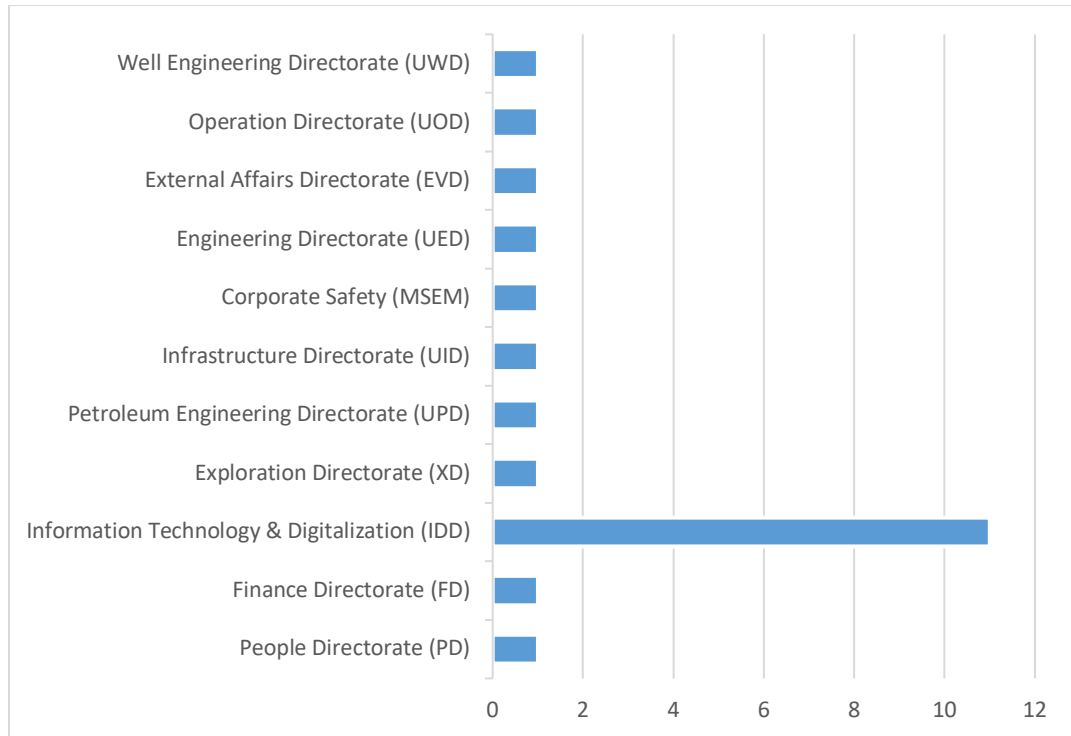
Figure 5.3. Respondents Distribution Per Business Unit

5.3.3 Digital Business & Strategy

As PDO is embarking on its digital journey, it is evident from the result that 95% of the respondents affirmed the importance of digital business to the success of the different business units within PDO. As a result, the respondents collectively emphasised the importance of digital business to the whole company. Although the importance of driving digital business is agreed among the different participants, the existence of a coherent strategy varied among the different business units, with almost 50% having and the others not having a digital strategy. This variance is predictable, as some business units started to experiment with digital technologies before others. As a result, the business units that experimented with digital

technologies had a clear strategy concerning such technologies will benefit the company. On the other hand, this experimentation reflects the lack of an overall digital strategy for PDO to guide the adoption of digital technologies within the company. While one could argue against the need for a centralised and coherent strategy, the results demonstrate two main reasons to favour a centralised approach to digitalisation:

Firstly, when participants were asked about the business unit efforts to develop the digital business, those who had experimented with digitalisation cited that PDO is either a slow adopter or laggard. This perception could be attributed to the fact that digital business must be developed beyond a silo approach. Secondly, when participants were asked how sufficient the funds allocated and resources to digital investment were, 43% stated "not enough" and 43% stated "about the right amount". This divide shows that business units who funded digital initiatives are satisfied in the investment level, while the others units are not. In addition, when participants were asked whether their respective business units were planning to invest more or less in digital business initiatives in the next 12 to 18 months, the participants did not provide a conclusive answer (23% stated "more", 23% stated "the same", and 23% stated "less"). This lack of consensus could be attributed to the current circumstances surrounding the oil and gas industry as a result of COVID-19's impact on oil demand. Hence, there is uncertainty regarding how digital investments will be managed. Nevertheless, the existence of a clear and coherent digital strategy can be

expected to help dispel such doubts.

Based on the above analysis, a spider diagram was created from the survey responses, based on the applied Likert scale (see **Figure 5.4**). While the different business units within PDO understand the importance of digitalisation, a coherent strategy is lacking.
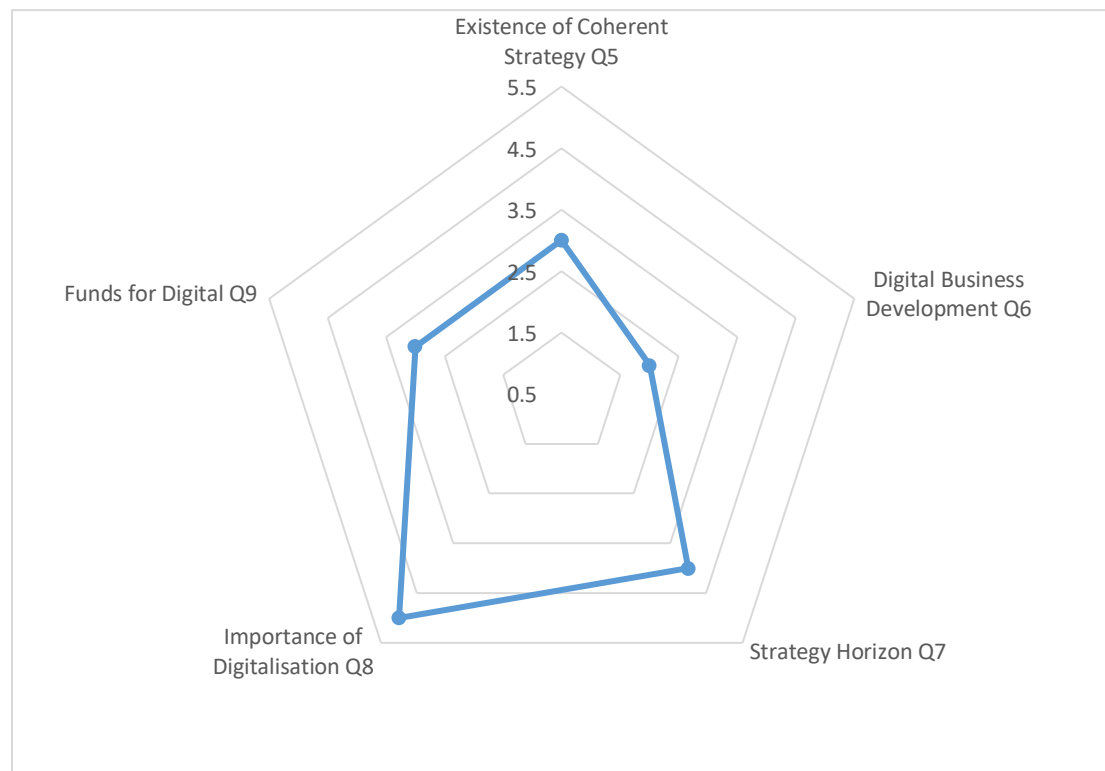
Figure 5.4. PDO Maturity on Digital Business & Strategy Dimension

Furthermore, when the analysis of the multiple-choice questions as part of this dimension revealed the following findings:

Firstly, the business units that experimented with digital technologies characterised the outcome of digital business initiatives as successful.

While the survey does not allow a definition of the success of the digital initiative, it is safe to assume that the digital initiatives achieved their objectives and, as a result, provided value to the respective business unit.

Secondly, when participants were asked how their respective business unit drives its digital business adoption and engagement internally, 62% responded that it is mandated by management. The literature suggests that this response can be explained by a power culture within PDO, as described by Handy's cultural typologies. This culture radiates from the centre and represents centralised decision making, where few managers have ultimate decision-making power. This authoritarian organisational culture awaits direction from the top to respond to key disruptions, including technological ones such as digital transformation. However, because of lack of a clear, coherent, and documented digital strategy, management steers all decisions related to digital needs, which could explain the organisational tendency to expect direction from the top. On the other hand, this response also shows the need for strong digital leadership to drive such digital adoption. This supposition was further supported by participants who were asked which of the top factors contributed to the success of digital initiatives: leadership was the top-cited factor. The second factor is strategy and vision, while the third is investment and commitment. Hence, participants associated the success of the digital initiative with the existence of the business unit strategy.

5.3.4 Technology Choices

In Chapter 2, the definition of "digital" and its association with five different technologies resulted in framing what one could describe as the "digital technologies": social media and collaborative technologies, mobile technologies, data and analytics, cloud computing services, and artificial intelligence and robotics. The MIT survey asked participants to rank the digital technologies likely to impact their respective business unit in the current year and in three to five years' time. Surprisingly, 71% of respondents stated that analytics, mobile, and robotic process automation (RPA; where business processes are automated through the use of a software robot) were the technologies important to the business in 2020 and would be in three to five years as well. Although this response was unexpected, it can be attributed to multiple factors:

Firstly, a review of the business drivers identified in Stage 1 of the research reveals that their majority relates to business optimisation. Drivers such as increase production, enhance business processes, enhance staff and asset efficiency, and talent and capability building are all business improvements that can be achieved through digital technologies such as those identified as part of the survey. The use of digital technologies in these three areas were experimented with at PDO, and as a result, business units who experimented with them had witnessed the success of the experiments, as indicated in the survey results. This opportunity for observation could explain the selection of these technologies.

Secondly, the fact that majority of respondents quoted the same technologies for this year and the next 3-5 years can be attributed to two factors:

a. Analytics, mobile, and RPA technologies had already been experimented with at PDO. Due to the uncertainty caused by the COVID-19 pandemic, the decline in demand of oil, and the associated impact on oil prices, investment in new technologies became unlikely. Hence, respondents preferred to conserve their working technologies.

b. Based on the analysis I did as part of Stage 4 of the research, new technologies are used for longer periods of time. For example, PDO used Windows 7 for more than 10 years. Thus, I contend that the respondents selected the same technologies for these years and 3-5 years based on organisation's history of technology adoption.

5.3.5 Digital Readiness

Although the main objective of utilising the MIT survey was to assess the readiness and maturity of PDO to adopt digital technology, the survey covered multiple dimensions in addition to maturity. When assessing digital maturity, this particular dimension has seven questions measured on a 5-point Likert scale and one that is multiple choice. The survey outcome demonstrates some strength and weaknesses in PDO's overall readiness for digitalisation. On the positive side, 60% of respondents stated that digital initiatives that were experimented within the different business units were

successful, while 40% stated it is neither successful nor unsuccessful. This result was expected, as some business units had not yet experimented with the digital technologies.

Furthermore, 60% of respondents agreed that their respective business unit accepts risk of failure as a natural part of experimenting with new initiatives. This affirmation provides evidence that risk taking mentality is part of the organisational culture of PDO with respect to the adoption of digital technology. Reflecting on the literature, it is important to articulate the reason for such risk tolerance. Although PDO is 60% owned by the government, one would expect it to be risk averse (Bozeman & Kingsley, 1998). However, the fact that PDO operates as a private company may explain its culture of risk taking and, thus, why a government majority company such as PDO has high risk tolerance as compared to other public companies, which are often associated with risk aversion (Bozeman & Kingsley, 1998).

This ability to tolerate risk is considered crucial for the success of digital initiatives (Kane, et al., 2017). Thus, certain business units may be willing to accept risk of failure during experimentation with new initiatives, and as such, they are more mature. By contrast, the risk tolerance will improve as more business units experiment with digital technologies and accept a "fail fast" mode of working. Because the survey was conducted across PDO with multiple business units participating, 60% of respondents indicated

approval of risk tolerance for digital adoption. On the other hand, when respondents were asked whether the business units are actively implementing initiatives to increase their agility in response to rapidly changing markets, 62% of the respondents stated their business is becoming agile as a result. This consensus indicates that the successful experimentation of digital technologies leads the business units who experimented with digitalisation to be risk tolerant and agile in their approach to digital technology adoption. In addition, 60% of respondents indicated that their business units value and encourage experimentation and testing as a means of continuous organisational learning.

Although PDO thus seems ready for digital adoption in certain respects, in others PDO's maturity remains low and requires improvement. When respondents were asked about the starting point of digital initiatives, 90% respondents stated that their business unit tends to start small when implementing digital business initiatives. This approach indicates less maturity, according to Kane et al. (2017), as mature companies tend to carry digitalisation initiatives across the company and take a broad approach rather than a piecemeal one. Furthermore, 62% of respondents indicated that digital initiatives support certain business objectives, but they are not a core part of the business unit strategy. This response also indicates that PDO is not yet a mature organisation in that respect, since in mature organisations, digital initiatives are a core part of the company strategy (Kane, et al., 2017). In order for such maturing to occurring, there

is a need for a coherent strategy. In addition, Section 5.3.3 demonstrates that the business units that reported success in digital initiatives had a clear strategy. This is also evident in the 33% of respondents who stated that digital initiatives are a core part of their business unit strategy, which can be attributed to the business units who experimented successfully with digital technologies and, consequently embedded digitalisation as part of the business unit strategy. The majority recognise the value of digitalisation, but not as a core part of the organisation strategy, indicating a lower maturity. This relative lack of maturity was also evident when respondents were asked to imagine the ideal digital organisation and to indicate how close the respondents' business units are to that ideal; 90% of business units scored between 4 to 5 out of 10, pointing to low maturity. **Figure 5.5** summarises the digital maturity of PDO.
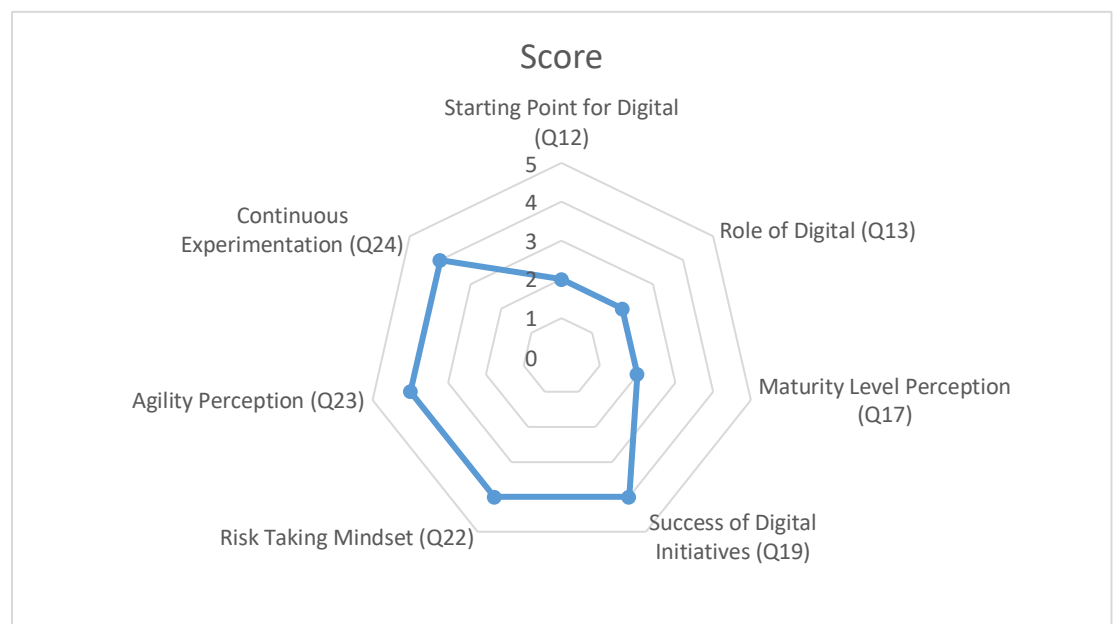
Figure 5.5. PDO Digital Maturity & Readiness Level

5.3.6 Resources & Talent

The fourth dimension in the MIT survey covers the resources and investment needed for digital transformation, which has two main parts. The first part relates to organisational practices and collaboration. When participants were asked whether their business unit management structure and practices interfere with their ability to engage successfully in digital business, almost 60% of the respondents agreed. This agreement makes evident that business units who experimented with digitalisation found the current organisational structure practices unsuitable for digital transformation. This perception could explain why digital experimentation was successful but had not yet been scaled across the organisation. On the other hand, when participants were asked whether the collaboration across teams and divisions was recognised and rewarded as part of the organisational culture and operating model, 52% confirmed such practices.

In addition, 86% of participants confirmed the use of emails and face-to-face meetings as means to collaborate with each other regularly. Furthermore, 52% of participants confirmed that their Business Unit is increasingly organised around cross-functional project teams to implement digital business priorities. Arguably, if collaboration is part of the organisational culture, and if participants had confirmed that they are organised in cross-functional teams already, then organisational practices

may not matter. According to Warner and Wäger (2019), redesigning internal structures is an important part of digital transformation capabilities. Therefore, it is not only critical to collaborate across teams but also to modify existing organisational structure practices, as participants confirmed. However, such need for organisational structure can be drawn from neither this assessment nor from the digital capabilities assessment, as there is little evidence to suggest the need for restructuring within PDO.

The second part relates to talents required for digital transformation. When participants were asked whether their business unit has sufficient talent today to support PDO's digital business strategy, 62% indicated not. On the other hand, 86% of participants stated that they will develop and train existing employees to acquire sufficient talent and to support the organisation's digital business strategy, as opposed to 71% who stated they would hire contractors and consultants. When the participants were asked how their business unit is implementing initiatives to develop such talents to succeed in a digital business environment, 95% stated that they will do that through a company-driven program, while 76% stated that cross-fertilisation between different business units and learning through experience will address this gap.

While this internal pride was also evident during the digital drivers focus groups Discussions (in which internal talent development was highlighted

as one of the main elements to support PDO as a leader in digitalisation within the country), the development of internal company programs at PDO was also in line with the results from Kane et al.'s (2017) study. On the other hand, when participants were asked about whether the business units utilise the digital knowledge, skills, interest, and experience held by their employees, 38% agreed while 38% were indecisive. This low response rate could be attributed to the low digital maturity of the organisation on digitalisation, and as a result, the skills available within the organisation are not yet up to the level where they can be utilised. This immaturity is also evident in a comparison of the results from Kane et al.'s (2017) study. Organisations that are digitally mature tend to effectively utilise the digital knowledge, skills, interest, and experience of their employees and, as a result, scored higher in this particular measurement.

Participants were also asked about the type of skills, abilities, or traits required within the business unit to compete in digital business, 76% of respondents stated that analytics skills are a top priority, compared to 57% of participants who chose technical skills, while creativity and innovativeness skills and critical thinking and problem solving were rated as less important, with only 52% of participants identifying them as a top priority. Although the results are very much in line with those of Kane et al. (2017), where both technical and analytics skills are most in-demand, Kane et al.'s (2017) study placed technical skills as more desirable than analytical ones. Furthermore, since majority of the digital experimentation

within PDO is based on analytics, analytics and technical skills are more in-demand to compete in digital business, as expected.

Finally, when participants were asked whether the geographic location(s) of the business unit frustrates their ability to acquire sufficient digital talent to accomplish the digital business initiatives, 57% of the participants disagreed. This disagreement is also complemented by the fact that participants agreed they would collaborate across teams and divisions and work with cross functional teams regardless of the location. Unlike the study findings by Kane et al. (2017) where geographical locations matter for talent acquisition, my study suggests geographic locations do not hinder digital talent acquisition.

The findings largely align with those of Kane et al. (2017); however, the lack of organisational structure was surprising. This lack of structure was expected to feature in the results, yet there was no evidence to suggest the need for it. The initial assumption was that since PDO is digitally immature, there is a need for new organisational structure to enable the transition and the execution of digital projects. **Figure 5.6** illustrates PDO's level of maturity regarding the resources and talents required for digital.
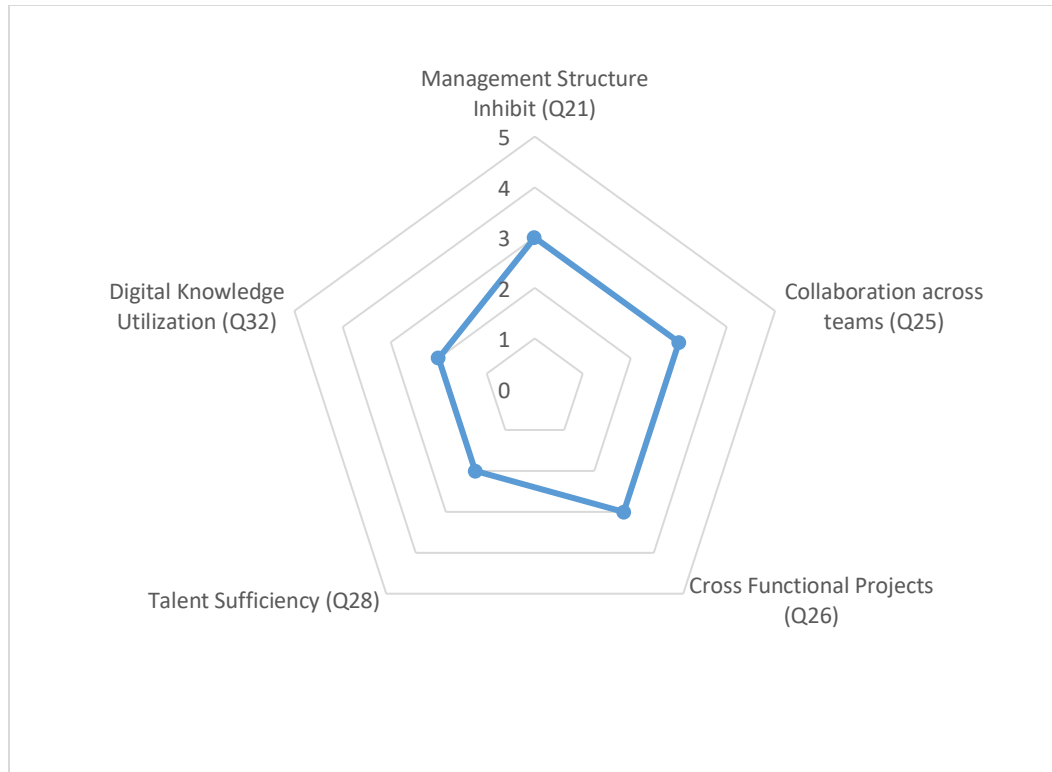
Figure 5.6. Talent and Resources Maturity

5.3.7 Talent Retention

The fifth dimension in the MIT survey covers the impact of introducing digital technologies to current talent and whether existing talent can be retained. It is needless to say that digital technologies and fourth-industrial-revolutions technologies will impact talents. Thus, a number of studies have been conducted by consultancy companies such as Delloitte and McKinsey or international organisations such as the World Economic Forum and Organisation for Economic Development on the talent needed for the future and what the future of work will look like. Therefore, it is important to explore how PDO is preparing for this dimension and how relevant it is to the company's talents.

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When participants were asked whether they expect their job to change considerably over the next three to five years as a result of digital business trends, 67% agreed, compared to 33% who disagreed. Such conviction is also in line with the study conducted by Kane et al. (2017) in which 76% agreed that their job will be impacted with digital technologies. On the other hand, when participants were asked whether digital business trends impacting PDO will significantly affect their decision of how long to work at PDO, 52% stated no impact, while 38% stated the possibility of an impact. Arguably, the higher percentage stating no impact was due mainly to the low digital maturity of PDO, as the study by Kane et al. (2017) shows only 22% of participants stating no impact of digital technologies on their jobs.

Although 67% of participants stated that digital trends will likely impact their jobs in the next three to five years, only 57% of participants indicated that they plan to work for PDO for more than three years, given the digital business trends. This trend can be attributed to the fact that PDO has a strong job security; participants tend to prefer to stay in a company with strong job security. More than 90% of participants stated that they are actively engaged at work, enthusiastic about the work they do, committed to growing their skills, and dedicated to helping their business unit and colleagues to succeed. This commitment was also evident from the previous section on how staff are collaborating in cross functional teams. Furthermore, 33% of participants stated that they tend to take on projects or assignments that leverage their existing strengths. This reflects the

willingness to learn new skills, but the low response rate could be attributed to the fact that not all business units experimented with digital technologies; thus, the need to change and take new assignments has not yet been felt. Kane et al.'s (2017) study confirms that employees who participate in such digital experimentation are more likely to be retained. This finding is also confirmed by the fact that more than 85% of the participants stated that it is important for them to work for an organisation that is a digital business leader. This desire among participants seems to be a driver of PDO's pursuit of digital leadership, and it was also one of the drivers identified in the first stage of the study. **Figure 5.7** displays the overall readiness for the talent retention dimension.

While the initial assumptions for talent retention were expected to present a high percentage of participants confirming that digitalisation shifts their jobs since the impact is felt globally, it was a surprising finding that such impact was not acknowledged by the participants.
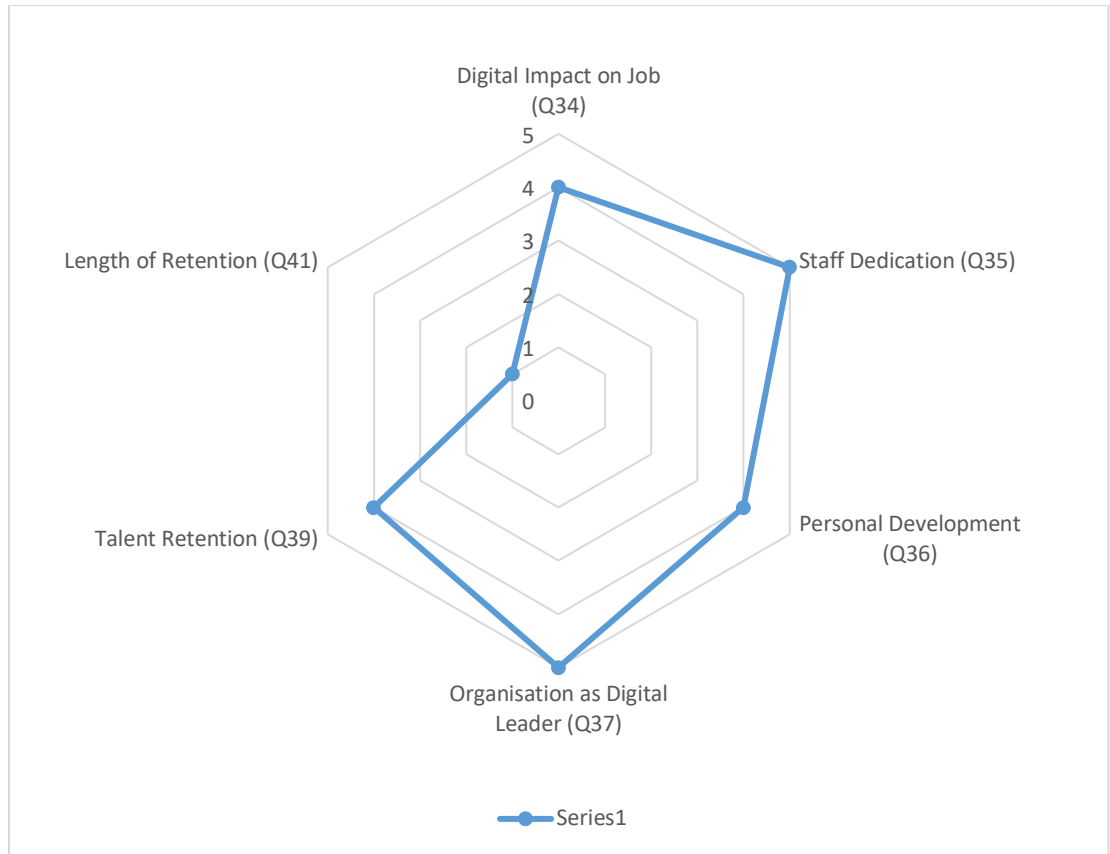
Figure 5.7. Talent Retention Maturity

5.3.8 Leadership

The MIT survey included a section on leadership readiness for digitalisation. It is not very detailed, and only four questions relate to leadership, but leadership is crucial to organisational readiness for digital adoption. According to Kane et al. (2017) digital transformation requires "considerable support" from leadership. Thus, it is important to assess this dimension and the readiness of PDO leadership to lead the adoption of digitalisation within the company.

When participants were asked whether PDO leaders have the vision necessary to lead digital business efforts, 62% of participants agreed. This response suggests strong confidence in leadership; however, when participants were asked which leadership attributes leaders need more of to drive digital business transformation, 71% stated an experimentation mindset and 67% stated a risk-taking attitude. These responses indicate that while participants believe in the current leadership's ability to drive digitalisation, they expect them to also have these two leadership attributes. This finding aligns with those of Kane et al. (2017), in whose study these two traits also ranked at the top.

In addition, when participants were asked how their business units develop leaders to lead in a digital business environment, 67% agreed that it should be done via coaching of existing leaders. While this finding suggests that the participants do not see a change on leadership as necessary and that they trust the existing leadership, participants believe that in order to achieve digital maturity, there is a need to capitalise on existing talents and provide coaching to support them. On the other hand, 55% of participants stated the lack of strategic direction is among the most substantive mistakes managers make with respect to digital business. This finding supports the previous findings (5.3.3) regarding the need for a clear and cohesive digital strategy for PDO.

5.3.9 Contribution to Action Learning

At this stage of the research, the five dimensions of digital maturity provide a clear picture of the gaps that PDO needs to close prior to adopting digital technology such as lack of coherent digital strategy, underutilised internal resources and its low readiness. Although these gaps vary from one dimension to another, the main assumption here is that PDO will need to close all of them to ready itself. However, this assumption is implausible; thus, the priority to identify which gaps to close is vital. This need was discussed during a debriefing session with PDO management, the focus of which was mainly on developing a PDO-wide strategy while accelerating current digital initiatives by elaborating existing resources.

By contrast, the result of the readiness assessment is the average score of all business units. Thus, not every business unit is as mature as the next. In order to resolve this incongruity, the proposed action was to start with the creation of a company-wide PDO digital strategy. The need for company-wide PDO strategy is evident from the results of the different dimensions as the main priority to close. In addition, one of the top drivers of digitalisation is innovation, and the basic ingredient of the innovation is to determine what and where to innovate; hence, a digital strategy is key. While this analysis came somewhat late, as PDO engaged an external consultant to develop the digital strategy, I believe that the insight captured from this stage could be used by the external consultant to further enhance digital ambition. This is mainly due to the fact that the external

consultant focussed on a particular oil field and did not cover fully the five dimensions identified in the readiness survey.

5.4 Stage 3: Digital Capabilities

5.4.1 Introduction

In the previous stage, and based on the survey results, PDO (as an organisation) demonstrated low maturity in the digital assessment. As a result, there were multiple capabilities identified as gaps for digital adoption to take place. Some of those capabilities relate to technical skills while others relate to leadership skills. To enable digital adoption, organisations require certain abilities to deliver such outcomes or values. These abilities are often referred to as business capabilities (Beimborn et al., 2005). Warner and Wäger (2019) have stated that for organisations to adopt digital technologies, they require external triggers and three types of capabilities: sensing, seizing, and transforming. Although Lammers et al. (2018) refer to those triggers as internal and external drivers for digital adoption, they were mostly investigated in the first stage and consolidated in Section 4.2. These triggers will drive certain capabilities to enable digital adoption. Since these three group of capabilities include a number of sub-capabilities, it was vital to investigate their relevance to each business unit in PDO. A data collection instrument was thus designed, based on Warner and Wäger's (2019) capabilities, in which the relevance of each sub-

capability and its importance were investigated. The survey was designed to use a 5-point Likert scale to identify the level of relevance and importance for each sub-capability (**Appendix H** illustrate the survey). **Table 5.7** illustrates the three capabilities, along with their associated sub-capabilities.

Main Capability	Sub-Capability
Sensing Capabilities	• Continuous scanning for technological trends
	• Screening of digital competitors
	• Sensing customer-centric trends
	• Analysing scouted signals
	• Interpreting digital future scenarios
	• Formulating digital strategies
	• Establishing a long-term digital vision
	• Enabling an entrepreneurial mindset
	• Promoting a digital mindset
Seizing Capabilities	• Creating minimum viable products
	• Considering a lean start-up methodology
	• Using a digital innovation lab
	• Balancing internal and external options
	• Scaling up innovative business models
	• Setting an appropriate speed of execution
	• Rapidly reallocating resources
	• Accepting redirection and change
	• Pacing strategic response
Transforming Capabilities	• Joining a digital ecosystem
	• Interacting with multiple external partners
	• Exploiting new eco-system capabilities
	• Hiring an experienced digital transformation expert
	• Digitalisation of business models
	• Designing team-based structures
	• Identifying digital workforce maturity
	• External recruiting of digital natives
	• Leveraging digital knowledge inside the organisation

Table 5.7. Digital Capabilities and Sub-Capabilities (Warner & Wäger, 2019)

The survey was sent to all participants who consented to participate in this research study (Total of 32). Out of the 32, 18 responded to this survey. Although this represents over 50% of the total population, the sample presented nine out of the 13 business units within PDO. Thus, participants who responded to the survey provided a wide representation between the IT organisation and business units. While this low rate of participation could be attributed to the time at which the survey was administered during the month of Ramadan, the participants split between IT and business at almost 50% each. **Figure 5.8** shows the survey participants distribution per business unit. In the following sections, I detail the survey findings and analysis of those findings.
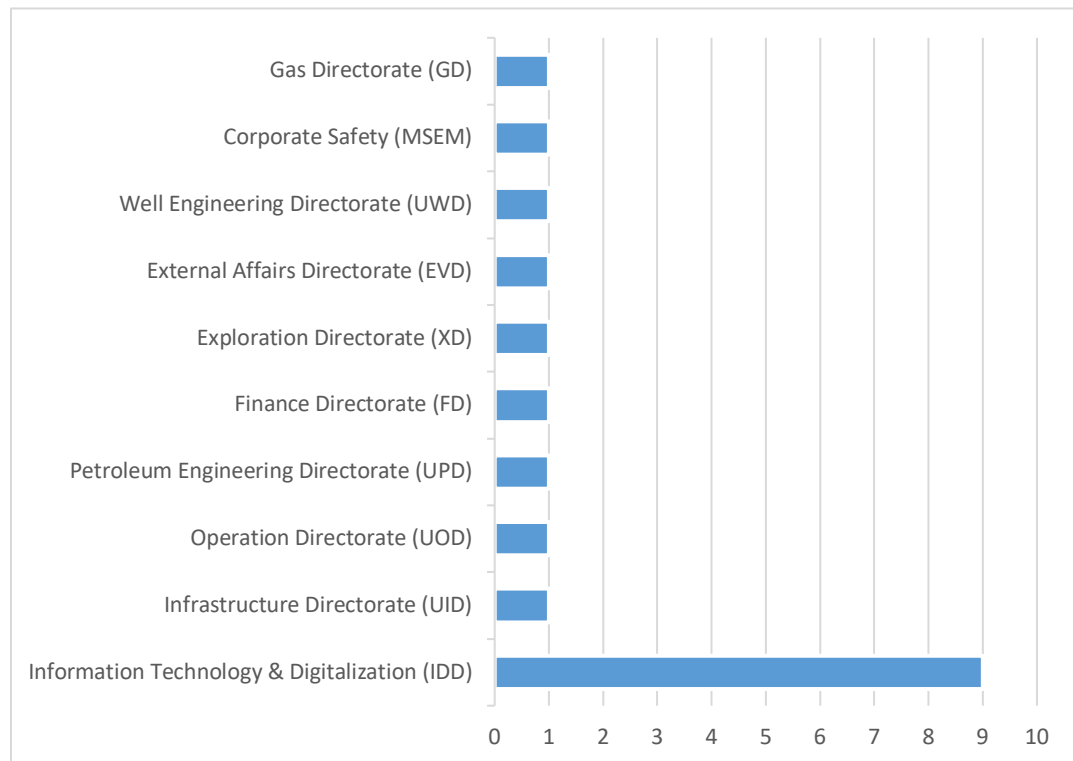
Figure 5.8. Participants Distribution Per Business Unit

5.4.2 Sensing Capabilities

As illustrated in Table 5.7, there are nine different sub-capabilities under the sensing capability. Based on the results, the respondents agreed in general that all of these sub-capabilities are relevant and important for enabling digital transformation. However, respondents varied in their perspectives on how strongly relevant or important the sub-capabilities were. The top sub-capability in terms of its relevance is establishing a long-term digital vision: 100% of respondents agreed upon its relevance and importance to their respective business units. Out of the 100%, 72% strongly emphasised the relevance of this capability to their business units. In addition, 100% of the respondents stated that this capability is important to the success of digital initiatives within their business unit, where 78% of them strongly emphasised its importance. Furthermore, 100% of respondents stated that formulating digital strategies is relevant and important for their business units, where more than 72% strongly emphasised the relevance and importance of this capability. This finding comes as no surprise, since having clear and coherent strategy was among the main findings of the previous stages of this research. This convergence provides clear evidence of the importance of establishing a clear digital vision and strategy, a key conclusion from the maturity assessment findings.

On the other hand, only 56% of respondents thought that screening of digital

competitors is relevant, and 67% thought it is important. In addition, 11% respondents strongly believed that analysing scouted market signals is relevant, and 6% strongly believed it is important to their respective business units. This result could be attributed to the fact that PDO does not yet see itself in competition in the digital space. This perception is due to its lower maturity in digital capabilities. Thus, screening digital competitors and analysing scouted signals might not yet be a top priority. While this finding was unexpected, given that competition was rated a most important driver of digitalisation, and the difference could be attributed to participants' interpretations of competition. Fearing competition (as a driver) is different than analysing and screening competition (as a capability).

Table 5.8 lists the sensing sub-capabilities and the percentage of respondents who strongly believe they are relevant and important.

Sub-Capability	Strongly Relevant	Strongly Important
• **Continuous scanning for technological trends**	61%	61%
· **Screening of digital competitors**	11%	17%
· **Sensing customer-centric trends**	50%	50%
· **Analysing scouted signals**	11%	6%
· **Interpreting digital future scenarios**	61%	61%

·	Formulating digital strategies	67%	78%
·	Establishing a long-term digital vision	72%	78%
·	Enabling an entrepreneurial mindset	39%	50%
·	Promoting a digital mindset	67%	78%

Table 5.8. Percentage of Respondents Who Strongly Believe Relevance and Importance of Digital Sensing Capabilities

5.4.3 Seizing Capabilities

Evidently, having a clear vision and strategy will enable the right level of sensing capabilities to enable digital transformation. In order to seize the digital initiatives, there are nine sub-capabilities identified by Warner and Wäger (2019). Similar to the sensing capabilities, the respondents in general believe that these capabilities are relevant and important to the success of the digital business within PDO. However, responses vary regarding the strength of belief in the relevance and importance of these capabilities. For instance, while 100% of respondents stated the relevance and importance of scaling up innovative business models, 50% emphasised their strong belief in its relevance, and 61% expressed the belief that it is crucial. In addition, 50% strongly stated the relevance of setting an appropriate schedule, and 55% strongly emphasised its importance. This is also unsurprising, as most of the digital initiatives within PDO struggle with scaling and speed of execution. This difficulty could also be attributed to

the low digital maturity of the organisation and the lack of adequate resourcing.

On the other hand, having and using a digital innovation lab does not seem an urgent need, currently, as 22% of respondents strongly believed it relevant to PDO, while only 28% that it is important. This result could be attributed to the fact that PDO remains in the early stages of digital maturity, and thus the use of digital innovation labs is not currently a priority. Compared to sensing capabilities, seizing capabilities received a lower percentage of respondents indicating strong relevance and importance. This difference could also be attributed to the fact that the respondents view sensing capabilities as prior to seizing and transforming capabilities.

Table 5.9 lists the seizing sub-capabilities and the percentage of respondents who strongly believed it is relevant and important.

Sub-Capability	Strongly Relevant	Strongly Important
• **Creating minimum viable products**	39%	28%
• **Considering a lean start-up methodology**	16%	33%

• **Using a digital innovation lab**	22%	28%
• **Balancing internal and external options**	33%	39%
• **Scaling up innovative business models**	50%	61%
• **Setting an appropriate speed of execution**	50%	56%
• **Rapidly reallocating resources**	33%	33%
• **Accepting redirection and change**	50%	50%
• **Pacing strategic response**	28%	39%

Table 5.9. Percentage of Respondents Who Strongly Affirmed Relevance and Importance of Digital Seizing Capabilities

5.4.4 Transforming Capabilities

We previously explored two groups of capabilities: sensing and seizing. Transforming capabilities relate to changing a business's operations and model (Warner & Wäger, 2019). Since these capabilities are important in improving the digital maturity (Warner & Wäger, 2019), it was essential to explore how the different participants view and value these capabilities.

Seventy-two percent of respondents strongly believed that leveraging digital knowledge inside the organisation is relevant, and 83% strongly believed it is important. During the maturity assessment stage, respondents

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cited that due to the low digital maturity of the organisation, utilising digital knowledge within PDO is low. Therefore, this strong belief in the need to leverage digital knowledge clearly indicates for PDO to transform digitally, it must leverage such internal knowledge. In addition, 39% of respondents cited the relevance and importance of external recruiting of digital natives to support the organisation's digital transformation. Hence, the respondents strongly believed that in order for PDO to transform digitally, the knowledge should come within. However, how this knowledge should be gained was also evident in the survey. Ninety-four percent of the respondents indicated a need to interact with multiple external partners to gain insight into what other companies are doing with digitalisation. In addition, more than 72% of respondents did not discount the need to hire an experienced digital transformation expert to help with digital transformational efforts. These transformational efforts include digitalisation of business models whereby 100% of respondents agree upon the relevance and importance of thinking beyond the current business model. **Table 5.10** summarises the percentage of respondents who strongly believed in the relevance and importance of transforming capabilities.

Sub-Capability	Strongly Relevant	Strongly Important
• **Joining a digital ecosystem**	39%	44%

• **Interacting with multiple external partners**	22%	39%
• **Exploiting new eco-system capabilities**	44%	55%
• **Hiring an experienced digital transformation expert**	17%	22%
• **Digitalisation of business models**	44%	44%
• **Designing team-based structures**	28%	28%
• **Identifying digital workforce maturity**	6%	22%
• **External recruiting of digital natives**	11%	11%
• **Leveraging digital knowledge inside the organisation**	72%	83%

Table 5.10. Percentage of Respondents Who Affirmed Relevance and Importance of Digital Transforming Capabilities Strongly

5.4.5 Contribution to Action Learning

Following this analysis stage, a debriefing session was conducted with PDO management to reflect on the different capabilities needed for digitalisation. Due to PDO's low digital maturity, it was evident that the focus on digital capabilities and sub-capabilities varied among different business units. As the journey to digitalisation was in its infancy stages, PDO management recommended a focus on digital sensing capabilities. Internal resources and internal organisation knowledge are seen as key pillars to drive digital transformation. Therefore, the adoption model includes such capabilities.

Should the adoption model be created from scratch, or can it be evolved based on current best practices? The next section evaluates previous technology adoption projects to reveal potential elements that could support PDO quest for digital adoption.

5.5 Stage 4: Previous Projects Analysis

5.5.1 Introduction

In the previous stages, the drivers that made PDO pursue digital technologies adoption were examined, consolidated, and documented. Those drivers were later used to gain insight into the company's readiness assessment, which identified key gaps in priorities for strategy and resources, among other gaps. The capability gap was further investigated using the survey based on Warner and Wäger (2019) regarding what PDO must focus on to build its digital capabilities. The main objective of this section is to identify and assess previous technology projects completed within PDO, with the aim of deriving key themes to inform the adoption model. This investigation was to assess whether DOI was used when adopting these technologies.

The starting point was to identify the technology projects implemented in the previous 10 years within PDO. The timeframe was limited to 10 years to ensure that records would be readily available and not archived, to speed up the inquiry. Over 50 projects were initially identified. However, investigating the lessons from 50 projects is a highly intensive task. Thus,

the number was further limited through a set of criteria. Since this study is focussed on building an adoption model for digital technologies, it is important to identify the projects based on certain characteristics: projects that impact a wider audience (the whole company), projects that introduce new ways of working resulting from technology adoption, and projects that use change management.

Based on the above characteristics, four main projects were identified. **Table 5.11** illustrates the different projects selected as part of this stage, with a description of the project and its importance and complexity.

Technology	Description	Implementation Duration	Main Usage of Technology	Importance	Complexity	Impact	Completion Year
High-Performance Computing (CIDIS)	Introducing server-based computing and storage technologies for processing seismic data to speed up the exploration processes	2 years	Time liberation	Reduced the interpretation process from 9 months to 6 months	Medium level	Improved the exploration timeline	2015
Skype for Business Implementation	Introducing Microsoft Skype for business tool to enable better collaboration	1.5 years	Collaboration	Provided means for employee to communicate and collaborate with each other	Medium level of complexity and integration	Improved communication and collaboration	2018
Windows 7	Introducing Windows 7 as the main platform for user community	3 years	Productivity	Enhanced employee productivity and provided enhanced access to	Medium with application compatibility being the main challenge	Enhanced Employee productivity	2010

				company resources			
Windows 10	Introducing Windows 10 as the main platform for user community	3 years	Productivity	Enhanced employee productivity and provided enhanced access to company resources	Medium with application compatibility being the main challenge	Enhanced Employee productivity	To be completed by 2022

Table 5.11. List of Technology Projects Implemented in PDO in the Last 10 Years

To investigate the projects listed in the above table, it was important to establish a basis for the analysis. Based on the DOI theory, five main variables determine the rate of adoption of innovations: the perceived attributes of innovations, type of innovation-decision, the communication channels, the nature of the social system, and the extent of change agents (Rogers, 2003). Based on these dimensions, a structured interview questionnaire was created and linked to each of the DOI dimensions (**Appendix I** illustrated the structured interview questions). The interviewees were selected based on their roles in these projects. These roles primarily include project manager, change manager, and technical project lead, all of which are part of the Information & Digitalization Department. Prior to their engagement, interviewees were asked to sign a consent form. **Table 5.12** lists the various projects, the people interviewed, and their roles.

Two types of analysis were executed during this stage. The first analysis concerned the interviewee responses to each of the structured questions

asked within the interview. The questions were based on the DOI parameters. The analysis was completed in Nvivo, with coding based on answers to each question. I selected this approach to identify any key themes from these interviews. The second analysis was to review secondary data such as project files, key project learnings, project minutes of meetings, and so on. The key objective of the analysis was to identify whether any specific themes could be derived. I completed the review by reading those materials and highlighting key findings.

The following sections examine the main findings from each of these projects. During the research design, the investigation of previous projects to capture learnings related to digital aspects were not considered, as digitalisation was viewed as new form of innovation. However, since I wanted to investigate the methodology used for digital adoption, I deferred this stage until the end of the study. Completing this stage early could have influenced the direction and the results obtained regarding the existing models, rather than exploring potential elements that were not present in history, potentially compromising the research objective.

Previous Project Technology	# Interview Conducted	Roles of Interviewees	Secondary Data Collected
Windows 7	2	Project Manager, Applications Rollout Manager	Yes
Windows 10	2	Project Manager, Change Manager	Yes

High-Performance Computing (CIDIS)	3	Project Manager, Technical Project Lead, Technical Support	Yes
Skype for Business	2	Project Manager, Technical Project Lead	Yes

Table 5.12. Description of the Interviewees

5.5.2 Windows 7

Following the review of secondary data, this project was initiated in response to the technological obsolescence of the Windows 2000 operating system. The drivers of this change were mainly to address the obsolescence, introducing new features to enable better collaboration. The project rollout occurred across PDO and impacted each individual working for the company. The review of the secondary data highlighted important ingredients to the success of the project. The obvious three points were the selection of team members, the structure of the project team, and the change management practices. The analysis of the interviews and a review of secondary data produces the main findings:

Firstly, although Windows 7 was introduced in response to the obsolete Windows 2000, according to the interviewees "the adoption rate of the new features was reaching 40-50%". This rate of adoption was mainly attributed to the change on the way the users needed to use the new features brought as part of this project. It is evident from the interviews and project data that users were "overwhelmed with the number of features within Windows 7". The rate at which these features were introduced explains why the rate

of adoption was modest. On the other hand, when interviewees were asked when these adoption rates were measured, their response was, "immediately measured after or within a short period of the project completion". This timeframe could explain the low adoption rate, as years passed before 100% adoption.

Secondly, it was evident from the interviews and secondary data analysis that this project used strong change management practices. Following the review of the secondary data, multiple communication channels were established, along with different types of onboarding activities for the users. The interviews confirmed this variation and the application rollout manager described it by stating that change management "included but not limited to the use of change agents, trial hubs, workshops, flyers and banners". Broad change management practices were among the reasons for the success of the project.

Thirdly, the clarity of the governance structure within the project enabled faster decisions, resulting in requests being addressed immediately. This was evidenced by the number of change requests (secondary data) within the project and how they obtained their steer. This governance structure helped in "speeding up the rollout of the Windows 7", according to the project manager, and as a result contributed to the 40-50% adoption rate.

Fourthly, on the topic of technology complexity, in the interviews it was evident that technology complexity varied among users. Users accustomed

to Windows 7 in their homes adopted the technology faster than did those who were not exposed. Although the project team introduce a trial hub for users to experiment with the new technology, it was time bound; consequently users might not have the same level of exposure as those who were using Windows 7 daily. Furthermore, older staff had more difficulty adopting the technology, while younger staff adopted it faster.

5.5.3 Skype for Business

One of the new technologies introduced as part of Windows 7 is a collaborative technology called Microsoft Office Communicator, which allows staff to chat and connect with each other. As this technology was reaching the end of its life, Skype for Business was considered to be its replacement. Following the review of the secondary data, and similar to Windows 7, the adoption of Skype for Business was triggered by technological obsolescence, and its rollout was also done across PDO. Following the analysis of the interviews and the review of secondary data, the following are the main findings:

Firstly, one of the challenges faced during the rollout of this technology regarded user adoption. According to the project manager, "strong change management practices" were employed to educate the user community, enabling faster adoption. According to the project technical lead, users were exposed to the technology "one month prior to actual installation" to enable faster adoption. Thus, one of the main findings from the interviews

and the secondary data was that good change management practices are important enablers of technology adoption.

Secondly, although the initial adoption of this technology was low, the current situation of COVID-19 and remote working prompted greater uptake of the technology. According to the technical project lead in PDO, 30,000 meetings occur daily using Skype for Business. The user community is asking for more enhancements as a result, and a new project to introduce Microsoft Teams is on the way. The key lesson here was that external factors can influence the adoption rate of new technologies.

5.5.4 High-Performance Computing: Comprehensive Data Interpretation System

One of the business challenges facing the Exploration department within PDO was the amount of time needed to process the seismic data in order for the petroleum engineers and geologists to start interpreting the data. Following the review of the secondary data, the comprehensive data interpretation system (CDIS) promised to deliver faster seismic data interpretation and reduce computation time. CDIS is a technology developed by Shell, and since Shell has shares in PDO, Shell was willing to pilot the technology within PDO. As a result of using this technology, PDO managed to reduce seismic data processing time by three months, which was considered to be very significant. According to the analysis of the interviews and the review of secondary data, the following are the main findings:

1) One of the main enablers of better adoption of this technology was the "employment of change agents early in the process" according to the project manager. During the technology evaluation stage, a number of key users were flown to Shell Houston to test, try, and become accustomed to the technology prior to its implementation within PDO. This trip enabled not only faster adoption, but also early buy-in from key stakeholders, resulting in better use of the technology (estimated at more than 50% at peak time).

2) Another key success of this technology adoption was the way in which the technology was introduced. According to the project manager, technical project lead, and technical project support, the technology was first trialled within Shell in Houston, then piloted within PDO, and then rolled out across the user community within the Exploration Directorate. This three-step method to introduce the technology was the first of its kind within PDO and resulted in better adoption and confidence in the technology's capabilities.

3) One of the key success factors for this project, according to the project manager, was the existence of "strong governance that enabled faster decision making". A committee comprising members from PDO and Shell was assembled to oversee the implementation of CDIS within PDO. The obstacles faced during the trial period or the pilot stage were swiftly dealt with, reducing the waiting time to deploy the technology.

5.5.5 Windows 10

As with the adoption of Windows 7, a new project to adopt Windows 10 was launched in late 2019 and will continue until 2022, rolling out Windows 10 to all PDO users. This new technology will introduce new cloud services, such as the use of Office 365 and One Drive, enabling better remote working. At the time the interviews were conducted, close to 1900 users were migrated, and lessons from the adoption of this technology was our prime concern. Given the analysis of the interviews and the review of secondary data, the following are the main findings:

Firstly, one of the strong points of the Windows 10 rollout has been smooth user experience during the migration. This smoothness was enabled through the use of dedicated team of change management that personalised the experience of the user community through careful planning and the use of software technology to understand the user behaviour prior to migration. According to the project manager, this personalised communication resulted in "positive feedback and less problems". These new ways of obtaining customer intimacy ensured high satisfaction with the migration and resulted in faster adoption.

Secondly, when planning for the Windows 10 migration, the project team went through the key learnings from the Windows 7 project. All information captured during the Windows 7 adoption was analysed, and pitfalls were thus avoided in the Windows 10 adoption. This previous experience

provided evidence of organisational learning. Although Windows 10 introduced its own challenges, the wisdom from previous projects was valuable. Hence, the lessons captured from this project will be useful in the development of the adoption model for digitalisation.

5.5.6 Contribution to Action Learning

Following the completion of analysis from these interviews, a debrief session was organised with PDO management to demonstrate some of the key lessons. There were three, in particular: the utilization of strong change management practices, the importance of having clear governance, and the need for a well-established project team with clear roles and responsibilities. Although there were debates on the direct applicability of these lessons for digital adoption, it was agreed that such insights captured from these four projects should be included as part of the adoption model.

5.6 Summary

In this chapter, the results obtained from the four stages of data collection were discussed. After each analysis, a review of the literature (to support the data interpretation) and a debriefing session with PDO management occurred to identify the actionable knowledge. Within each stage, deductive reasoning was employed to arrive at the key findings and conclusion. During the first stage, there were two key internal drivers frequently mentioned, which scored higher in terms of business impact and generated value: increase in production and cost reduction. Although

competition was the only key external driver identified and frequently mentioned, it did not score high on the business impact and generated value matrix.

During the second stage, the overall digital maturity of PDO based on Kane et al.'s (2017) instrument was assessed. This assessment yielded a resulted an overall low score for PDO in terms of its digital maturity, and it further identified multiple gaps. While the business units that experimented with digitalisation (e.g., Operations, Exploration, and Petroleum Engineering) showed higher maturity, other business units that had just embarked on digital adoption (e.g., Logistics and HR) understood the need for certain key elements, such as leadership and strategy. Following the discussion with PDO management, it was agreed to focus on building an overall digital strategy along with utilising existing resources to accelerate the digital adoption. While focussing on only these two gaps could result in slower maturity, these two are the most pressing gaps.

In the third stage, the digital capabilities were assessed based on Warner and Wäger's (2019) conception of them. PDO exhibited more sensing capabilities due, to its low digital maturity, yet there were certain indications of seizing and transforming capabilities. Following the debriefing of PDO management, further development of sensing capabilities was the priority. This was driven mainly by the fact that components within the sensing capabilities remain lower in response rate.

Finally, the fourth stage of previous-project review concluded the need for strong change management and governance to be in place for any future digital adoption model.

Although one of the challenges in conducting the data collection is the size of the sample used, the fact that the selected sample is representative of the overall PDO business was sufficient to convince PDO management on the credibility of the findings. Another limitation could be the use of descriptive statistical analysis of the collected data. While descriptive analysis provides a simpler means by which to articulate and understand findings, it has limitations as it does not go deep into the data analysis. On the other hand, since this is an action learning research, it was simpler to draw the actions from descriptive statistical analysis.

Chapter 6 – Evaluation of Outcomes, Recommendation & Model Development

6.1 Introduction

In the previous chapter, there were four different stages for data collection and each stage employed different methods. The findings from the different methods used such as surveys, focus group workshops and interviews were analysed and discussed. The key findings were presented in details in Chapter 4 and later summarised in Section 4.5. It was notable that debriefing sessions with PDO management took place where gaps such as lack of cohesive digital strategy and lack of utilising organisational capabilities to enable company-wide execution were prioritised. In addition, other opportunities such as governance and change management practices were identified from previous technology adoption projects.

The findings were further actioned through their application to describe the organisational digital status quo or through multiple engagements to clarify the necessary steps. As a result, there were multiple outcomes learnt from the different stages of this study. This chapter divides into three main sections. The first section discusses the reflection of the research outcomes based on the key findings from and the actionable

knowledge generated from each of the four research stages described in the previous chapter. The outcomes will be critically analysed to determine their relevance to the adoption model development. The second section will critically analyse the different adoption paths based on the digital maturity models from the literature review. Finally, the proposed model will be justified and its different elements detailed. **Figure 6.1** illustrates the different research stages indicating that stage 5 of this research is the model development.
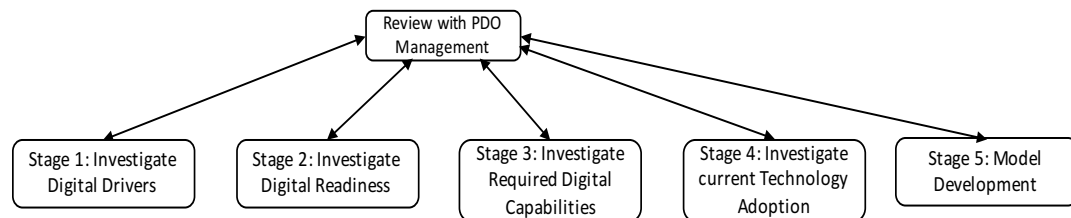
Figure 6.1. Research Stages

6.2 Reflection on Research Outcomes and Recommendations

During each phase of this action research, there was a high degree of unanimity in the views expressed by the participants. This agreement could be viewed as both positive, in that it showed consistency among the key stakeholders, ensuring a smoother implementation, but also negative in that perhaps it highlights groupthink during this study. On the other hand, groupthink as described by Janis (1972) assumes that the group opinion is

formed in the same group setting in which pressure for uniformity is generated. This is not the case here. For instance, the need for a coherent digital strategy was identified during the digital drivers stage (based on focus group discussions), maturity assessment stage (an online administered survey), and the digital capabilities stage (which is an online administered survey). Furthermore, the group composition varied among the different participants, making it difficult for these different groups to construct a groupthink.

Similar findings from the different stages were often repeated either in similar wording or intent. While in the Chapter 4, those findings were identified and critically analysed in chapter 5, it is important at this stage to classify and categorise these findings to derive a meaningful recommendation of what must be done. Using Nvivo, the findings that either have similar wording or similar intent from the different stages were used as input to arrive at the different categories. These categories formed a list of recommendations used in model development. In this section, a reflection on those recommendation will be examined, along with their role in model development. Crucially, when evaluating each recommendation, one must consider the time snapshot of the year 2020 during which the data collection took place (see Figure 1.3). PDO at that point in time scored low digital maturity, and digital initiatives were scarce. Furthermore, the action learning done following each research stage took place in 2020 and was included as part of the outcome classification and categorisation. Since

then, PDO has expanded its approach to digitalisation, with many business units crafting their own digital strategies.

6.2.1 Digital Strategy & Vision

During the second stage of the research, I completed the digital maturity assessment. One of the maturity components was to investigate PDO readiness in the dimension of digital business and strategy. During the investigation of this dimension, the participants from the survey highlighted strategy and vision as the second top factor for successful digital implementation. This emphasis was also evident from the survey, which suggested that digital initiatives were mandated from management rather than driven through a documented and coherent digital strategy. Furthermore, during the debriefing session with PDO management following the maturity assessment, it was agreed to focus on having an overall strategy for digitalisation across the PDO. The importance of strategy was also evident during the third stage of the study, where 100% of the participants highlighted the importance and relevance of formulating digital strategies and viewed this capability as an important part of the Digital Capabilities Survey. Consequently, strategy seems to be an important pillar of any digital adoption model.

While the DOI theory merely focussed on the rate and breadth of innovation adoption, it offers no guidance regarding the need for a strategy or direction for innovation. However, based on the evidence collected from

the workshops and surveys during the different research stages, digital strategy and vision seems an essential component of successful digital adoption. While the PDO formulated their digital ambition in 2019 with the help of BCG, participants from the different sections articulated the limitation of such a strategy in terms of its coverage. This belief was apparent during the workshops and surveys conducted in 2020, following the digital ambition formulation. Thus digital strategy should be part of the model development.

6.2.2 Digital Leadership

As discussed in Chapter 2, the literature review on leadership's role in digitalisation stressed on the need for leadership to drive successful digital transformation efforts within organisations (Bongiorno, et al., 2018). While the literature review did not identify any specific leadership traits required for successful digital transformation, it surfaced a number of skills. In addition, the DOI Theory emphasises the need for leadership in diffusing innovation. However, the focus of the leadership effort was mostly driven towards opinion leadership, an informal type of leadership necessary to enable complex communication flows (Rogers, 2003). The question raised was whether leadership is an important pillar to drive digital adoption within PDO? The exploration of digital maturity in the second research stage (digital readiness), leadership was identified as one of the components to be investigated. Since the instrument used for the data collection was not developed by me, only four questions related to leadership were

investigated, which could be limiting as not all leadership aspects could be covered. Nevertheless, Study participants agreed that the top factor that will drive successful digital transformation is leadership. This result was expected, since most of the literature reviews highlighted the need for digital leadership, but it was important to base the model's development also on an evidence collected from the research study. Although the literature review did not identify any specific leadership traits, the survey outcomes in the second stage of the research demonstrated that an experimentation mindset and risk-taking attitude are the top two attributes of digital leadership. In addition, in the third stage of the research and during the investigation of digital capabilities, it was apparent that leadership skills were identified as one of the skills needed for digital capabilities. Although the essential of skills were not clearly articulated in the research, the literature provided a good set of such skills. Thus, leadership is another important pillar to be included in the digital adoption model.

6.2.3 Digital Talent Development

One of the barriers to digital transformation is the lack of resources to implement digital initiatives (Stentoft, et al., 2019) (Lammers, et al., 2018). Any DOI requires human capital and talent to deploy. However, and in the context of PDO, it is important to assess whether such a dimension is essential for the adoption model's development. During the digital maturity assessment in the second stage of the research, two elements

were explored: resources and talents, along with talent retention. In the resource and talent element, the availability of talents was explored. It was evident that talents are currently unavailable within PDO to support the anticipated digital ambition.

However, most participants within the survey agreed that such talents should be developed internally within PDO, rather than through hiring new external talent. This response came as no surprise, since participants also confirmed that current knowledge within PDO is rarely utilised. Therefore, the use and development of such talents will need to be cultivated through a structured and well-defined program. This was also discussed during the debriefing sessions with PDO management, and in 2021 the company launched a "digital muscle program" in response to such a gap where human resources are heavily involved with DCoE in digital skill development. Furthermore, in the second dimension of talent retention, the majority of participants agreed that they would love to work for an organisation that is a digital leader, and the majority believe that digital trends will impact their jobs within PDO. Notably, talent and capability building are among the top four drivers identified during the first stage of the research.

I thus contend that talent can be further advanced if talent and human capital development is included as one of the main pillars of digital model adoption.

6.2.4 Digital Capabilities

In the third stage of the research, the different digital capabilities required to drive digital transformation were examined based on Warner and Wäger's (2019) capabilities model. There were three main categories of digital capabilities — sensing, seizing, and transforming — including nine sub-capabilities for each of the three main capabilities.

Due to PDO's low digital maturity in digital transformation, PDO participants focussed mainly on the sensing capabilities as the starting point for building digital capability. They provided less emphasis in terms of relevance and importance on seizing and transforming capabilities. Nevertheless, I believe that all the digital capabilities based on Warner and Wäger's (2019) model will be required as PDO grows to maturity. Thus, it is important to reflect on the digital capabilities outcome and understand its relevance to the adoption model development.

During the assessment of the sensing capabilities, it was notable that establishing long-term vision and strategies was considered most relevant and important to digital adoption; hence the digital strategy pillar. In addition, the participants also highlighted the need for continuous scanning for new technological trends, including those which are customer centric. This kind of capability necessitates insights into industry trends, and interpretation of such trends can impact the company either positively or negatively. A good example of missing digital opportunities is Kodak's

failure to adopt digital photography because they misinterpreted the signals of where photography would go next (Lucas & Goh, 2009). Based on the outcome from the sensing capabilities, it is evident that a number of capabilities were needed urgently (as reflected by the high percentages of relevance and importance from participants), while other capabilities were identified with lower percentages of relevance and importance due to the low digital maturity of PDO. Therefore, it seems important to include such capabilities in our adoption model.

Although the percentage response in terms of relevance and importance was less for the seizing capabilities, it was remarkable to see the importance of continuous redirection, the speed of execution of digital technologies, and the introduction of new innovative business models scoring high in terms of relevance and importance. I opine that while some of these capabilities are more relevant to how project management is done, the reflection made from such outcomes was a good indication of the need for an adoption model.

As with seizing capabilities, the participant's response (in terms of percentage for relevance and importance) to transforming capabilities was also low. Leveraging existing organisational knowledge tops the list in terms of relevance and importance, which provided good evidence on the importance to consider the people side. However, participants also highlighted the need for digitalisation of business models and exploitation

of new eco-system capabilities. Since these capabilities will provide evidence for other pillars, such digital capabilities must be included as part of the model.

6.2.5 Business Model Innovation

One of the drivers identified for digital transformation within PDO is for the company to use digital technologies to create a new business frontier. During the first stage of the research, participants within the focus group workshop discussed that one of the main drivers for PDO to go digital is to innovate its business model to excel, becoming one of the top companies within the country or even regionally. While Lammers et al. (2018) did not identify this driver as part of his study, this gap could be attributed to his study's scope covering industries within only the Australian market. Nevertheless, Lammers et al. (2018) indicate that further study is necessary: "to assess the level of maturity of one area, a systematic study is needed, thus future research might also pursue this goal by using either existing models or new ones" (Lammers, et al., 2018). Therefore, I submit that including business model innovation as part of the adoption model will not only provide means for the company to advance its digital maturity, but also provide a means by which continuity can drive digital transformation, since the focus becomes constant innovation. In addition, one of the areas highlighted during the maturity assessment is the lack of digital business development. Since digital transformation drives companies to innovate their current processes and optimise their operation, this will play a

significate role in business model innovation (Yoo, et al., 2012) Furthermore, business units who experimented with digital technologies improved some of their internal processes and in doing so were slowly innovating their business model. Since slow adoption can help explain PDO's low maturity, the focus should shift from traditional thinking to a mindset of digitalisation within PDO. This shift is possible only if the focus on continual innovation is embedded in the adoption model.

Furthermore, the analysis of the digital capabilities, as part of the third stage of the research, made obvious that the participants emphasised the importance and relevance of scaling and digitalising business models. Thinking beyond the current business model was imperative for PDO not only to meet its digital drivers but also to transform into a digital company in which talents is attracted and, thereby, innovation is born. Thus, the pillar of business model innovation must be included as part of the adoption model.

6.2.6 Digital Change Management

The evidence provided from the study outcomes suggests the need to embed various elements in the adoption model, such as digital strategy, new forms of leadership, talents and capabilities, and business model innovation. For these elements to be successfully included within PDO, there is a need for strong change management practice. Because change management models such as Lewin's (1947) or Kotter's (1996) seek

organisational change, I contend that similar practices are required for change management to drive digital transformation. The review of previous technological adoption (as part of the fourth research stage) made evident that change management practices supported the acceleration and fast adoption of these technologies. For instance, both the rollout of Windows 7 and that of Windows 10 had a dedicated person to lead the change management initiative. On the other hand, for Skype for Business and high-performance computing projects, the project manager acted also as change manager. Regardless of who is playing the role of change manager, the need for change management practices to accelerate technology or innovation within PDO is apparent. Thus, change management need to be part of the digital adoption model.

6.2.7 Digital Governance

A primary challenge for digital transformation that is highlighted within the literature is the lack of well-balanced governance (Warner & Wäger, 2019) (Obwegeser et al., 2020). This study further affirms that the existence of good and well-defined governance can support the adoption of innovation within PDO. Throughout the fourth stage of the research, one of the main outcomes from analysing different successful technology adoptions was the presence of well-defined governance. It enabled not only better adoption but also faster decision-making. While the need for governance is evident from the different analysis of previous technology adoption projects, in the context of digital transformation the need for governance must be

articulated clearly. The work of Obwegeser et al. (2020) provided seven key principles to guide governance within digitalisation. Some of these principles, such as information centralisation and decentralised governance structure, were already in development as I completed this thesis. Hence, I infer that the other principles are of equal importance and as a result Governance needs to be included in the model development.

6.3 Possible Paths to Adoption

Based on the research outcomes discussed, it was evident that PDO does not lack the motivation for digital adoption, but there is no single path to go digital. As illustrated previously, there are multiple internal and external drivers for PDO to pursue digital adoption. However, it is also apparent that PDO lacks an overarching strategy for digitalisation, and the company has low level of digital maturity (based on the MIT Sloan Maturity Assessment model by Kane et al., 2017). To generate the potential paths to digital adoption, I argue that maturity models are a good starting point, since such models represent the growth of digitalisation within organisations. While organisations that have adopted digital technologies grew their maturity over a period of time through continuous cycles of failure and success, it is important to start with how the maturity of PDO can be interpreted by the different maturity models from the literature review. Projecting current PDO maturity on the two models discussed within the literature review — namely the five levels of digital maturity in the model of Uhl and Gollenia (2016) and the four levels of digital maturity specified by Westerman et al.

(2011) — the following paths can be obtained:

(1) **The Path of Maintaining a Reactive Mode.** The maturity model as per the 5-levels digital maturity model of Uhl and Gollenia (2016) classifies organisations based on their strategy coverage from level one, where there is no clear direction, to level five, where digital opportunities are mature and the organisation reaps the benefits of adopting digital technology. Based on the findings from the maturity assessment (based on the MIT Sloan Model), PDO was found to be taking a more reactive approach to digital adoption. This means that PDO is selectively implementing digital technologies without a clear and cohesive strategy by which to drive a company-wide adoption.

If the company continues to employ this strategy, it will face two notable challenges. The first challenge relates to multiple initiatives carried out with potential redundancy. The second is that if PDO continues to maintain the status quo with regards to digital adoption, it will lose the opportunity to capitalise on its effort towards pursuing strategic objectives or business model innovations. Alternatively, a longer period of time may be necessary to adopt digitalisation, as the reactive approach translates to a firefighting mode rather than a structured planed mode. On the other hand, I argue that the identified digital drivers will not be fulfilled with such strategy. Given immense pressure to reduce costs that the oil and gas industry is under and the low demand for oil in COVID-19 times, digital adoption will

have to accelerate beyond mere reaction.

However, due to cost pressure, PDO may yet find reactive mode of adopting digital technologies to be preferable, using digitalisation when and if needed. Investments in digital technologies in these difficult times may require time to realise value. Nevertheless, I contend that if digital technologies are used where most needed, as per the identified digital drivers, near-term benefits may be seized. The fact that digital experimentation within the different business units has met success is a signal that the status quo should not be maintained and that PDO must shift to a more managed approach to its digital adoption. However, this path remains valid to consider.

(2) **The Digital Fashionistas Path**. Based on Westerman et al.'s (2011) digital maturity model, PDO can be classified as a digital fashionista. Hence, digital projects within PDO are implemented in silos and in different business units. While digital fashionistas tend to implement a very interesting experimentation of digital projects, the value generated from these experiments is often limited to the business unit level, and in some the digital project's contribution to the overall PDO objectives remains unclear.

While empowering different business units to move towards adopting digital adoption in a fast way might seem attractive, such a rush may result in clashes between the business units and cause duplication and anergy.

Furthermore, it is evident from the outcomes of this research that while the different business units succeeded often in their digital experimentation, evidence suggests the interference due to the reporting structure created an inability to do business digitally. Thus, collaboration between multidisciplinary teams will be necessary to drive digital initiatives. Thus while digital fashionistas can lead certain digital initiatives within their individual business units, to scale them across PDO, more collaboration is required. Such collaboration could not be accomplished without a clear strategy and proper preparation of the organisation to adopt digital technologies. In addition, change management will become paramount for any initiative that will require a mixing of business units. For PDO to become a Digirati (high in digital intensity and high in transformation intensity), Westerman et al. (2011) urge a cohesive vision, good governance, digital culture, and measurable business benefits.

Nevertheless, this path may be considered if PDO desires to embrace business units who are leading the digital fashion. The attraction to this path for PDO may lie in that, as demonstrated, business units who experimented with digital technologies did so successfully.

3) **Evidence-Based Path**: While the above two paths used the models from the literature review along with the findings from the maturity assessment results, this path uses the collective outcomes from the research to craft the adoption model. The next section will describe this path, and I will

argue its validity as the most attractive option for PDO.

6.4 Proposed Adoption Model

In this section, the third path (evidence-based) to digital adoption will be detailed. From the previous discussions on the research outcomes, PDO will need to follow a more detailed and structured approach to digital adoption, considering the findings from literature and the different research stages. On this path, multiple components form the basis of the proposed adoption model. I took an evidence-based approach to what should be included within the adoption model. This means no component was considered as part of the adoption model unless found in the research outcomes. These components include digital strategy and vision, digital leadership, digital talent development, digital capabilities, business model innovation, digital change management, and digital governance. With the acknowledgment that other elements may be required for a digital adoption model, the above seven components were nevertheless those revealed in this study. Therefore, they form the basis of the digital adoption model proposed for PDO.

It is important at this stage to be able to design a visual representation of the adoption model. This representation articulates how the components connect to each other. A further analysis of the seven elements of the digital adoption model resulted in a classification of them, based on their

context, into three main categories: strategic components, execution components, and enabling components. Strategic components are those components that deal with direction and establishing the vision for digitalisation within the company. They include, but are not limited to, the creation of a PDO-wide digital strategy. The execution components must occur for PDO to adopt digital technologies. Based on the research outcomes, having adequate digital leadership, developing digital talent to execute and be part of digital initiatives, building digital capabilities that address current and future needs, and continually innovating the business model are all components that must built and executed over a period of time. While those execution components are not strategic in nature, they form the main pillars for the adoption model. Without these components, there will be no adoption.

The third part of the adoption model is enabling components. These components are important for the adoption model but not new to digitalisation. Companies such as PDO already have a governance structure in place, along with change management practices for the different technology innovations. Therefore, the existence of these components is important to enable the overall digital adoption, but they need to be customised to the needs and the nature of digital transformation. The main reason for this classification is to clarify the purpose of each component. To visualise how these seven elements fit into one model, it was important to review how concepts (e.g., the one just analysed) can be articulated

visually. **Figure 6.3** illustrates the visual representation of the proposed adoption model. The temple shape is only for clean presentation and has no distinct meaning.
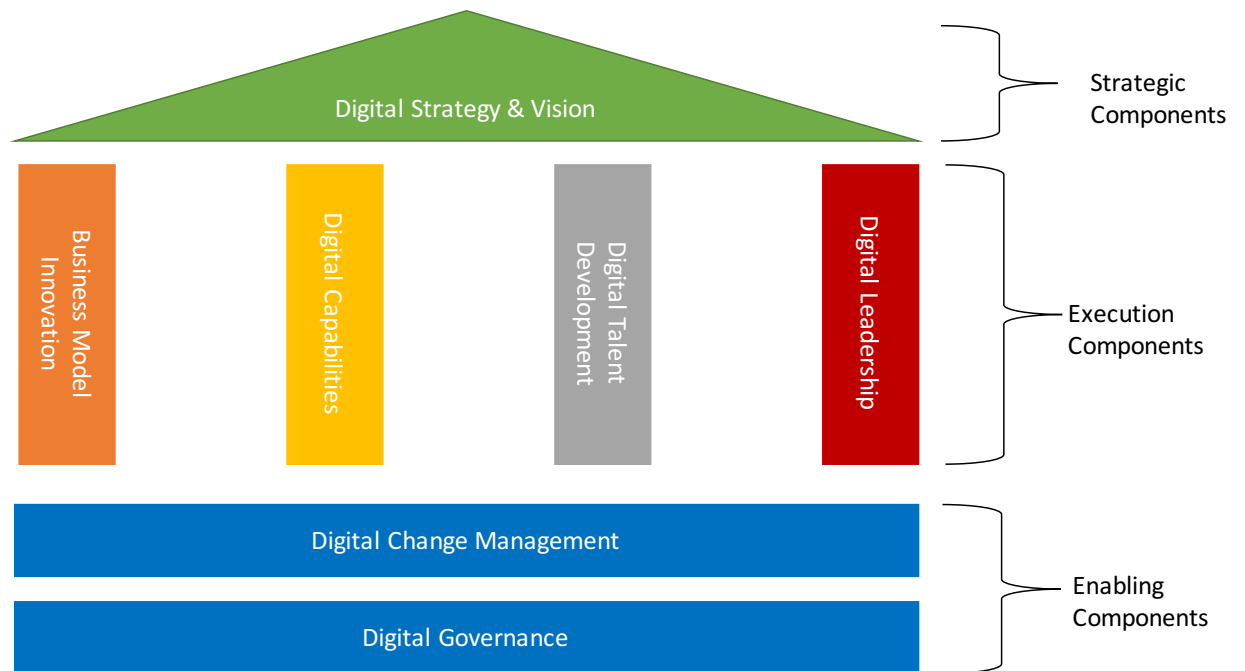
Figure 6.3. Adoption Model Illustration

6.5 Adoption Model Description

In the previous sections, the different outcomes of the action research were discussed, with the objective of determining how these outcomes can be linked through the development of an adoption model. While Section 5.4 introduced the proposed digital adoption model and managed to represent the model's components in a visual illustration (Figure 5.3), in this section it is important to detail model's components, along with how these

components should be used within PDO to support the company in its quest to adopt digital technology.

Notably, the adoption model components were based on the outcomes of the various surveys, workshops, and interviews, which occurred in 2020. While it is possible that some of these outcomes have evolved over a period of time and that the maturity of the organisation might have improved, it was evident from the literature review that digital maturity takes time. Thus, the model provides guidance for how PDO should approach digital transformation.

Prior to the data collection stage of the research, PDO employed BCG in late 2019 to develop the digital ambition for PDO and to support the company in their execution of few digital initiatives. BCG along with the DCoE team worked together to craft a digital ambition for PDO. While such discussions involved me based on my organisational position and not based on my role as a researcher, these discussions were limited to the technology selections.

The digital ambition focussed on a specific oil field in a specific area within PDO's concession. The reason for limiting the digital ambition to that particular oil field was that the company wanted to focus on what digital initiatives could be experimented with. As a result, the digital ambition exercise identified around 12 digital initiatives, mainly within the drilling and exploration space. Although most of these initiatives are focussed on

AI-based models and building predictive analytics, I opine that once these initiatives are scaled they will transform PDO's business towards digitalisation.

On the other hand, the digital ambition does not cover the digitalisation of other business units within PDO, limiting it to these 12 initiatives. Another limitation that wide-scale adoption of these initiatives is driven from technology perspective, and the digital ambition lacks detail with respect to the operating model and path to wider adoption. This ambiguity confirms the need for this action research as a starting point to identify the nontechnical elements required to realise the digital ambition. Another point of confirmation on the value of creating an adoption model came from the fact that the data collection stage (which included tools such as surveys, interviews, and workshops) occurred after the identification of digital ambition, yet it was evident from the discussions and the survey results that the crafted digital ambition lacks PDO-wide coverage and that the vision for digitalisation was not clearly articulated. Thus, there is a room to introduce an adoption model addressing these gaps and help PDO drive a successful digital adoption.

6.5.1 Digital Strategy & Vision Component

The need for a cohesive digital strategy that has PDO-wide coverage is evident from the outcomes of this research. Although PDO has already developed their digital ambition with the help of BCG, the strategy part

remains vaguely defined, as reported by the people and business units who experimented with digitalisation. Hence, enhancing the digital vision and strategy to be clearer and more inclusive is a key component of the proposed adoption model.

In order to explain the main elements needed within this component, it is vital to address all the gaps identified during the data collection stage, which later formed part of the research outcomes. The action research findings provide number of elements, as outlined in the two sections below.

6.5.1.1 PDO's Digital Vision

Does PDO want to be a digital enterprise or does PDO want to use digitalisation to inject improvements in a more targeted manner. As per the literature review, organisations can select and choose which direction they need to drive digital transformation. Ross et al. (2017) argue that for successful digital adoption, the organisation must choose one approach to digitalisation: optimisation or transformation. The fact that PDO does not have a vision statement regarding digitalisation resulted in different business units adopting different digital strategies. This dynamic was evident from the survey and workshop findings, so it is important to note that even business units who experimented with digitalisation deemed the adoption rate to be slow, due to the number of organizational boundaries they need to cross.

6.5.1.2 Inclusive Digital Strategy

One of the main findings from the survey is that digital adoption is driven by management and not through an inclusive strategy. Participants highlighted that while the PDO's digital ambition addressed strategic choices for certain business units, other business units were not included. However, I argue that a good digital strategy should be an inclusive strategy not only PDO-wide, but also able to provide direction to each of the different business units. Similar to a business strategy, digital strategy needs to address priorities within each business unit and how digitalisation can support those priorities.

While the existence of digital strategy is vital for the adoption model, it must also be implemented. Several pillars ground the digital strategy: digital leadership, digital talent development, digital capabilities and business model innovations. The following sections address each of those components and what they entail in details.

6.5.2 Digital Leadership Component

Although leadership was not among the gaps prioritised during the debriefing session with PDO management, subsequent literature review made clear that it was important. Thus, the first pillar of executing a strategy is to have and prepare leadership for the digital era, because the role of leadership within digitalisation is critical to the success of digital adoption (Rüth & Netzer, 2020). The adoption model in Figure 5.4 classes leadership under strategy, and leadership plays a vital role in crafting the

digital vision and strategy of the company. The action research findings provided good evidence that the current leadership has the trust of the workforce to lead PDO through the digital transformation. Although this outcome is very positive, it is important to state what roles leadership should play within digitalisation. These roles are summarised below.

6.5.2.1 The Digital Compass

Digital technologies can prompt numerous business changes. As technologies such as Big Data and AI evolve over a period of time, their application within the organisation and for what purpose must be directed (Rüth & Netzer, 2020). Leaders play a vital and directive role in digital adoption and application within their organisation. In addition to their role in providing direction, leaders must play an integration role to break the silos. The action research findings suggested that business units who have experimented with digitalisation have good leaders to integrate their activities and break the silos. Breaking the silo will accelerate digital adoption and, as a result, leadership was identified as the top factor required to achieve this goal. To what extent PDO leadership is prepared for this role was not detailed in this study. Nevertheless, the journey to adoption of digital technologies has proceeded at a good pace since the data collection phase of this research.

6.5.2.2 Capacity & Capability Building

One of the action research findings is that resource allocation for digital

varied among different business units. While some units had "about the right amount", other units did not have enough. In addition, the action research provided an evidence of lack of talents required for digital adoption. Hence PDO faces a capacity and a capability challenge to adopt digital technologies. While this challenge was addressed by improving the capacity and the capability of the DCoE, leaders are expected to capitalise on knowledge within the organisation to drive better adoption.

6.5.2.3 Digital Mindset

The action research identified two main leadership attributes required to drive digital business transformation. The first is the experimentation mindset, and the second is the risk-taking attitude. This gap is expected to be closed through coaching the existing leaders (as per the study findings) and through ensuring their readiness for the change. Although this capability is not available internally in PDO, part of the change management is to improve leadership's readiness for such skills. Furthermore, Warner and Wäger (2019) stated that in addition to the above two leadership attributes, having an entrepreneurial mindset is key to scaling digital projects. While such a mindset is not limited to leaders, I argue that it is a key attribute for digital leadership.

6.5.3 Digital Talent Component

The second component of the digital adoption execution components is digital talent. Although the action research identified talent and capability

building as key drivers of digital adoption, the interviewees expressed a plan to work for PDO more than three years, yet they expect PDO to be a digital leader. One of the outcomes of the action research acknowledge that the majority of people interviewed cited the importance of working for an organisation that is a business leader. I argue that if PDO is not driving towards digital adoption, they will lose talents.

Furthermore, it was noticeable that during the debriefing session with management, the talent gap was taken seriously. Following the identification of this gap, DCoE and HR worked on the "digital muscle program" to enhance talent.

In sum, this action research identified the following main elements within the digital talent component.

6.5.3.1 Talent Development

The action research identified two key strategies for developing talent within PDO. The first strategy was to have a company-wide program for digital skills development. This program will help to increase and improve the understanding of digital technologies and their potential use within PDO. Fortunately, this program was launched in 2021 following the debriefing session with PDO management. On the other hand, the action research provided evidence of a lack of digital knowledge, skills, interest, and experience held and applied by PDO employees. Thus, a company-driven program will enable talent development through upskilling existing

talents. The second strategy is to enable cross fertilisation between different business units and learning through experience. In addition, the action research identified that technical and analytical skills are the top two types of skills in need of development within PDO. If talent were developed using these two strategies, one could argue that there will be an improvement in the perception of digitalisation within PDO and, as a result, will improve the digital adoption.

6.5.3.2 Talent Retention

The war for digital talent has already begun, and the search for specialised skills is becoming more demanding (Kane, et al., 2017). While this action research concluded that the workforce trusts in existing PDO leadership, this perception should be nurtured, as it will lead to better utilisation of existing talents. In addition, the research outcome also suggested that the people surveyed will stay at PDO for the next few years. While the literature provides many strategies for staff- and talent-retention practices, the evidence collected from this research suggests that working for a digital leader itself leads to talent retention, which will in turn help the company achieve successful digital transformation.

6.5.4 Digital Capabilities Component

The third component of the execution components is digital capabilities. While the talent component addresses the people side, the digital capabilities address the organisational element. The work of Warner and

Wäger (2019) is foundational to enabling digital capabilities. Although the action research identified that sensing capabilities are of great importance, I would argue that, given the PDO's current digital maturity, there is a focus on sensing capabilities, as they form the basis for digital capabilities. However, as the digital maturity of PDO increases, there will be a need for more digital capabilities, such as seizing and transforming. The action research outcomes provide the following actions for PDO to develop these capabilities.

6.5.4.1 Develop Cross Functional Team

Both Warner and Wäger (2019) and Kane et al. (2017) indicated the need to build a cross functional team to improve digital capabilities within organisations. Although the action research findings indicated that only half of the participants recognise and reward cross-team collaboration, I opine that PDO requires more cross team collaboration to build digital capabilities. Furthermore, the action research findings also emphasise the need to break the organisational structures, as they interfere with digital capability building. Although the DCoE team is central part of building cross-functional teams for digital projects, the action research findings evidence that the current focus of DCoE is driven towards developing technical skills within. This internal development could be further enhanced with cross fertilisation of skills between different business units.

6.5.4.2 Develop Strategic Agility

One of the main findings from the action research is the inability of PDO to successfully scale digital pilots. While business units who experimented with digitalisation have stated that their business unit is becoming agile as a result, there is a lack of a strategic approach to agility within PDO. The action research also identified the need to scale up innovations, a key part of seizing the capability PDO needs to develop. According to Warner and Wäger (2019), agility will enable the creation of minimum viable products that, in turn, will drive digital business innovations. Although one cannot underestimate the amount of effort needed to build agility within PDO, the outcome from this research suggests that digital experimentation and "fail fast" approach that some business units took lead to improvement in their agility to respond to business challenges.

6.5.5 Digital Business Model Development Component

The fourth pillar of the execution components is business model innovations. While the strategic vision of PDO's digital ambition will determine the breadth and depth of the business model innovation, it was clear from the action research findings that one of the external drivers for PDO digital ambition is to lead digitalisation within the country. This leadership position can be obtained only through continuous renewal of the company's business model. While PDO has leaned its business processes (through lean management practices) since 2012, I contend that combining the lean methodology with digitalisation will drive further process-culture-technology innovations that are needed for business model development

(Romero, et al., 2019). It is worth noting at this point that the maturity of PDO will dictate the spectrum of the business model innovation.

At this early stage, more focus has been placed on optimising current business practices through the use of digital technologies. As PDO grows in digital maturity, the focus will shift from improving current business processes to digital transformation where business model innovations will take place. Given that digital business innovation is something to be done in future and depends on organisational digital maturity, it should form part of the digital adoption strategy for two main reasons: Different business units within PDO exhibit different levels of digital maturity; thus, there will be a point in time when business model innovation will be initiated in one business unit earlier than in others. Secondly, while sensing capabilities have received the most attention from PDO, the action research finds requisite elements of seizing and transforming capabilities. These elements relate to the need for business model innovation to be one of the pillars of digital adoption.

6.5.6 Change Management Component

While the above sections have focussed on strategic and execution components, this section and the next address enabling components within the proposed digital adoption model. For PDO to execute a digital strategy, it requires a focus on inducing change in how to operate and fast tracking the adoption of digital technologies. While the action research attests that

previous technology projects employed strong change management practices, the diversity of the change brought by digital technologies requires even stronger change management than the typical change management practices to which PDO is accustomed. This shift is needed mainly because the change management required by digitalisation must be supported by many pillars, including leadership practices, organisational structures, and business models. While one of the main contentions of the DOI theory is the need for change agents, I argue that change agents must be complemented by change management practices such as the ADKAR (i.e., awareness, desire, knowledge, ability and reinforcement) methodology that PDO currently has, or something similar.

6.5.7 Governance Component

Another enabling component for digital adoption is governance. Although PDO has a well-established governance structure, the documents reviewed as part of Phase IV indicate that such governance is project-based. In 2019 and during the BCG work, a Digitalization Committee was formed and chaired by the managing director to steer digital initiatives. It included key directors from different business units. The roles and responsibilities of this committee were clarified in 2020. While the introduction of this body is key to digital transformation success, it is important to articulate the need to follow governance principles stipulated by Obwegeser et al. (2020). Although some work has already begun within some of these principles, it is important to articulate each principle and its applicability to PDO's

digital adoption.

Firstly, centralise information about digital initiatives rather than the initiatives themselves. Since the focus is on the identified list of projects as part of PDO digital ambition, the DCoE is currently keeping a record of all the digital initiatives within the company.

Secondly, decentralised governance of digital initiatives as digital maturity grows. Currently, the governance is centralised through the digitalisation steering committee due, to low digital maturity.

Thirdly, decentralise ideation, but centralise idea evaluation and prioritisation. Although the DCoE currently has a system in place to prioritise digital opportunities, the focus is merely on the one identified as part of the digital ambition.

Fourthly, establish KPIs to measure the real impact of digital initiative. This is still in early stages, but has been identified as one of the priorities for the DCoE team to develop.

Fifthly, avoid siloed solutions and encourage integration. Since PDO remains in its infancy with respect to digital maturity, the solutions deployed target particular business units. However, this approach will need to be evaluated as PDO digitally matures.

Sixthly, implement a "fit-for-purpose" mapping system that recognises value potential and degree of feasibility for each initiative. This is a current

practice in PDO, whereby the practicality of the projects are evaluated.

Seventhly, evaluate different scenarios for digital initiatives adoption. This evaluation is still in its infancy, but scale-up efforts are being evaluated to produce the right level of impact.

6.6 Summary

The different outcomes from this research study have been examined and grouped to form the evidence-based approach to the proposed digital adoption model. Seven outcomes were detailed: strategy and vision, leadership, talent development, digital capabilities, business model innovation, change management, and governance. The importance of having a coherent and PDO-wide digital strategy was examined and debated. Although BCG produced the digital ambition for PDO, this ambition was limited to a particular oil field.

The importance of digital leadership and PDO readiness for the new form of leadership was further discussed. While participants reported an overwhelming trust in existing PDO leadership, the need for them to have an experimental and risk-taking mindset was noteworthy. Following the identification of the talent gap from this research, the "digital muscle program" was launched and can be considered a key achievement of this action research. Although multiple paths to digital adoption were examined, the proposed approach is based on the study findings. The proposed approach examines how each of the seven components can be

implemented within PDO. Crafting a coherent PDO-wide digital strategy and

talent development were found to be the top two gaps that PDO is currently

focussing on.

Chapter 7 – Conclusion & Implications

7.1 Introduction

PDO is embarking on a journey to adopt digital technologies in order to address the different challenges the oil and gas industry is facing. Although PDO initiated its digital ambition and pursued the journey of digital transformation through the engagement with BCG, many challenges have inhibited digital acceleration and the wide adoption of digital technologies within the company. This action research aimed to help PDO to develop an adoption model to use in its quest for digital adoption. It is no longer sufficient to adopt digital technologies but to accelerate digitalisation across the different business units within PDO.

This study deployed a combination of quantitative, qualitative, and action research to develop a proposed digital adoption model. In the previous chapter, I discussed the potential paths for PDO to digitalise and discussed in details of the proposed adoption model. This chapter is structured into three main parts. Section 7.2 addresses the overall conclusion from this action research and the contribution made to my organisation. Section 7.3 discusses the limitations of the action research and its implications. Section 7.4 comprises a personal reflection on this research.

7.2 Conclusion & Practical Contributions

At the beginning of this study, a number of objectives, and research questions were raised. Firstly, this action research intended to establish the company drivers behind digital adoption. While each business unit has its own drivers to pursue digital, this action research managed to derive a collective view on PDO drivers to adopt digital. Four main drivers were identified as a result of this research; namely, digitalisation will help PDO to increase its hydrocarbon production, enhance existing business processes, improve staff and asset efficiency, and develop talent and capability.

The action research found that the consolidated drivers were well received within PDO management, and the findings of the research are very much aligned with the strategic objectives of the company. This is one of the practical implications realised at this stage. The methodology of two focus group discussions with reference to the drivers identified by Lammers et al. (2018) can be considered a good methodological contribution that associates the literature with practice.

Another aim this action research investigated was to assess PDO's digital maturity and to understand its readiness for digital adoption. The research found that PDO is digitally immature. Although there were six dimensions under the digital maturity assessment tool, PDO scores varied with respect to maturity from low to medium, with an overall score of low digital

maturity. Some business units are more digitally mature than others. This assessment identified key gaps such as lack of coherent strategy and talent development, later acted upon by PDO as a result of this research.

The action research also investigated how to encapsulate previous experience of technological adoption within PDO into the proposed digital adoption. An analysis of four critical adoption of technology projects was conducted, including primary data collected through interviews and secondary data collected through document reviews. The use of change-management practices and strong governance provided the ingredients for success in these projects. As a result, including them as part of the proposed adoption model was natural.

One of the aims of this action research was to identify the digital capabilities needed for digital adoption. The work of Warner and Wäger (2019) formed the basis to identify the relevance and importance of the different capabilities to PDO. While the research identified sensing capabilities as the most cited in terms of both importance and relevance, seizing and transforming capabilities are necessary, I observe, as PDO matures. One of the practical implications was to foresee what PDO will need in future to grow mature through seizing and transforming capabilities.

At the initiation level of this research, there was a debate of whether DOI theory or TOE framework will apply to PDO digital adoption. Neither can be

used as models to guide the development of digital adoption and as a result, the evidence-based approach from the research investigation was used to create the adoption model.

Although the starting point of the action research was challenging. This was mainly because of the level of ambiguity of what a digital adoption model should look like. A number of unknowns arose in terms of what this action research can deliver and its contribution to PDO's digital ambition. As things progressed, a series of discussions occurred at the proposal stage, and more and more clarity started to emerge. As seen from the above discussion, this action research managed to address all the research questions, and it revealed new and valuable insights about PDO's digital journey. For instance, the initial assumption about what drives PDO to adopt digital differed from what the study revealed. Although there were 13 different drivers cited by the digital experts (those who lead or participated in digital projects) within PDO, the top four drivers resonated well within PDO management team during a debriefing session. The actionable knowledge generated from this research is good evidence of its validity and applicability to PDO.

As I was preparing for the interviews, surveys, and group discussions within PDO, BCG was defining (along with PDO DCoE team) the digital ambition. While the action research identified the need for an inclusive and cohesive digital strategy, this gap was partially realised through the creation of the

digital ambition in 2019 and was later improved, as identified by this research, in 2020 and 2021. The realisation of PDO management that digitalisation is not about the technology but about strategy aligns with the findings of Kane et al. (2015) and highlights not only the importance of this action research but also its credibility. Although there were no particular criteria for mixed methods found in the literature, the criteria from Lincoln and Guba (1985) were mostly met by this research, apart from generalisability (a notable limitation discussed in Section 7.3).

This action research revealed that the current leadership practices within the organisation are trusted by the workforce. Leadership is a key component driving digital transformation, and notably, digital experts believed in the current leadership's ability to lead digitalisation. While the study highlighted gaps, such as risk tolerance and an experimental mindset within current leadership, it is worth mentioning that the study identified how such gaps can be closed, offering a key contribution to managerial practices. In addition, the study revealed the importance of the leadership team to break cultural silos and facilitate cross fertilisation among business units, aiming to achieve success in digital adoption.

This action research has revealed the low digital maturity of PDO as an organisation, and digital experts have reflected good knowledge about the importance of digitalisation for PDO and their willingness to work for a digital leader. The research also illuminated successful digital experiments

within PDO and the readiness of certain business units for digital adoption. The main contribution from the maturity assessment was understanding what has worked well within the business units that experimented with digitalisation. The identified set of practices such as continuous experimentation, agility, and risk taking comprise yet another contribution to the managerial practice. The fact that the adoption model is built around evidence-based study from this action research provides a more practical approach to digital adoption.

When assessing the different technology projects implemented historically in PDO, it was evident that strong governance and change management practices reinforced the project success. PDO is mature in terms of its governance structure, and for digital adoption, the need to have a high level strategic body to drive digital adoption was formed.

The main practical contribution of this research is multi-faceted, including but not limited to development of coherent digital strategy (under implementation by PDO), talent development (under implementation by PDO), the need for better collaboration, better governance, and change management practices. All of these are included in the adoption model.

7.3 Summary of Research Implications

There are multiple implication that this action research provided. On the theoretical front, a survey was developed out of Warner & Wäger (2019) digital capabilities during the research design. Each of these capabilities

were assessed against their relevance and importance to the organization. The use of this instrument resulted in identification of key capabilities required in the short and long term. Using this instrument in other research could contribute towards understanding organizational digital capabilities needed for digital adoption and which of those are important and relevant.

Another implication of this research was the employment of mixed methods to assess different research objectives and questions. During the first stage of the research, I used two focus group discussions instead of one and the output from both was further consolidated and agreed with PDO management. The method of using multiple inquiry methods to gain insights was one of the methodological contributions of this research.

During this study, the use of descriptive analysis was used. One of the difficulties found in the initial research discussions is how to analyse the data to arrive at a meaningful actionable knowledge. Since this study is based on a workplace problem and multiple debriefing took place with PDO management, the use of descriptive analysis was seen as a strong contribution to how scholar practitioner should analyse results in a managerial setting. This is a key implication of how action researcher could utilise such tools to arrive at meaningful insights.

Finally, there were two main practical contributions of this research. This study provided empirical evidence supporting the drivers to adopt digital technologies developed by Lammers, et al. (2018). In addition, although the adoption model was developed based on the evidence collected on this research study, following the debriefing with PDO management, all pillars were acknowledged as important. The first two pillars that started to materialise were the strategy and talent development. These can be considered as key contributions of this research to practice.

7.4 Research Limitations & Future Research

7.4.1 Research Limitations

This action research faces five limitations, which bear upon its applicability and generalisability. The first is the difficulties encountered during the proposal development stage. Although the initial examination of the research problem revealed the difficulty of initiating digital transformation within PDO, many challenges were faced during the proposal stage. It was difficult to articulate precisely the practical difficulties faced by PDO in adopting digital technologies without carefully investigating the problem at the DBA level. Fortunately, the initial review of the literature provided good evidence of the challenges facing organisations in general during their

digital adoption and the specific challenges within the oil and gas industry. While the proposal development stage took longer than expected, it provided me time to reflect and explore details the problem and why it is important to solve through action research. During the proposal development stage, there were multiple and sometimes contradictory reviews that led to the problem statement, the research aims, and the research questions in the way they are. For instance, there were different views during the proposal development between me, first supervisor, and the proposal reviewer of which research methods to be used. This variation resulted in eventual agreement upon mixed methods, but the agreement took longer than expected. Thus the research context influenced the selection of the research methods.

The second limitation of this study is the possibility that the research is influenced by my bias. The perception that PDO has a problem in adopting digitalisation was initially related to my observation within my own environment. While it is difficult to manipulate the outcomes of the interviews, surveys, and workshops conducted during this study, I am left to provide my own interpretation of the qualitative and quantitative outcomes. This bias could have been augmented through the presentation of the voice of participants prior to interpretation and by the continuous dialogue between me and my first supervisor at the different research stages. This continuous dialogue provided ongoing interrogation of the outcome interpretations. In addition, my own views also evolved during the

study timeline. The initial assumption was that since PDO did not have a digital strategy, that was the root cause of the problem. However, as this action research revealed, more gaps were also identified.

The third limitation was the selection of a representative population sample. As stated previously, PDO had over 8,000 employees during the time the research was conducted. Research participants were limited to those individuals who had participated or led digital projects within PDO. These individuals were identified based on the digital projects known to me at the time the research methodology was designed, but this list could have been expanded through further identification of potential candidates. While the identification of these participants was done with the help of the DCoE (responsible for cataloguing all digital initiatives within the company), certain outliers were identified at later stage. Since those digital outliers were only two projects, they were unlikely to impact the outcome of this study significantly.

The fourth limitation of this research was the fact that the mode of the data collection had switched to online channels rather than face-to-face communication due to the COVID-19 pandemic. Although the different sessions were recorded and transcribed, there are limitation in terms of capturing the true meaning of some of the statements made, due to the online mode of interviewing. Difficulties such as losing some parts of their speech due to low fidelity sound or connection, or some participants getting

disconnected and re-connected, were faced in this online setup. While the research considers verbal aspects of what was said (e.g., intonation), it was difficult to judge any discomfort felt by the participants as a result of the workshops or interviews. Nevertheless, the iterative mode of this action research increased confidence in the results.

The fifth limitation of this action research is its low participation rate. While 40 individuals were identified as part of the sample group, the one who consented to participate was only 32. It was a challenge to get those individuals to participate in the study especially because they needed to provide a signed consent form to participate or they could not be included. Furthermore, while the initial uptake of participation was low during the first stage of identifying the drivers of digitalisation, it peaked during the maturity assessment, then dropped again during the capability assessment, due to the timing of Ramadan. Since I had to complete data collection within a particular time frame, data collection took place during Ramadan. This variation in participation rate is due to a number of factors, such as remote working due to the COVID-19 pandemic and the fact that the research took place during the summer months, when some prospective participants were on leave. Nevertheless, once the findings were presented to PDO management, the general feeling was that it reflected the reality in the ground even though the number of participants were low. In addition, the fact that there is consensus on some of the findings by members of the DBLs provided a level of comfort that the research outcomes represent a

true picture of PDO's digital journey.

7.4.2 Future Research

During the different stages of this action research, a number of key research questions emerged. Since the focus was on developing a digital adoption model for PDO, these research questions could form potential future research. **Table 7.1** summarises the research questions generated from this study.

New Research Questions	Proposed Method of Inquiry
Could there be drivers for organisations to pursue digital adoption other than the ones listed by Lammers (2018)?	**Qualitative Methods**
What if maturity assessment was developed by the researcher? Will this change the outcomes?	**Qualitative Methods**
There is an inherent assumption that technology adoption is similar to digital adoption, thus that DOI and TOE are applicable frameworks?	**Qualitative Methods**
How can the applicability of this adoption model to other organisations be assessed? Can a tool be developed for such analysis?	Quantitative Methods
How can successful digitalisation be measured, and what does success entail? Developing success criteria for digital	Qualitative Methods

Table 7.1. New Research Questions

During the initial stages of problem-statement framing, the adoption of digital technologies was thought to be an innovation diffusion issue; hence, the DOI theory by Rogers (2003) was applied. However, during the review of the four technology projects within PDO, not all the five factors influencing the adoption were present; yet, these technologies were implemented successfully and were effective in their adoption rate. The assumption made for the use of DOI theory as an adoption mechanism is

mainly driven by the association of the characteristics of digital technologies with innovations. A future study could assess the different implementations of technologies adopted within PDO based on their innovation characteristics (part of the DOI theory) and assess which of the innovation characteristics (e.g., relative advantage, complexity, etc.) facilitate adoption. Since this mapping needs deeper understanding of the association between the two, this association could be done using qualitative methods to review secondary data from this project, in addition to interviewing project managers.

One of the key outputs of this action research is the adoption model for digitalisation. Since DCoE is responsible for driving the digital agenda within PDO, the adoption model was presented to them in Jan 2021. Although the creation of the model was based on action research findings, its implementation within PDO has yet to be seen. While certain pillars of the model were identified and actioned (due to PDO management's willingness to accelerate them), others remain to be tested. Thus, a future study could examine the success of this adoption model within PDO through the creation of a success matrix, supported by envisioning workshops with PDO management. This task is planned to be led by DCoE.

The second potential future research direction is the expansion of the proposed adoption model to include other oil and gas organisations embarking on a similar journey. In Chapters 1 and 2, the contextual factors

surrounding this research were explored. Although the design of the adoption model was based on the findings and the evidence collected from this research study, the model itself can be generalised to include other organisations within the same industry, given the research limitations. As one could see, that the design of the adoption model was not entirely based on the DOI theory (apart from the use of change agents). Thus, if the investigated organisation has the same organisational characteristics of PDO, then one could assume the potential generalisability of this research. The main argument will be that organisations that have similar organisational characteristics within the oil and gas industry could utilise this digital adoption model. However, the applicability of this model to other organisations could be further investigated.

The third potential direction for future research is driven by the literature review. One of the findings of this action research is the difficulty of navigating the existing organisational structure within PDO. Although this matter was not included within the adoption model as a distinct pillar (due to the fact that multidisciplinary teams can be facilitated through digital leadership), the literature suggests the need for a new organisational structure to drive digital adoption. Resca et al. (2013) argue that in order for organisations to achieve competitive advantages through the use of technology, they must have the strategy, organisational structure, and IT in place. Thus, future research could probe the development of an organisational structure that will enable faster adoption of digital

technologies. This possibility is also evident from the work done by Galbraith (1982) on how innovative organisations utilising innovative technologies for their businesses use unique structures to address their differentiation. Future studies could identify what unique organisational structures enable digital adoption.

7.5 Personal Reflection

Prior to starting this action research, the DBA program within University of Liverpool developed the foundational elements for me to be a scholar practitioner. The different modules provided me guidance on how to conduct a critical literature review, how to question assumptions made by my peers within the learning set participation, and how to go about problematising my workplace problem. As a result of these modules, I was able to gain extensive knowledge not of how to conduct action research only, but also about myself and my ability to play such role.

Although being an insider researcher has its advantages and challenges (Brannick & Coghlan, 2007), the initial challenge for me was to highlight to PDO management that there is a problem in the way digitalisation is run within the company. I was lucky that my research proposal was not approved immediately, since the extra time allowed me to discuss with my management their assumptions, until we reached agreement regarding the importance of this research. What complicated the matter is that the person who sponsored by research (i.e., the chief information and

digitalisation officer) passed away, and new person took over. The new CIDO's belief that DCoE and BCG would solve all PDO's digital problems proved fallacious when I began my research. He then became excited about this research, and after the digital drivers stage was completed, he has been a strong supporter ever since.

Another key lesson from this research is to be aware of my internal assumptions. Each researcher has a specific view about reality and how knowledge is generated. The frequent engagement with my supervisor made me aware of my prejudice and helped me to question and challenge my own assumptions. This, of course, shaped how I interpret and consider the different outcomes not only within this research but also in my daily work. My colleagues witnessed improvement in my engagement with them, and my management started to see me as critical thinker, which eventually landed me a promotion to head of digital strategy and integration, in February 2021.

I believe using action research was one of the key strengths of this research. The application of AR to resolve workplace problems is among the most effective ways, due to its simplicity, structure, and ability to generate actionable knowledge through cycles of discussions, analysis, and interpretation. Although the actionable knowledge was not automatically implemented, this could be one of the weaknesses of AR study.

Another key tool I used during my DBA study and also during this research

is my research journal, including sticky notes of my own observations and reflections throughout my study. These notes made it easier for me to reference key concepts within the literature during the different research stages. Some of these reflections were translated to actionable knowledge and helped to resolve some of my workplace problems, such as inconsistency in decision making and ethical considerations during data collection. Since I am an insider researcher, I was offered more information than necessary. Being aware of such ethical situations helped me to reject certain information and not include it as part of this research, due to confidentiality. Although such choices could impact my research, I needed to ensure no potential harm to participants or to PDO.

Finally, during the different engagements I had in preparation for this thesis, I captured key lessons. The first is how to think critically and question my assumptions. The second is consider a variety of perspectives (e.g., ethical, political, social). These lessons improve rigour. The third regards my own development and how I evolved as a scholar practitioner through this DBA program.

7.6 Summary

Although the literature provided numerous articles around digital adoption, there was no actionable model that could be used to drive digitalisation within PDO. The evidence-based approach proved valuable in confirming the findings from the literature review such as the drivers, the importance

of digital strategy, and the need for digital leadership. Although certain themes from the literature were found plausible, a number of factors (e.g., organisational structure issues) were not considered within this study, and as a result, contradicting the findings from literature (please refer to section 2.11.1). The fact that two of the key pillars of this model (namely strategy and talent development) were actioned by PDO provides legitimacy to the practical contribution made by this research, despite its small sample size. This value could support the argument that such an adoption model can be expanded to other companies operating within oil and gas, given similar contextual factors. While this action research is not new to the oil and gas industry in Oman, as similar action research was conducted in PDO before, the methodology used for this investigation is more pragmatic and structured. This structure was evident in the debriefing sessions with PDO management. In addition, the methodology followed by this research was unique in its own way. Mixed methods were used to investigate different research objectives during the integration of the findings from the two methods in the analysis stage, producing meaningful interpretations.

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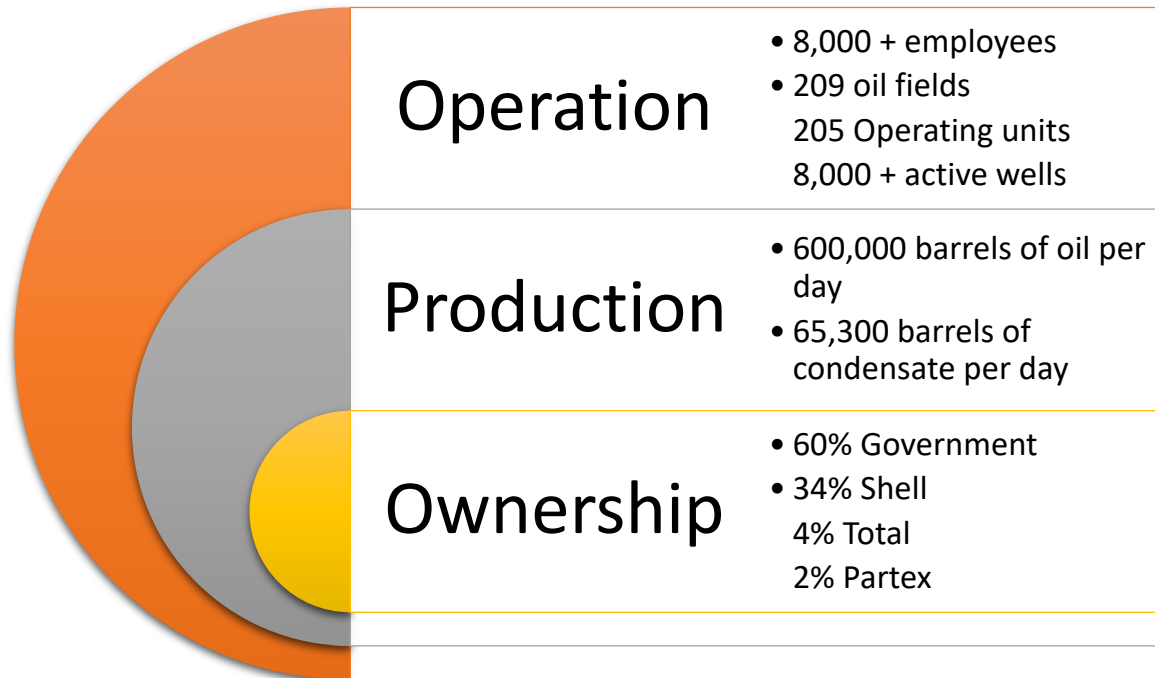Tiago Oliveira, M. F. M., (2011). Literature Review of Information Technology Adoption Models at Firm Level. *The Electronic Journal Information Systems Evaluation,* 14(1), pp. 110-121.

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Appendix A – Petroleum Development Oman Fact File (summarised from
https://www.pdo.co.om/en/about/factfile/Pages/default.aspx)

Operation	• 8,000 + employees
	• 209 oil fields
	  205 Operating units
	  8,000 + active wells

Production	• 600,000 barrels of oil per day • 65,300 barrels of condensate per day

Ownership	• 60% Government
	• 34% Shell
	  4% Total
	  2% Partex

Appendix B – Researcher Biography

Abdullah Al-Rashdi joined Petroleum Development Oman in 1994 after completing his Bachelor Degree on Telecommunication from Sultan Qaboos University. He pursued his further studies and completed his Master of Science degree on High Frequency Engineering in 1995 from University of Leeds in UK. He started his career from 1995 as a Telecom Supervisor in one of the operating units (Nimr Field – one of the Oil fields in southern parts of Oman). He moved in 1997 to take the role of Network Operation Engineer in the head quarter in Muscat (capital city of Oman). In 1999, he took the role of IT Project Engineer for Infrastructure Projects. In 2004, he took over the role of Project Manager, then Senior Project Manager in 2007. In 2010, he completed his Master in Business degree from Sultan Qaboos University through part time. Following his MBA, Abdullah moved to strategy and planning to take the Enterprise Architecture role in 2011. He then became the Information Technology Chief Architect responsible for overseeing the technology roadmap of PDO and ensure the introduction of new technologies. In 2018, the IT organisation was upgraded in terms of its mandate to take care of digitalization and as a result Abdullah role was updated to be the Digitalisation Chief Architect.

Abdullah has more than 25 years of experience in Information Technology with a demonstrated history of working in the oil & Gas industry. Skilled in IT & Digital Strategy Development, Digital Technologies, Strategic Road-mapping, Coaching, Communication, IT Service Management, Data Center, and Project & Portfolio Management. Strong professional with 2 Master degrees and various certifications from international bodies such as PMI, Toastmaster, Open Group and leading business schools such as London Business School and Darden Business School. Passionate about Technology in general and the Fourth Industrial Revolution.

Appendix C – Researcher's Position in PDO (up to Feb 2021)
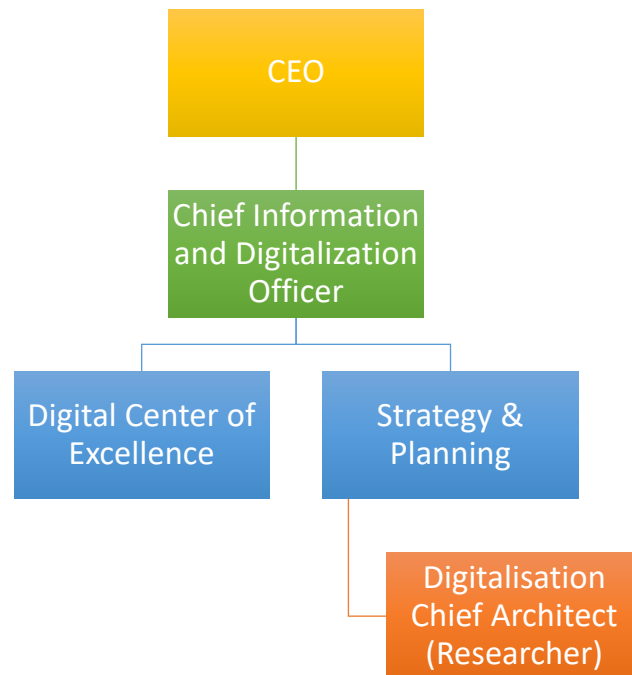

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                    ┌─────────────┐
                    │     CEO     │
                    └──────┬──────┘
                           │
            ┌──────────────┴──────────────┐
            │  Chief Information           │
            │  and Digitalization          │
            │  Officer                     │
            └──────────────┬──────────────┘
                 ┌─────────┴─────────┐
       ┌─────────────────┐   ┌─────────────────┐
       │ Digital Center of│   │   Strategy &    │
       │   Excellence    │   │    Planning     │
       └─────────────────┘   └────────┬────────┘
                                      │
                             ┌────────────────┐
                             │ Digitalisation │
                             │ Chief Architect│
                             │  (Researcher)  │
                             └────────────────┘
```

Researcher's Position after Feb 2021 (I was promoted following my contribution to PDO's digital journey through the knowledge generated by this action research)

```
                    ┌──────────────────┐
                    │       CEO        │
                    └────────┬─────────┘
                             │
                    ┌────────┴─────────┐
                    │ Chief Information│
                    │ and Digitalization│
                    │     Officer      │
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                    │   Digital Center of  │
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                    │     Strategy &       │
                    │      Planning        │
                    │    (Researcher)      │
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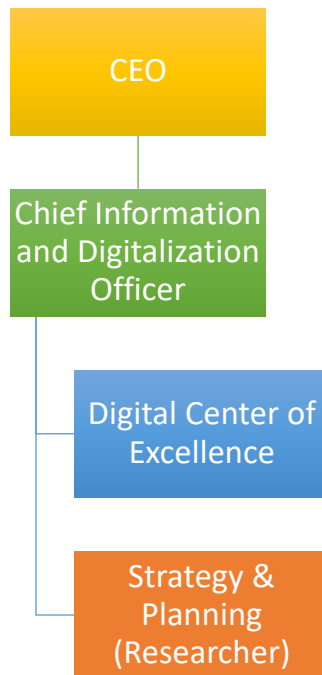
Appendix D1 – PDO Strategy Map

To be renowned and respected for the excellence of our people and the value we create for Oman and all our stakeholders

Shareholder's expectation

Value

Plateau production ≥550kb/d for 10yrs	Reserves & CR replacement >1
Grow Gas Business to support demand	Cross Company Continuous Improvement

Sustainability

No harm to people and the environment	Enhance social responsibility
Define, lead and increase ICV investment	

Key strategic themes

Maximise Recovery	Exploration	Deliver Projects as Promised	Operational Excellence	Cost Leadership
Minimise decline through WRM	Cream core plays	Embed CPD	Prioritise AIPSM	Implement structural change cost reduction initiatives
Make EOR work	Mature new plays opportunities	Make EMC/ODC work	Deliver operate & maintain improvements	Unlock value through Contracting & Procurement
Rejuvenate/rationalise aging assets	Make unconventionals work	Uphold project assurance & controls	Realise well delivery improvements	Pursue ICV opportunities in goods, services & skills in PDO & with contractors
Focus on water-floods	Exploit NFE/NI opportunities	Develop resource based project delivery plans	Reduce flaring	
Unlock CR portfolio	Commercialise tight gas	Drive improvements in project governance & execution management	Deliver energy efficiency improvements	Minimise NAG imports
Optimise condensate production			Ensure gas supply security	
Focus on depletion compression projects			Embed CWE	

Enablers

Proritise Safety	Attract, develop & retain staff	Embed Lean	Strengthen information management	Exploit new technologies	Enhance stakeholder engagement

Appendix D2– Nvivo Output Sample

Appendix E – Sample Consent Forms

UNIVERSITY OF
LIVERPOOL

Participant consent form

Version number & date: Version 10 – 30 March 2020

Title of the research project: Adoption of Digital Transformation within Oil & Gas: Case Study of Petroleum Development Oman

Name of researcher(s): Abdullah Sultan Al-Rashdi (IDP3)

Please initial box

1. I confirm that I have read and have understood the information sheet dated 2/4/20 for the above study, or it has been read to me. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☑

2. I understand that taking part in the study might involve taking part in one or more of the following methods: interviews, focus groups, and completion of questionnaires. The interviews and focus groups will use a combination of written and recorded interviews with my consent. The interviews and focused groups will be done remotely using skype for business or similar technologies given the COVID19 situation. ☑

3. I understand that my participation is voluntary and that I am free to stop taking part and can withdraw from the study at any time without giving any reason and without my rights being affected. In addition, I understand that I am free to decline to answer any particular question or questions. ☑

4. I understand that I can ask for access to the information I provide, and I can request the destruction of that information if I wish at any time prior to anonymization. I understand that following anonymization I will no longer be able to request access to or withdrawal of the information I provide. ☑

5. I understand that the information I provide will be held securely and in line with data protection requirements at the University of Liverpool until it is fully anonymised and then deposited in the school repository for sharing and use by other authorised researchers to support other researcher in the future. ☑

6. I understand that signed consent forms and original audio/video recordings/ questionnaires will be retained in secure computer until 5 years from the date of completion of the study. ☑

7. I agree for my personal data (name, email address) to be transferred into and out of the EU solely in relation to this research and solely in exchange of data between the researcher and the participant and the University of Liverpool personnel or partners. All exchanges shall by through end to end encrypted email. I have been informed of the safeguards in place to protect my personal data when it is transferred. ☑

8. I agree to take part in the above study and retain all legal rights. ☑

███████████	Date 05/04/2020	Signature
Researcher	Date	Signature

Appendix F- Participant Information Sheet

Participant information sheet

1. **Title of Study**

Adoption of Digital Transformation within Oil & Gas: Case Study of Petroleum Development Oman

2. **Version Number and Date**

Version 10 – 30 March 2020

3. **Invitation to participate in a research study**

I am doing a Doctorate in Business Administration with the University of Liverpool. I'm conducting a study on Digital Transformation in the Oil & Gas sector, using Petroleum Development Oman (PDO) as a case study. The purpose of the study is to develop a model for adoption of digital technologies within PDO. My role in the organization is to plan and develop the overall architecture for PDO Information Management & Technology including, but not limited to digital technologies and applications.

You are being invited to participate in this research study. Before you decide whether to participate, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and feel free to ask us if you would like more information or if there is anything that you do not understand.

Should you agree to take part, you will be asked to sign the attached participant consent form. You have one week to become familiar with the research and what it will involve. After reading both forms, if you agree to take part you will be informed of the schedule of interviews, focus groups and timing of the questionnaire completion. The interviews and focus groups will be conducted remotely using Skype for Business or similar technologies.

We would like to stress that you do not have to accept this invitation and should only agree to take part if you want to.

Please note that your responses will remain anonymous and confidential. If at any point during the interviews, focus groups or during the completion of the survey, you wish to withdraw your participation, you can terminate your involvement without explanation and your responses will not be recorded.

Thank you for participating in this research. If you would like to be kept informed about the result, kindly indicate your interest by sending me an email to Abdullah.al-rashdi@online.liverpool.ac.uk. If you have any further clarification, my contact details are below.

4. What is the purpose of the study?

The research is aimed at developing a model for how our company should go about adopting digital transformation. The research will use mixed methods where both qualitative and quantitative methods will be utilised for data collection and analysis. The research methods will complement each other. While quantitative methods will be used to assess levels in areas such as organisation digital readiness, digital capability, digital maturity, etc qualitative methods such as interviews and focus groups are aimed at understanding what adoption methods will be suitable and what barriers prevail within the organisation to successful digital transformation and how the organisation can coalesce around an agreed digital transformation strategy. The potential outcome of the research will a roadmap for how our organisation goes about adopting digital technologies.

5. Why have I been chosen to take part?

All participants have been identified based on their exposure to working or experimenting with digital technologies in their business units. These will include but not limited to Digital Business Leads, Business Unit Portfolio Consultants and business users within the Digital Centre of Excellence, as well as other staff who have been participating in digital projects in other parts of the organisation. As belonging to this group, you will be invited to take part in interviews, focus groups and complete a questionnaire. The data collection involves action research methodology so you may be asked to take part more than in once for each of these data collection methods. Due to COVID 19 these interviews and focus group discussions will be conducted remotely using Skype for Business or similar technologies.

6. Do I have to take part?

The participation is voluntary and that participants are free to withdraw their participation at any time, without explanation, and without incurring a disadvantage.

7. What will happen if I take part?

The research will be using a combination of quantitative (such as surveys) and Qualitative (such as interviews or focus groups) methods. The researcher (Abdullah Al-Rashdi) will be carrying these research methods during 2020. Although participation is voluntary, the participation requires the information about the participant's opinion to be recorded. This information will be analysed and accordingly developed into a model for how digital should be adopted in the organization under study. Any individual interviews will be undertaken in private virtual rooms using Skype for Business or similar technologies. All data and records will be securely held as described below. The anticipated time commitment in each interview and focus groups is approximately 60 minutes and will be audio recorded. The interview and focus groups will be conducted during working hours within the company compound (in private virtual meeting rooms using Skype for Business and similar technologies) to ease logistics. The surveys completion time is between 45 to 60 minutes. The survey will be an online survey sent to the participant's individual email.

8. How will my data be used?

All participant's data will be used for research purpose only. The University of Liverpool processes personal data as part of its research and teaching activities in accordance with the lawful basis of 'public task', and in accordance with the University's purpose of "advancing education, learning and research for the public benefit".

Under UK data protection legislation, the University acts as the Data Controller for personal data collected as part of the University's research. Abdullah S. Al- Rashdi (IDP3) acts as the Data Processor for this study, and any queries relating to the handling of your personal data can be sent to

Student Researcher: Abdullah Al-Rashdi
Email: Abdullah.al-rashdi@online.liverpool.ac.uk or abdullah.ash.rashdi@pdo.co.om.
Telephone: +968-24670119

The following table provides a summary of how the participant's data will be collected and used.

How will my data be collected?	Participant data will be collected in the form of interviews, focus groups and questionnaires
How will my data be stored?	Electronic data will be stored in the researcher's computer for a period of 5 years. Access will be password secured. Paper data will also be kept for 5 years and kept in locked storage facility.
How long will my data be stored for?	5 years
What measures are in place to protect the security and confidentiality of my data?	Any paper copies of research material will be kept in a secure, locked cabinet. All other data will be kept on password secured drives and regularly backed up to external systems for security.
Will my data be anonymised?	All participant's data will be anonymised
How will my data be used?	The data will be used for research purposes to help developing the Digital Adoption Model for the organisation.
Who will have access to my data?	The researcher, the supervisor, and UoL and their other authorised personnel.
Will my data be archived for use in other research projects in the future?	The collected data will be used for the purpose of the DBA thesis and then development, implementation and monitoring of the digital strategy for the organisation. The anonymised aggregate data may later be used by the organisation for digital related initiatives, but all personal details will have been removed.

How will my data be destroyed?	After the 5 years, all collected data will be deleted from all personal computers and external drives. Any paper data will be shredded. Anonymised data and research findings will be kept as part of company records and for future planning and strategizing of the digital transformation strategy.

9. Expenses and / or payments

The participant's will not get any payment as part of this research.

10. Are there any risks in taking part?

The participants have no direct reporting line to the researcher, hence there is no conflict of interest with regards to the participants of the study. There are no adverse consequences or risks in taking part in this research and nothing you say do will have impact negative on you. There are no personal or professional perceived disadvantages or risks involved in participating in this research. Should the participant experience any discomfort or disadvantage as part of his/her participation in this research, the participant can withdraw from the research by informing the researcher.

11. Are there any benefits in taking part?

The participants may benefit from the analysis done in this research as they are part of the digitalisation effort of the organisation.

12. What will happen to the results of the study?

A summary of results of the research will be made available to the participants. In addition, the results may be published in management journals.

13. What will happen if I want to stop taking part?

Participants can withdraw their participation in the study at any time, without explanation. Results up to the period of withdrawal may be used, if participants are happy for this to be done. Otherwise participants may request that the results be destroyed, and no further use iis made of them. As responses will be anonymised, participants may only withdraw prior to anonymisation, after which it will not be possible to

identify respondents and thus extract specific responses. Should you wish to withdraw please email the researcher, on the email shown below.

14. What if I am unhappy or if there is a problem?

If you are unhappy, or if there is a problem, please feel free to let us know by contacting the researcher Abdullah Al-Rashdi via email address Abdullah.al-rashdi@online.liverpool.ac.uk or Dr Shaukat Ali via email: shaukat.ali@online.liverpool.ac.uk   and we will try to help. If you remain unhappy or have a complaint which you feel you cannot come to us with then you should contact the University's Research Ethics and Integrity Office at ethics@liv.ac.uk. When contacting the Research Ethics and Integrity Office, please provide details of the name or description of the study (so that it can be identified), the researcher(s) involved, and the details of the complaint you wish to make.

The University strives to maintain the highest standards of rigour in the processing of your data. However, if you have any concerns about the way in which the University processes your personal data, it is important that you are aware of your right to lodge a complaint with the Information Commissioner's Office by calling (+44) 0303 123 1113.

15. Who can I contact if I have further questions?

Student Researcher: Abdullah Al-Rashdi

Email: Abdullah.al-rashdi@online.liverpool.ac.uk or abdullah.ash.rashdi@pdo.co.om. (IDP3)

Appendix G- MIT Sloan survey

Dear Participant,

I am doing a Doctorate in Business Administration with the University of Liverpool. I'm conducting a study on Digital Readiness & Maturity on Oil & Gas sector citing Petroleum Development Oman (PDO) as a case study. The purpose of the study is to assess the maturity of digitalization within PDO, and what PDO needs to do to improve its maturity. When referring to "my Business Unit" in the survey questions, it means your directorate.

This letter serves to invite you to participate in my research through the completion of this survey. Please feel free to contact me at Abdullah.al-rashdi@online.liverpool.ac.uk if you would like more information or if there is anything that you do not understand

If you decide to participate, you will be asked to share your opinions and beliefs regarding digital technologies. The survey is divided into 2 main parts; the first part is related to you as an individual and the second part is related to your opinion about the digital transformation maturity initiatives within your organization. The survey is around 45 questions and will take approximately 10 to 15 minutes to complete. Please note that your responses will remain anonymous and confidential.

If at any point during the survey you wish to withdraw your participation, you can terminate your involvement without explanation and your responses will not be recorded.

The survey can be accessed by clicking on the 'Next' button below.

Thank you for participating in this research. If you would like to be kept informed about the result, kindly indicate your interest by sending me an email to Abdullah.al-rashdi@online.liverpool.ac.uk. If you have any further clarification, my contact details are below.

Yours sincerely, Abdullah Al-Rashdi Email: Abdullah.al-rashdi@online.liverpool.ac.uk or abdullah.ash.rashdi@pdo.co.om. Telephone: +968-24670119

Section A – Demographics

1. What is your age?

a) Less than 25

b) 25-34

c) 35-44

d) 45-54

e) 55-60

f) 60+

g) Prefer not to answer

2) How long have you worked at PDO?

a) Less than 2 years

b) 2-5 years

c) 5-10 years

d) More than 10 years

e) Prefer not to answer

3) Which business unit you work for

a) Information Technology & Digitalization (IDD)

b) Infrastructure Directorate (UID)

c) Engineering Directorate (UED)

d) Operation Directorate (UOD)

e) Corporate Planning Directorate (UPCD)

f) Petroleum Engineering Directorate (UPD)

g) Finance Directorate (FD)

h) People Development Directorate (PDD)

i) Exploration Directorate (XD)

j) External Affairs Directorate (EVD)

k) Well Engineering Directorate (UWD)

l) Corporate Safety (MSEM)

4) Which of the following best describes your role

a) Digital Business Lead (DBL)

b) Digital Advisor

c) Digital Architect/Planner

d) Business Portfolio Analysts

e) Section Heads

f) Other

Section B – Digital Maturity

5) To what extent do you agree with the following statement: My Business Unit has a clear and coherent digital business strategy:

a) Strongly Agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Strongly Disagree

f) don't know or not sure

6) How would you characterize your business Unit efforts to develop as a digital business?

a) Leader

b) Fast Follower

c) Mainstream

d) Slow Adopter

e) Laggard

f) Don't Know or not sure

7) How far into the future does your Business Unit project when developing its enterprise digital business strategy?

a) One year or less

b) One to three years

c) Three to five years

d) Five to ten years

e) more than ten years

f) Don't Know or not sure

8) To what extent do you agree with the following statement: Being a digital business is important to the success of my Business Unit:

a) Strongly Agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Strongly Disagree

f) don't know or not sure

9) How much time, energy, and resources does your Business Unit spend implementing digital business initiatives?

a) Not nearly enough

b) Not enough

c) About the right amount

d) Too much

e) Much too much

f) Don't know or not sure

10) Is your Business Unit planning to invest a higher or lower amount in digital business initiatives in the next 12 to 18 months?

a) Significantly more

b) Increasing compared to previous years

c) About the same

d) Lower than previous years

e) Significantly lower

f) Don't Know or not sure

11) My Business Unit is using digital technology essentially:

a) To do what we've always done, but faster and cheaper

b) To do what we've always done, but faster

c) To do what we've always done, but cheaper

d) introduce new business models

e) To do business in fundamentally new and different ways.

f) Don't Know or not sure

12) When my Business Unit implements digital business initiatives, they tend to start as

a) Mostly Small Experiments

b) Mostly Wide and Coordinated PDO-wide experiments

c) Both small and wide experimentation

d) Not applicable

e) Don't Know or not sure

13) To the best of your knowledge, how would you best characterize the primary role of digital business within your Business Unit

a) Digital initiatives are a core part of our Business Unit strategy

b) Digital initiatives support certain business objectives, but they are not a core part of My Business Unit strategy

c) Digital initiatives are used in my Business Unit, but the business objectives aren't always clear

d) My Business Unit talk about digital business more than actually doing anything about it

e) My Business Unit does not pay much attention to digital business

f) Don't know or not sure

14) My Business Unit primarily drives digital business adoption and engagement internally through:

a) Cultivating a strong digital business culture that strives for risk taking, collaboration, agility, and continuous learning

b) Expecting employees to be motivated to embrace digital business opportunities

c) Mandating from management

d) Including in performance review

e) Recognition

f) Providing financial incentives Other

g) Don't Know or not sure

15) To the best of your knowledge, which specific technology is the most important to your Business Unit this year?

a) Analytics

b) Mobile Technologies

c) Internet of Things

d) Cognitive Technology / Artificial Intelligence

e) Robotic Process Automation (RPA)

f) Additive manufacturing (3D Printing)

g) Virtual reality

h) Other (please specify)

16) To the best of your knowledge, which specific technology will be the most important to your Business Unit in the next 3 to 5 years?

a) Analytics

b) Mobile Technologies

c) Internet of Things

d) Cognitive Technology / Artificial Intelligence

e) Robotic Process Automation (RPA)

f) Additive manufacturing (3D Printing)

g) Virtual reality

h) Other (please specify)

17) Imagine an ideal Organization or Business Unit utilizing digital technologies and capabilities to improve processes, engage talent across the organization, and drive new and value-generating business models. On

a scale of 1 to 10, how close is your Business Unit to that ideal?

1	2	3	4	5	6	7	8	9	10

18) What does your Business Unit need to do differently in order to progress toward this ideal?

a) Improve strategy and innovation

b) Develop better talent model (recruiting, developing, managing)

c) Better develop and deploy digital capabilities (e.g., analytics, cloud)

d) Increase Agility

e) Increase financial commitment

f) Improve Stakeholders Engagements

g) Other (please specify)

19) How would you characterize the outcome of digital business initiatives in your Business Unit to date?

a) Very Successful

b) Successful

c) Neither Successful nor Unsuccessful

d) Unsuccessful

e) Very Unsuccessful

f) Don't Know or not sure

20) What was the most important factor that contributed to the success or lack of success of your Business Unit digital business initiatives?

a) Strategy and vision

b) Leadership

c) Culture

d) Investment and commitment

e) Digital knowledge and experience

f) Implementation effectiveness

g) Communication and change management Talent

h) Technology

i) Organizational structure

j) Market and competition

k) Other (please specify)

21) To what extent do you agree with the following statement: My Business Unit management structure and practices (e.g., reporting relationships and decision-making processes) interfere with its ability to engage in digital

business successfully.

a) Strongly Agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Strongly Disagree

f) don't know or not sure

22) To what extent do you agree with the following statement: My Business Unit accepts risk of failure as a natural part of experimenting with new initiatives.

a) Strongly Agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Strongly Disagree

f) don't know or not sure

23) To what extent do you agree with the following statement: My Business Unit is actively implementing initiatives to increase agility in its response

to rapidly changing markets.

a) Strongly Agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Strongly Disagree

f) don't know or not sure

24) To what extent do you agree with the following statement: My Business Unit values and encourages experiments and testing as a means of continuous organizational learning

a) Strongly Agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Strongly Disagree

f) don't know or not sure

25) To what extent do you agree with the following statement: Collaboration across teams and divisions is recognized and rewarded as part

of our culture and operating model.

a) Strongly Agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Strongly Disagree

f) don't know or not sure

26) To what extent do you agree with the following statement: My Business Unit is increasingly organized around cross-functional project teams, not necessarily functions and divisions, to implement digital business priorities.

a) Strongly Agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Strongly Disagree

f) don't know or not sure

27) Collaboration at my Business Unit is done primarily through these channels: (Please select top three.)

a) Email

b) Scheduled, in-person local meetings

c) Conference calls

d) Video conference

e) Non-scheduled, in-person local meetings

f) Travel for in-person meetings

g) Social media platform

h) Simulation and virtual reality

i) Don't know / not sure

j) Other (please specify)

28) To what extent do you agree with the following statement: My Business Unit has sufficient talent today to support our organization's digital business strategy.

a) Strongly Agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Strongly Disagree

f) don't know or not sure

29) My Business Unit uses the following approaches to get sufficient talent to support our digital business strategy: (Please select top three.)

a) Develop and train existing employees

b) Recruit new employees

c) Hire contractors and consultants

d) Engage in external relationships (e.g., partners and other Social media and marketing external collaboration)

e) Recruit leaders

f) Participate in mergers and acquisitions

g) Leverage talent-market platforms to provide capabilities for digital business initiatives

h) Use crowdsourcing and competitions to provide capabilities for digital business initiatives

i) I don't believe my organization plans to get this talent

j) Don't know / not sure

k) Other (please specify)

30) What skills, abilities, or traits are most in demand at your Business Unit

to compete in digital business?

a) Technical skills

b) Analytics skills

c) Business skills

d) Social media and marketing

e) Creativity and innovativeness

f) Change oriented and exploratory

g) Business-technology skills

h) Leadership and management

i) Talent / resources

j) Communication and collaboration skills

k) Critical thinking and problem solving

l) Cultural diversity

m) Other (please specify)

31) My Business Unit is implementing initiatives to develop our talent to succeed in a digital business environment and drive continuous learning using: (Please select top three.)

a) Learning through experience working on opportunities across the

organization

b) Learning through internal (company-driven) programs, courses, and content

c) Learning through external (employee-driven) programs courses, and content

d) Learning through social learning collaboration platforms or communities that allow employees to share experience and knowledge

e) Learning through careers organized around cross-functional projects and assignments

f) My company isn't implementing initiatives to develop our talent and drive continuous learning

g) Don't know / not sure

h) Other (please specify)

32) To what extent do you agree with the following statement: My Business Unit effectively utilizes the digital knowledge, skills, interest, and experience held by our employees.

a) Strongly Agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Strongly Disagree

f) don't know or not sure

33) To what extent do you agree with the following statement: The geographic location(s) of my Business Unit hinders our ability to acquire sufficient digital talent to accomplish my Business Unit digital business

a) Strongly Agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Strongly Disagree

f) don't know or not sure

34) To what extent do you agree with the following statement: I expect my job to change considerably over the next 3 to 5 years as a result of digital business trends.

a) Strongly Agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Strongly Disagree

f) don't know or not sure

35) To what extent do you agree with the following statement: I am actively engaged at work, meaning I am enthusiastic about the work I do, committed to growing my skills, and dedicated to helping my Business Unit and colleagues succeed.

a) Strongly Agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Strongly Disagree

f) don't know or not sure

36) Do you tend to take on projects or assignments that leverage your existing strengths OR take on projects or assignments that require learning new skills?

a) Strongly Agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Strongly Disagree

f) don't know or not sure

37) To what extent do you agree with the following statement: It is important to me personally to work for a Business Unit that is a digital business leader.

a) Strongly Agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Strongly Disagree

f) don't know or not sure

38) To what extent do you agree with the following statement: My Business Unit provides its employees with the resources and/or opportunities to develop skills and opportunities to thrive in a digital business environment

a) Strongly Agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Strongly Disagree

f) don't know or not sure

39) Do you think the digital business trends impacting your Business Unit will significantly affect your decision about how long you will work at PDO?

a) Yes

b) No

c) May be

d) don't know or not sure

40) Explain why you think those trends will affect your decision about how long you work for PDO.

a) Company viability

b) Overall uncertainty about market, company, my job, tech trends

c) Career opportunities

d) Need opportunities to develop new skills

e) Want to work for a leader

f) Organization issues

g) Other (please specify)

41) Given digital business trends, I expect to work for PDO:

a) Less than one year

b) One to three years

c) Three to five years

d) Five to ten years

e) More than ten years

f) Don't know or not sure

42) To what extent do you agree with the following statement: Our leaders have the vision necessary to lead our digital business efforts.

a) Strongly Agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Strongly Disagree

f) don't know or not sure

43) Which leadership attributes do your leaders need more of to drive digital business transformation? (Please select top three.)

a) Experimentation mindset

b) Risk-taking attitude

c) Willingness to speak out; be challenging

d) Confidence in taking the lead

e) Relentless desire to excel

f) Emotional intelligence

g) Resilience

h) Don't know / not sure

i) Other (please specify)

44) How is your Business Unit developing leaders who have the skills and capabilities necessary to lead in a digital business environment? (Please select top three.)

a) Providing training to our existing leaders

b) Providing coaching to our existing leaders

c) Providing development (project and job-rotation opportunities) to our existing leaders

d) Recruiting leaders from outside our industry

e) Recruiting leaders from within our industry

f) Recruiting leaders from technology companies

g) No specific learning and development initiatives

h) Don't know / not sure

i) Other (please specify)

45) What are the biggest mistakes managers make with respect to digital business?

a) Lack of understanding of digital technologies and their impact

b) Lack of strategic direction

c) Resistant to change

d) Difficulty aligning the technology to the business

e) Insufficient talent and training

f) Difficulty planning and implementing initiatives

g) Moving too slowly

h) Focus on incremental change rather than transforming the business

i) Organization design is hierarchical and not collaborative

j) Overenthusiastic, driven by hype rather than analysis

k) Insufficient leadership commitment

l) Other (please specify)

Appendix H- Digital Capabilities Survey

Dear Participant,

I am doing a Doctorate in Business Administration with the University of Liverpool. I'm conducting a study on the required Business Capabilities to enable Digital Transformation in Oil & Gas sector citing Petroleum Development Oman (PDO) as a case study. The purpose of the study is to identify the main capabilities required within PDO to drive successful Digital Technologies Adoption. When referring to "my Business Unit" in the survey questions, it means your directorate.

This letter serves to invite you to participate in my research through the completion of this survey. Please feel free to contact me at Abdullah.al-rashdi@online.liverpool.ac.uk if you would like more information or if there is anything that you do not understand

If you decide to participate, you will be asked to share your opinions and beliefs regarding digital technologies. The survey is divided into 4 main parts; the first part is related to you as an individual. The second part addresses Digital Sensing

Capabilities. The third part addresses Digital Seizing Capabilities. The final part addresses the Digital Transforming capabilities. The survey is around 31 questions and will take approximately 5-10 minutes to complete. Please note that your responses will remain anonymous and confidential.

If at any point during the survey you wish to withdraw your participation, you can terminate your involvement without explanation and your responses will not be recorded.

The survey can be accessed by clicking on the 'Next' button below.

Thank you for participating in this research. If you would like to be kept informed about the result, kindly indicate your interest by sending me an email to Abdullah.al-rashdi@online.liverpool.ac.uk. If you have any further clarification, my contact details are below.

Yours sincerely, Abdullah Al-Rashdi Email: Abdullah.al-rashdi@online.liverpool.ac.uk or abdullah.ash.rashdi@pdo.co.om. Telephone: +968-24670119

Section A – Demographics

1. What is your age?

a) Less than 25

b) 25-34

c) 35-44

d) 45-54

e) 55-60

f) 60+

g) Prefer not to answer

2) How long have you worked at PDO?

a) Less than 2 years

b) 2-5 years

c) 5-10 years

d) More than 10 years

e) Prefer not to answer

3) Which business unit you work for

a) Information Technology & Digitalization (IDD)

b) Infrastructure Directorate (UID)

c) Engineering Directorate (UED)

d) Operation Directorate (UOD)

e) Corporate Planning Directorate (UPCD)

f) Petroleum Engineering Directorate (UPD)

g) Finance Directorate (FD)

h) People Development Directorate (PDD)

i) Exploration Directorate (XD)

j) External Affairs Directorate (EVD)

k) Well Engineering Directorate (UWD)

l) Corporate Safety (MSEM)

4) Which of the following best describes your role

a) Digital Business Lead (DBL)

b) Digital Advisor

c) Digital Architect/Planner

d) Business Portfolio Analysts

e) Section Heads

f) Other

Section B – Digital Sensing Capabilities

These are business capabilities required to scan the external environment for unexpected trends that could disrupt the organization. Please rate the following statements based on their relevance and importance if used within your business units

5) Continuous scanning for technological trends

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

6) Screening of Digital Competitors

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

7) Sensing customer-centric trends

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not	Not applicable to my business

have this capability in place)				important	unit

8) Analysing Scouted signals

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

9) Interpreting digital future scenarios

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

10) Formulating digital strategies

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

11) Establishing a long-term digital vision

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

place)					

12) Enabling an Entrepreneurial Mindset

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

13) Promoting a digital mindset

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

capability in place)					

Section C – Digital Seizing Capabilities

Seizing capabilities are a set of experimental capabilities that supports action and commitment by using techniques such as rapid prototyping and agile development to effectively balance risk and reward. Please rate the following statements based on their relevance and importance if used within your business units.

14) Creating minimum viable products

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

15) Considering a lean start-up methodology

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

16) Using a digital innovation lab

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

17) Balancing internal and external options

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

18) Scaling up innovative business models

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

19) Setting an appropriate speed of execution

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

20) Rapidly reallocating resources

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

21) Accepting redirection and change

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

22) Pacing strategic response

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

Section D – Digital Transforming Capabilities

Sensing and seizing capabilities help create and discover opportunities, but to execute a digital strategy, the organization need transforming capabilities to realize the full potential of strategic change. Please rate the following statements based on their relevance and importance if used within your business units.

23) Joining a digital Ecosystem

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

24) Interacting with multiple external partners

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

25) Exploiting new eco-system capabilities

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

26) Hiring an Experienced Digital Transformation Expert

Relevance (how relevant this capability to your business	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

unit)					
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

27) Digitalization of business models

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

28) Designing team-based structures

Relevance (how relevant this capability to your	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

business unit)					
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

29) Identifying digital workforce maturity

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

30) External recruiting of digital natives

Relevance (how relevant this capability to	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business

your business unit)					unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

31) Leveraging digital knowledge inside the organization

Relevance (how relevant this capability to your business unit)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit
Importance (how important to have this capability in place)	Strongly Relevant/Important	Relevant/ Important	Irrelevant/ Not important	Highly irrelevant/ Highly not important	Not applicable to my business unit

Appendix I – Structured Interviews Questions

Based on the Diffusion Of Innovation Theory, there are five main variables determining the rate of adoption of innovations, namely; the perceived attributes of innovations, type of innovation-decision, the communication channels, the nature of the social system and extent of change agents (Rogers, 2003). The structured interview questions are built to answer each of the above dimensions:

A- Relative Advantage Dimension

A.1- What were the main drivers to start this project?

A.2 - Did it improve the status quo at that time and in what way?

A.3 – Were the main objectives of the project achieved?

B- Compatibility Dimension

B.1- What was the perceived value of this new technology from users point of view prior to rollout?

B.2 - Was it something they would like to have and use?

B.3 – Was the cultural values compatible with this project prior to implementation?

C- Complexity Dimension

C.1- How complex was the new technology introduced by this project?

C.2- How easy the new technology to be used by the different users?

C.3 – What was the level of usability of the technology?

D- Trialability Dimension

D.1 – Were users given the chance to try the new technology prior to adoption?

D.2 – What was the user acceptance of the new technology upon trial?

E- Observability Dimension

E.1- To what extent was the new technology (introduced by this project) visible to others (e.g. for viral adoption)

F- Innovation Decision Dimension

F.1- How the decision to go for this technology was made?

F.2- How the decision on change requests were handled during the project execution and rollout?

F.3- What was the governance structure of the project looked like?

G- Communication Channels Dimension

G.1- How was the communication management was done?

G.2- What were the communication channels used?

G.3- How effective was the communication management?

H- Nature of Social System Dimension

H.1- How was the culture of the organisation prior to the introduction of this technology?

H.2 – Were there any cultural challenges with the introduction of this technology?

I- Change Management Dimension

I.1- How was the change management was handled?

I.2- How change agents are used to drive the change?

J- Project Documentation Dimension

J.1- Following the adoption of the technology, what were the main learnings?

J.2- Would you change anything if you have to re-do the project again?

J.3 – Is there any project documentation we can review for this project?

J.4 - Any feedback you think is essential for this research