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Dynamic Capabilities and Digital Transformation for Innovation in the South African Mining Industry

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A research report submitted to the Wits Business School, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Management in the field of Innovation Studies.

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Dedication

To my wife, you've supported me throughout this degree whilst enduring the toughest period in your life. Through thick and thin – we shall conquer it all. I love you.

Abstract

This case study research encapsulates the evaluation of digital transformation (DT) through dynamic capabilities on value realisation in the South African mining industry. The research focuses on a qualitative methodology in the form of semi-structured interviews. The following two research sub-questions have been analysed as part of this research: Dynamic capabilities enables DT in the South African mining industry; and DT enables and sustains value realisation in the South African mining industry.

Dynamic capabilities theories have been researched for several decades with many authors arguing that these capabilities are essential for firms to be successful and competitive in dynamic environments. Mining organisations have been slow to adopt technologies and this industry has a large impact on the gross domestic product (GDP) of South Africa. The operationalisation of dynamic capabilities was investigated to enable components of DT which in turn was evaluated to enable and sustain value in the South African mining industry.

A South African listed mining organisation was chosen as part of an embedded case study. Several levels of participants across The Firm as well as participants from its DT partners were interviewed. These interviews were scheduled for 60 minutes with additional questions being asked as a follow-up to the base set of questions. These interviews were recorded on Microsoft Teams with embedded transcription features through the utilisation of Microsoft Streams. However, these transcriptions required significant work as the base files included time stamps, spaces, inaccuracies, and metadata for phrases of sentences within the transcript. This additional work was conducted by the author to ensure the privacy of the participants as well as The Firm.

The transcripts were analysed several times utilising ATLAS.ti 9 which is a computer assisted qualitative data analysis software (CAQDAS). A thematic analysis was conducted, and the software assisted with codifying and interacting multiple inductive and deductive themes between the different participants. These interactions were additionally illustrated through Sankey diagrams utilising the software.

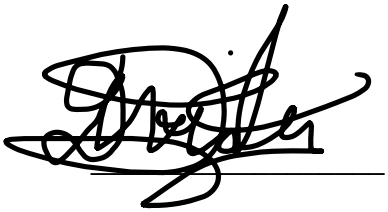
The deductive and inductive themes were analysed and concatenated as part of major themes which were found to be imperative in enabling DT through dynamic capabilities and realising value in the South African mining industry. All themes, ultimately affected the people, processes and technology of The Firm which impacted the enablement and sustainability of value.

The high-level findings were that the dynamic capabilities operational actions can enable DT, in an asset- intensive mining industry, through a phased approach of exploration, building and extending. Macro-level factors impact micro-level factors through dynamic capacities and dynamic capabilities processes. The components of DT enable and sustain value in a tangible and intangible manner where The Firm focuses on both qualitative and quantitative value with processes, methodologies, and frameworks in place to ensure value realisation, with several innovation concepts that were underpinned in the research.

Declaration

I declare that this research report is my own, unaided work. It is submitted in partial fulfilment of the requirements of the degree of Master of Management in Innovation Studies at the Wits Business School in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

WBS Master of Management in Innovation Studies



Dasheek Naidu

Table of Contents

List of Figures xi

List of Tables xii

Abbreviations and Acronyms xiii

1. Introduction 1

1.1. Purpose of the Study 1

1.2. Context of the Study 3

1.3. Research Problem Statement 3

1.4. Significance of the Study 4

1.5. Delimitations of the Study 5

1.6. Assumptions 5

1.7. Limitations of the Study 6

1.8. Definition of Key Terms 6

1.9. Research Questions 7

1.10. Outline and Structure of the Report 8

1.11. Conclusion 9

2. Literature Review 10

2.1. Introduction 10

2.2. Digital Transformation 11

2.2.1. Value Categorisation 11

2.2.2. Structural Changes 12

2.2.3. Impact Categorisation 12

2.2.4. Digital Transformation Definition 13

2.2.5. Enabling Digital Transformation 13

2.3. Digital Transformation in Mining 13

2.3.1. Technology in the Mining Sector 13

2.3.2. Technology Integration 15

2.3.3. Digital Transformation in South Africa – Research Gap 16

2.4. Theoretical Frameworks 18

2.4.1. Introduction 18

2.4.2. Overview of DCF 18

2.4.3. The Evolved Constructs of DCF 19

2.4.4. Dynamic Capabilities Framework Explanatory Concepts 20

2.4.5. The Practice of Dynamic Capabilities Framework 21

2.5. Operationalising Digital Transformation through Dynamic Capabilities 21

2.5.1. Dynamic Capacities 23

2.5.2. Dynamic Capabilities Process 24

2.5.3. Integration of Process and Capacities 25

2.5.4. Strategic intent and capabilities 25

2.6. Conceptual Framework 26

2.7. Propositions 27

2.8. Conclusion 28

3. Research Strategy and Methodology 30

3.1. Introduction 30

3.2. Research Strategy and Design 31

3.3. Selection of Participants 32

3.4. Research Methodology 34

3.4.1. Data Collection and instrument: semi-structured interviews 34

3.5. Data Analysis 35

3.5.1. The data analysis process 36

3.5.2. Transcription of interviews 38

3.5.3. The decision to use Computer Aided Qualitative Data Analysis Software (CAQDAS) 38

3.5.4. Familiarisation and Coding 39

3.5.5. Analysing the data using thematic analysis 39

3.5.6. Ensuring trustworthiness 40

3.6. Ethical Considerations 40

3.7. Reliability and Validity 41

3.8. Conclusion 42

4. Data Presentation 43

4.1. Introduction 43

4.2. Participants' Demographic Profile 43

4.3. Presentation of the Findings 45

4.4. Analysis Pertaining to Research Sub-question 1 55

4.4.1. Exploration 55

4.4.2. Building 61

4.4.3. Extending 69

4.4.4. Conclusion Research Sub-question 1 73

4.5. Analysis Pertaining to Research Sub-question 2 75

4.5.1. Mining Industry is Capital Intensive 75

4.5.2. Qualitative and Quantitative Value 76

4.5.3. Value in the Approach and Methodology 78

4.5.4. Enabling and Sustaining Value 79

4.5.5. Value Realisation Framework 83

4.5.6. Conclusion: Research Sub-question 2 84

4.6. Conclusion 86

5. Discussion of Results 88

5.1. Introduction 88

5.2 Research Sub-question 1: Discussion 88

5.2.1. Dynamic Capabilities 89

5.2.2. Development and changes amongst leaders 90

5.2.3. Change Management 90

5.2.4. Changes in Organisational Structure 91

5.2.5. Skills development of Employees 92

5.2.6. Agile and start-up Methodology 92

5.2.7. Changes in Organisational Culture 93

5.2.8. Summary 94

5.3 Research Sub-question 2: Discussion 97

5.3.1. Capital Intensity of the Mining Industry 98

5.3.2. Qualitative and Quantitative Value 98

5.3.3. Value in Technology Deployment Methodology 98

5.3.4. Value Realisation Framework 99

5.3.5. Summary 100

5.4 Innovation, Transparency, and Inclusivity 101

5.4.1. Innovation 102

5.4.2. Transparency and Inclusivity 103

5.5 Macro-level Factors and Embedded Dynamic Capabilities 103

5.5.1. Macro-level Factors 103

5.5.2. Embedded Dynamic Capabilities 105

5.6 Conclusion 106

6. Conclusion 109

6.1. Introduction 109

6.2. Major Findings 109

6.3. Overall Relevance 113

6.4. Recommendations 114

6.5. Limitations 114

6.6. Suggestions for Future Research 115

References 116

Appendix 1: Interview Protocol for semi-structured interviews 129

Appendix 2: Summary of Digital Transformation and Dynamic Capabilities Theory Definitions (From Literature Review) 133

List of Figures

Figure 1: Digitalisation of sectors relative to each other (Young & Rogers, 2019)..... 14

Figure 2: An eco-systematic approach to competitiveness in the era of the 4IR (Liu, 2017)..... 16

Figure 3: Adaptation of the research findings from Yeow et al. (2017). 25

Figure 4: Conceptual framework (author's own development) 26

Figure 5: Data analysis of the interview data adapted from J. W. Creswell & Creswell (2018)and Evans (2017)..... 36

Figure 6: Consent message that was displayed during the Teams recordings..... 37

Figure 7: A snippet from a VTT transcription file..... 37

Figure 8: Sankey diagram illustrating the operational actions were active/utilised across the various dynamic processes 73

Figure 9: Sankey diagram illustrating that dynamic capabilities has enabled multiple digital transformation aspects at various phases..... 74

Figure 10: Sankey diagram illustrating the components of digital transformation which has enabled or interacted with both tangible and intangible value as per the codifications in ATLAS.ti 9. 86

Figure 11: An adaptation of Figure 8 and Figure 9 which demonstrates the interaction between dynamic capabilities operational actions, dynamic processes and digital transformation. 96

Figure 12: Further analysis of Chapter 4 resulted in a concatenated interaction of Figure 11. .. 97

Figure 13: An adaption of Figure 10, illustrating those multiple themes/components of DT some of which highlighted in section 5.2 also enable and sustain value. 101

Figure 14: Updated conceptual framework which includes the influence of macro-level factors as well as the components of value. 104

Figure 15: Dynamic capabilities processes at a strategic level can enable capabilities that allow for dynamic capabilities processes to occur throughout the organisation as sub-levels outside the strategic level. 105

Figure 16: A combination of Figure 8, Figure 9 and Figure 10 to demonstrate the flow of how dynamic capabilities concepts interact to enable components on digital transformation which in turn enables and sustains value. 108

List of Tables

Table 1: Overview of the participants. 43

Table 2: Deductive themes based on conceptual framework and literature review. 47

Table 3: Inductive themes obtained through the analysis of the interviews. 51

Abbreviations and Acronyms

4IR – fourth industrial revolution

B-BBEE – Broad-based Black Economic Empowerment

BU – business unit

CAQDAS – computer assisted qualitative data analysis software

CEO – chief executive officer

DAU – data access unit

DCF – dynamic capabilities framework

E&P – exploration and production

GDP – gross domestic product

HR – human resource

IoT – internet of things

IT – information technology

JSE – Johannesburg Stock Exchange

MHSA – Mine Health and Safety Act No. 29 of 1996

MVP – minimum viable product

RBV – resource-based view

RoI – return on investment

RPA – robotic process automation

SADC – Southern African Development Community

SCADA – supervisory control and data acquisition

SingularityU – Singularity University

SoW – scope of work

UAV – unmanned aerial vehicle

VRIN – valuable, rare, inimitable, and non-sustainable

VRF – value realisation framework

VTT – video text track

1. Introduction

1.1. Purpose of the Study

The fourth industrial revolution (4IR) is driving digital transformation (DT) strategies across multiple sectors throughout the world (Yoo & Yi, 2022) as firms seek to remain relevant, competitive and profitable in volatile and hyper-competitive markets (Shuen et al., 2014). The mining industry,in general, is an industry that is rooted in archaic systems and has traditionally favoured incremental innovation over radical innovation strategies (Gao et al., 2019). However, the mining industry has recently shown an inclination towards DT in the pursuit of ever diminishing profitability as well as to ensure competitive advantage (Gao et al., 2019).

Several studies have argued that a firm's dynamic capabilities enable its successful DT strategy (Yeow et al., 2018;Warner & Wäger, 2019;Ellström et al., 2021). The dynamic capabilities paradigm offers an understanding of competitive advantage and value realisation that goes beyond the limited textbook models (Teece et al., 1997;Barreto, 2010) by providing a strategic framework which allows organisations to be sustainable and competitive in dynamic environments. Dynamic capabilities are distinguished from a firm's ordinary capabilities, which inform best practices and can be found within the marketplace and therefore can be bought (Teece et al., 1997). Ordinary capabilities include a firm's skilled personnel, facilities, and equipment as well as its processes and routines (Shuen et al., 2014;Schoemaker et al., 2018). In contrast, dynamic capabilities are the inimitable signature practices and differentiated business models used by competitive firms, and are rooted within a firm's heritage, culture, values, collective abilities and context-specific knowledge acquisition and learnings (Shuen et al., 2014). Consequently, dynamic capabilities cannot be purchased off the shelf unless the entire organisation is acquired (Shuen et al., 2014;Barreto, 2010). Dynamic capabilities when combined with a consistent, coherent strategy, that accommodates innovation, can co-determine a firm's performance and competitive advantage (Shuen et al., 2014;De Mendonca & De Andrade, 2018). Thus, as a firm develops its DT strategy it is essential that the firm has the strong ordinary capabilities as well as the dynamic capabilities to successfully drive value and competitive advantage during the DT journey.

South Africa has a long history of mining across several resources with various mining methodologies deployed in both underground and open-pit mines (Macmillan, 2017). Resource mining has a large impact on the GDP of the country, even though it has been declining over the years (Macmillan, 2017). The South African mining industry has been faced with numerous challenges some including but not limited to:

- Safety, with numerous injuries and deaths over the years (Macmillan, 2017)
- Financial pressure due to the cyclical nature of commodity prices (Neingo & Tholana, 2016)
- Labour unrests (Neingo & Tholana, 2016)
- Contamination of water (Ochieng et al., 2010)
- Impact on electricity supply and usage in the country (Ateba & Jurgens Prinsloo, 2019) and,
- Sustainability and environmental impacts (Masood et al., 2020).

Such challenges may present an opportunity for South Africa as well as similar developing countries to implement technologies as solutions to these problems. These technologies may form part of an organisational digital transformation drive focused on adding value to the organisation and its greater community.

The purpose of this study is to closely investigate the relationship between dynamic capabilities and DT in the mining industry in South Africa. As the mining industry modernises through various strategies, including DT (Young & Rogers, 2019;Peter, 2021), this study provides important insights into the DT landscape in South Africa generally and within the mining sector specifically. It will further provide insights regarding whether the dynamic capabilities are an enabler of DT strategies in asset intensive industries such as mining. As DT is more prominent in the ICT sector in Africa (Ndemo & Weiss, 2017), this research will provide innovative guidance to mining executives as well as partner firms and service providers on the implementation of DT through dynamic capabilities in the mining sector of South Africa. Additionally, the effects of people, process and technology through dynamic capabilities will provide mining decision makers and stakeholders with insight on enhancing their internal strategies and business processes (Young & Rogers, 2019;Verina & Titko, 2019). Furthermore, this research will provide guidance on how

to direct these strategies and processes to enhance DT in the mining sector generally, and within the South African context specifically.

1.2. Context of the Study

The research predominantly focused on an identified mining company in South Africa henceforth referred to as The Firm, and its associated DT partner firms, henceforth referred to as Partner Firms. Permission was obtained from both The Firm and the participants, with the condition of anonymity as requested by The Firm. The Partner Firms are the consultancy organisations that have been identified as strategic partners for the DT process. They have a high level of understanding of the DT environment and provided significant insights in respect of the processes, procedures, constraints, limitations, and successes of DT in the mining industry in South Africa. A similar methodology was adopted by the insightful article on DT in asset intensive industries by Gao et al. (2019). Additionally, some of these consultants and/or partners are ranked as lead providers by Gartner in the digital and analytical fields (Capgemini, 2020). The digital and analytical fields are highlighted as important components for DT (Young & Rogers, 2019).

1.3. Research Problem Statement

The global mining industry's performance has not improved in the past decade with significant declines on return of capital (Job & Mcaree, 2017). The South African mining industry contributes over 300 billion rands to the South Africa's gross domestic product (GDP) with approximately half a million employees and approximately 4 million direct dependents (Minerals Council of South Africa, 2020). This highlights the historical role of the mining sector in South Africa's economy, and although the sector's contribution as a percentage of GDP and technology edge (Ghebrihiwet, 2019) may have fallen in recent years it remains a significant source of economic growth and employment. Furthermore, several peripheral mining related (direct and indirect) industries also rely on the mining sector, highlighting the substantial economic and social impact of the sector (Ledwaba, 2017). Therefore, it is imperative to ensure the continued survival and sustainability of the industry amidst trends of diminishing profits. The GDP of South Africa and other Global South countries are highly dependent on mining, however, the research development and 'mining innovation' has shifted away from Southern Africa towards the Global North (Faccer et al., 2014).One of the strategies that a firm, in the Global South, may adopt in pursuit of maximising

value realisation and maintaining competitiveness is DT (Matt et al., 2015). However, DT may require that firms have certain dynamic capabilities that will ensure the successful adoption of a DT strategy. DT and dynamic capabilities are both prevalent research themes across several fields of study and within numerous peer-reviewed academic papers, as is discussed in detail in the literature review of this report. These papers have demonstrated the success of DT to add value to organisations through people, processes and technology (Young & Rogers, 2019); as well the ability of dynamic capabilities to ensure that an organisation is competitive in high volatility environments (Shuen et al., 2014). There is, therefore, an opportunity to identify and evaluate the effects of dynamic capabilities in pursuit of DT in the South African mining industry.

1.4. Significance of the Study

DT strategies have been both radically and incrementally adopted by several industries (Kutnjak et al., 2019). However, mining firms have been slow to adopt these strategies due to their existing infrastructure, systems, non-diverse workforce and issue regarding digital literacy (Young & Rogers, 2019). Nevertheless, there has been a notable shift, as mining firms seeking to remain competitive and profitable start to pursue DT strategies while taking into account the nuances of the South African industry (Monzon, 2021). As such, this study which examines DT in the mining sector of South Africa, will have far reaching implications for several stakeholders including, mining firms, service providers, industry experts, industry strategists, other asset intensive and related industries, policymakers in South Africa and beyond.

The study provided a natural extension of the dynamic capabilities framework (DCF) by determining its usefulness/applicability to other industries outside of the traditional technology industries[1] in which it was developed. It will further provide additional engagement with the work of Shuen et al. (2014), which sought to use dynamic capabilities within the oil and gas sector, and the work of Gao et al. (2019) on the limitations and structural constraints of DT in asset intensive industries. Furthermore, the research contributes to a wider understanding or knowledge of strategies within the mining sector, including but not limited to DT. Hence, these findings provide strategic insight and guide management on how South African mining

[1] IT, media and finance – later illustrated in Figure 1 (Chapter 2)

organisations can be competitive by developing dynamic capabilities, as also highlighted by Pisano (2015), with the intent of realising value through DT.

1.5. Delimitations of the Study

The scope of the research is limited to the mining industry in South Africa, with a focus on a single organisation, The Firm, and the selected case study participants and the selected Partner Firms. Therefore, other asset intensive industries and mines are not included within the scope of the study although the findings may be applicable to these industries as well. Furthermore, the decision to focus on the South African mining industry although intentional, does limit the study in terms of transferability to other countries even in the neighbouring Southern African Development Community (SADC) region and the African continent. This is due to the specific contextual and nuanced legislative, economic, geo-political, environmental and other factors that are specific to South Africa, which prevents the generalisability of the findings. However, certain findings may still be applicable in other geographical contexts. Finally, there is significant scope for similar studies to be undertaken in more countries and contexts, to provide more holistic and generalisable findings.

The interview component of this research is based on inputs from The Firm as well as several Partner Firms that assist/ed The Firm and other similar firms in the mining industry with their DT strategies and journeys.

The participants in this study are from the management, executive, operational and end-user bands of The Firm and the Partner Firms. The managers all fall within the innovation, technology, support, and operational functions of the, and will include the leaders responsible for initiating and driving the DT strategy.

1.6. Assumptions

The following assumptions were made:

- It is assumed that all the interview participants conveyed information honestly, openly and within their professional capacity.

- If participants were reluctant to be truthful and honest in the interviews it would have had a negative impact on the findings and relevance of the study. This was mitigated through the sample size and different types of participants.
- The views of the participants gathered from the interview process were used as a valid source of data and used to inform the findings of the study.
- All participants in the interviews have a detailed and/or expert level of understanding of the DT strategy and processes in the mining industry in South Africa.
- There is a relationship between DT and dynamic capabilities.
- There is a relationship between DT and value realisation.
- Participants are knowledgeable in firm practices and processes and/or company strategy.

1.7. Limitations of the Study

The limitations of the proposed research are threefold:

- The embedded, single-case study design that limits the research to a single-case study is primarily due to access and timeframe constraints and could possibly limit the generalisability of the research. However, the study should be possible to replicate within other mining companies in South Africa, Africa and beyond. The service providers additionally aid the generalisability, due to their wider professional network and experience.
- The decision to focus on the mining sector specifically, excludes other asset intensive industries which may have similar experiences. Thus, this study could have benefited from a multi-industry approach.
- The academic nature of the operationalisation of the DCF may made it difficult to articulate the questions in a way that is easily understood by all interviewees. As such, it was necessary to carefully construct the questions so as not to be exclusionary to those without the academic frameworks of understanding.

1.8. Definition of Key Terms

1. Digital Transformation - “DT is a process wherein organisations respond to changes taking place in their environment by using digital technologies to alter their value creation

processes" (Vial, 2019). The author adapted this definition by including inputs from both Vial (2019) and Young & Rogers (2019) as follows: DT is a process wherein organisations' people, process and technology "respond to changes taking place in their environment by using digital technologies to alter their value creation process".

2. Dynamic Capabilities Framework (DCF) - "A dynamic capability is the firm's potential to systematically solve problems, formed by its propensity to sense opportunities and threats, to make timely and market-oriented decisions, and to change its resource base." (Barreto, 2010).
3. Dynamic capabilities processes – A three phased approach of exploration, building and extending.
4. Dynamic capacities – include 'sensing', 'seizing' and 'transformation' which categorises the operationalisation actions of the DCF (Yeow et al., 2018).
5. Dynamic capabilities operational actions – are operational actions such as learning searching, scanning, calibrating, designing, committing, creating, accessing, leveraging and releasing. The operational actions form part of enacting the dynamic capabilities processes and are categorised as dynamic capacities.

For a comprehensive list of definitions that were utilised as part of the thematic analysis, refer to *Appendix 2: Summary of Digital Transformation and Dynamic Capabilities Theory*

1.9. Research Questions

Research question: *How could dynamic capabilities enable DT in the South African mining industry to ensure and sustain value realisation?*

This research question is further broken down into the following two sub questions:

Sub question 1: *How could dynamic capabilities enable DT in the South African mining industry?*

Sub question 2: *How could DT enable and sustain value realisation in the South African mining industry?*

1.10. Outline and Structure of the Report

Chapter 1: provides the purpose, context and research problem determined by the study. It further delves into the significance of the proposed study as well as its delimitations. A brief overview of the assumptions and key definitions of the proposed study. Finally, the chapter ends with the overarching research questions as well as the concluding remarks.

Chapter 2: presents a critical review of the existing literature on the topics and themes related to the research questions. The literature review focuses on peer reviewed articles that address the following four overarching themes:

- DT
- Operationalising DT through dynamic capabilities
- DT in the mining industry
- The DCF

Two gaps are highlighted in this section and posed as the research questions and propositions in Chapter 1 and Chapter 2. The literature review forms the basis for operationalising dynamic capabilities to implement digital transformation in order to realise value.

Chapter 3: presents the research methodology that will be used and explains how the chosen methodology assists the researcher in determining if dynamic capabilities enable DT in the South African mining industry. The primary research method of semi structured interviews was conducted. This chapter ensures that the methodology utilised ensures the correct data was collected in a manner that analysis can be conducted to answer the research questions.

Chapter 4 consists of a presentation of the data collected from the semi-structured interviews. This includes the results in relation to both research sub-questions as outlined in Chapter 1. Data was analysed utilising computer assisted qualitative data analysis software which integrated the both deductive and inductive themes to support the enablement and/sustainability of DT and value.

Chapter 5 presents an in-depth discussion and analysis of the data collected and presented in Chapter 4 by concatenating both deductive and inductive themes. This analysis is then supported by theory based on the literature review and conceptual framework. This analysis is conducted inline with the research questions.

Chapter 6 concludes the research and includes the major findings, overall relevance of the research as well as the recommendations. The chapter highlights how dynamic capabilities enable DT; and how DT can realise and sustain value in the South African mining sector.

1.11. Conclusion

In conclusion, the overarching concern of this research proposal is to determine whether dynamic capabilities enable DT in the mining industry in South Africa and whether digital transformation enables value realisation within the same. The reason for this study can be summarised as follows:

- DT in the mining sector is an under-studied phenomenon and is a fertile research ground for determining if the process enables value realisation. This research will thus provide guidance for management to implement digital transformation initiatives/strategies within the mining industry.
- The relationship between DT and dynamic capabilities has been addressed in the academic literature but there remains significant scope for additional research, especially from an operationalisation perspective.
- The Global South and Africa is an under-studied geographical area in innovation and management studies in asset intensive industries, and therefore case studies from the continent will provide nuanced perspectives on innovation processes, limitations, and successes in the developing world.

2. Literature Review

2.1. Introduction

This section of the research report provides an overview of the current literature on DT and the DCF. Integration of DCF and DT is further highlighted. An overview of the South African mining industry is provided and the application of dynamic capabilities as an enablement framework for DT in this industry is recommended. The following articles provided knowledge in both these areas, with three of these articles being review journal papers in the relevant subject:

- “Aligning with new digital strategy: A dynamic capabilities approach” (Yeow et al., 2018)
- “Understanding digital transformation: A review and a research agenda” (Vial, 2019)
- “A review of digital transformation in mining” (Young & Rogers, 2019)
- “Digital transformation in asset-intensive businesses: lessons learned from the metals and mining industry” (Gao et al., 2019)
- “Dynamic capabilities in the upstream oil and gas sector: managing next generation competition” (Shuen et al., 2014)
- “Dynamic capabilities and strategic management” (Teece et al., 1997); and
- “Dynamic capabilities: A review of past research and an agenda for the future” (Barreto, 2010).

These papers served as a primary source of knowledge with numerous secondary research articles as supplementary sources of information. Two research gaps have been highlighted as follows:

1. The application of dynamic capabilities in DT in the mining industry.
2. The implementation of DT in the South African mining industry.

Firstly, this chapter will highlight the concept of DT, arriving at a more adept definition for this research. Secondly, an overview of DT in mining is provided. Thirdly, a review of the DCF is conducted. Fourthly, the operationalisation of DT through DCF is reviewed. Fifthly, a conceptual framework is derived, and finally, the chapter concludes with the research propositions.

2.2. Digital Transformation

There have been numerous papers written on DT across several industries and disciplines within various countries. Many of the definitions of DT vary resulting in challenges in the clarity of the concept (Vial, 2019). Vial (2019) reviewed 282 research contributions with many of the DT technologies related to analytics, social platforms, cloud, mobile, Internet of Things (IoT), and with 4IR technologies such as blockchain beginning to emerge. These technologies often result in disruption by changing the expectation and behaviour of consumers, changing the landscape of competitiveness, and, increasing the availability of data (Vial, 2019). These digital technologies have expanded the field of innovation through concepts such as digital innovation[2] (Gregory et al., 2019); have facilitated other forms of innovation by digitising manual processes, products and business models; as well as facilitated the disruption of many industries and sectors through the concept of digital disruption[3] (Christensen et al., 2015). However, implementation of these technologies do not result in DT; DT is a process that increases in maturity over a period of time (Kane, 2017) and these technologies on their own add little to no value (Vial, 2019). Organisations need to respond to these disruptions strategically by leveraging these technologies to uncover new avenues of value realisation (Vial, 2019).

2.2.1. Value Categorisation

Vial (2019) categorises the redefinition of the creation of value as four major changes:

1. **New propositions of value** - such as augmenting or transitioning the sales of physical products to the sale of services.
2. **Value networks** - such as involving the seamless integration of multiple stakeholders.
3. **Digital channels** - such as new digital solutions to improve the brand of the organisation.
4. **Ambidexterity and agility enablement** - these technologies may allow firms to adapt quicker to environmental changes as well as opportunities to scale.

[2] Digital Innovation is defined as "…the creation of (and consequent change in) market offerings, business processes, or models that result from the use of digital technology" (Nambisan et al., 2017)
[3] Digital disruption is defined as "…the rapidly unfolding processes through which digital innovation comes to fundamentally alter historically sustainable logics for value creation and capture by unbundling and recombining linkages among resources or generating new ones." (Skog et al., 2018)

These components of value can be seen to add more than just monetary value and therefore consists of intangible value (Love & Matthews, 2019), which will be further highlighted in this research. Processes to sustain and enable value are also imperative with some researchers advising that value frameworks be implemented to ensure the realisation of value (Munir et al., 2018). To achieve this value an organisation usually undergoes several forms of structural changes.

2.2.2. Structural Changes

DT is associated with several structural changes which have the ability to bring about significant change in the organisation, these include: **organisational structure**; **organisational culture**; **development and changes amongst the leaders;** as well as, the requirement of **new or changes in the employee roles and skills** (Vial, 2019). As such, changes in the value processes result in numerous alignment issues as referred to by Yeow et al. (2018). Vial (2019) categorises these as inertia and resistance barriers, which emphasises the rigid nature of the successful core business to changes as well as the fatigue created by innovation or transformation. These structural changes may also be necessary to embark on a DT journey that results in value realisation, these structural changes can also be seen as an operational outcome of certain dynamic capacities which will be expanded in Section 2.5 (Yeow et al., 2018;Chirumalla, 2021).

2.2.3. Impact Categorisation

After overcoming these barriers and alignment concerns an organisation generally experiences four categories of impact as a result of DT, this includes:

1) **Organisational level impacts**, such as impact to organisational efficiency and the changes in business processes.
2) **Organisational performance**, such as firm growth, financial performance, competitive advantage, and reputation.
3) **Higher-level impacts**, such as impact to industry and societal levels.
4) **Undesirable outcomes**, not part of the above impact levels however mainly in the security and privacy domain (Vial, 2019).

2.2.4. Digital Transformation Definition

Taking into consideration the changes, value creation and organisational impacts, the following DT definition has been proposed: "*Digital transformation is a process wherein organisations respond to changes taking place in their environment by using digital technologies to alter their value creation processes*" (Vial, 2019). It is further necessary to highlight the importance of people in these processes as part of the organisation and value creation. A firm's people, process and technology is imperative in DT (Young & Rogers, 2019;Verina & Titko, 2019).

Taking the above into consideration, the following definition of DT is proposed:

"Digital transformation is a process wherein organisations' people, process and technology respond to changes taking place in their environment by using digital technologies to alter their value creation process"

2.2.5. Enabling Digital Transformation

This raises the question, how does an organisation deploy a DT strategy, in such a way that the technologies which are implemented ensure value is created, structural changes occur, and positive impacts are created?

The work of Yeow et al. (2017) argues that aligning an organisation with a new DT strategy requires a DCF approach. The authors then go further to develop an operationalisation aligning process that utilises the dynamic capabilities capacities as actions to support the components of their process. This is highlighted later in this chapter. In the next section, the contextual understanding of DT in the mining sector is provided.

2.3. Digital Transformation in Mining

2.3.1. Technology in the Mining Sector

Technology has had a significant impact on the mining industry and researchers have been invested in the change of technology in the industry for approximately 70 years, development

technology has assisted the mining sector significantly as processes moved from being labour intensive to more machine operated (Young & Rogers, 2019). Moving into the 4IR and what is noted as the 'first digital decade' (Young & Rogers, 2019), we have more data than ever created, with multiple emerging technologies (Liu, 2017). These technologies have been extremely beneficial to multiple industries, however, the mining sector has lagged behind other industries such as the media, IT, and finance & insurance industries as illustrated by Figure 1 (Young & Rogers, 2019).

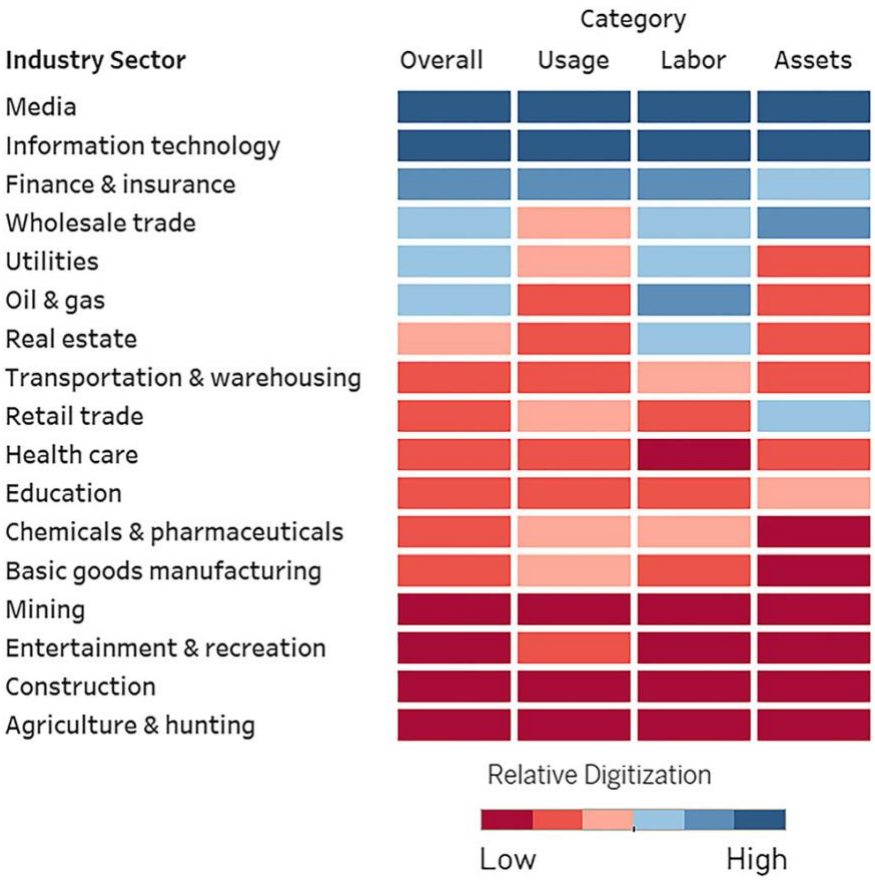


Figure 1: Digitalisation of sectors relative to each other (Young & Rogers, 2019)

Even though mining has been behind in comparison to other industries, there have been several innovative solutions based on emerging technologies and current technologies which has been part of DT processes, as highlighted by Sganzerla et al. (2016), including but not limited to:

- **Autonomous operations** – highlighting at the time that there were already over two hundred autonomous trucks operating on different mining companies. This initiative has a significant impact on safety and production improvements.
- **Mobility** – utilisation of geolocation devices has improved safety and production by controlling activity through geo-fencing in relation to other scheduled activities.
- **Analytics** – are being used to assist greatly in decision making but can be applied to other aspects such a detecting early failure of equipment.
- **Digital Worker** – the use of wearable technology such as augmented reality has increased maintenance activities and shown reduction in down-time of critical assets
- **Drones** – inspection of equipment (such as conveyor and powerlines) across long ranges are being conducted using unmanned aerial vehicles (UAVs) in combination with specialised cameras.
- **Intelligent sensors** – Are becoming more intelligent and powerful, such as video analytics combined with cameras. This is also further highlighted in the operational technology space by Young & Rogers (2019).

2.3.2. Technology Integration

Young & Rogers (2019), highlights the importance of data, connectivity and decision-making though DT in the mining sector:

- **Data** – the importance of the integration of operation technologies such as sensors on pumps with information technologies such as servers and networks. This allows for the flow of information at different layers through your technology stack.
- **Connectivity** – the structured movement of data is important and how it gets to its destination. For example, the movement of data from a truck to a server on premises or to the cloud servers in another country.
- **Decision-Making** – the ability to turn this data into insights for people to make decisions. Therefore, driving an integration between analytics and people which ultimately converts these decisions into value drivers for the business. The more advanced these technologies and processes, the more autonomous they may become ultimately removing the human from certain activities.

Young & Rogers, (2019) and Verina & Titko, (2019) emphasises that integration of the people, process, technology, connectivity, data, and decision-making may add significant value in the mining sector and identifies 12 areas that DT can enhance in the mining sector: education; workforce development; safety, transparency; supply chain management; reduces environmental impacts; innovation standards; operational excellence; alternative investments; lowering innovation hurdles; and, business intelligence. Hess et al. (2016) further recommends that companies need to continuously evaluate their technologies and digital strategies to ensure that they remain competitive in their respective industries.

2.3.3. Digital Transformation in South Africa – Research Gap

Liu (2017) developed an approach to competitiveness in the 4IR era which focuses on an eco-systematic approach.

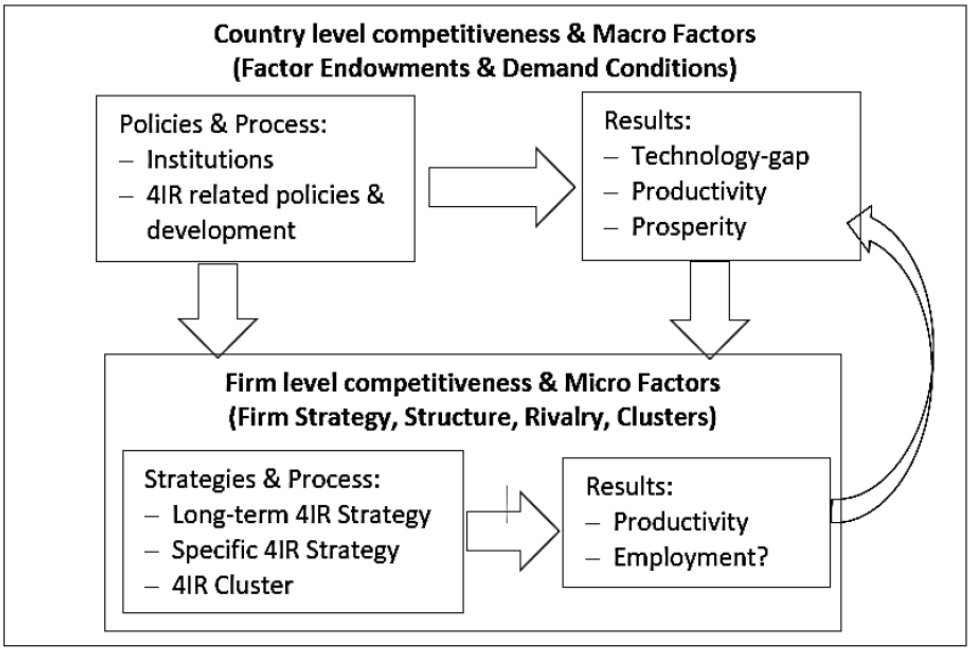


Figure 2: An eco-systematic approach to competitiveness in the era of the 4IR (Liu, 2017)

The approach highlights the integration between the macro-level factors such as policies and processes, macro technological-gap, productivity, and prosperity. The macro-level factors have a large impact on the competitiveness at a micro-level/firm-level (Liu, 2017). Therefore, highlighting the need for firms to have access to conducive macro environments which will impact the firm.

Similarly, this can be applied to the South African context and how macro-level legislation may affect DT in the South African mining firm, relevant legislation includes the Mine Health and Safety, Act No. 29 of 1996 (MHSA) (Mine Health and Safety Council, 2018). This serves as the main legislation in the mining industry in South Africa, thus adding distinctive nuances to the industry. Additionally, the macro-level infrastructure constraints are particular to South Africa as we see the impact of load shedding on paediatric hospitals (Gehringer et al., 2017), with Malikane (2015) demonstrating that poor institutional and physical infrastructure results in African firms excessively underutilising their capacity. These firms are further inhibited by higher financial lending interest rates (Lee, 2017). It is therefore argued that the macro-level factors highlighted by Liu (2017), which may impact the DT of mining companies in South Africa, will exhibit more context specific nuances than are highlighted in the primary source papers of this research. In addition, seminal papers such the Young & Rogers (2019) paper focuses on US companies and the Gao et al. (2019) does not highlight any African firms. Furthermore, Ndemo & Weiss, (2017) highlighted Africa's emerging DT in industries, with no mention of the mining industry in the paper. Taking the above into consideration including the high impact of mining on the GDP of South Africa - **there is scope for additional research of DT in the mining industry in South Africa which includes the industry specific micro and macro environments**[4]**.** The importance of DT in the South African mining sector can be tested by understanding its effects on value realisation. This also essentially means understanding the changes to people, process, and technology.

[4] It is important to note that DT in the South African mining sector has in the recent past, particularly in 2021, become an increasingly popular topic in the traditional media as evidenced by several news articles across various media platforms including miningnews.co.za (Phoshoko, 2021), Mining Review Africa (Peter, 2021), and NS Energy (Murray, 2021) amongst many others. In addition, consultancy companies such as Accenture released research reports on "Extracting value and building resilience with data-led mining in South Africa" (Accenture, 2020) and PricewaterhouseCoopers (PwC) collaborated with the Mining Council South Africa to release a report titled "The state of digital transformation in the South African mining industry: Ten insights into 4IR" (PWC & Minerals Council South Africa, 2021) which details how the mining industry is increasingly using innovative technologies in pursuit of value. This notable uptick in attention is evidence that there is a significant and increasing appetite in the South African mining industry for DT strategies in pursuit of value realisation and serves to further highlight the relevance of this research.

2.4. Theoretical Frameworks

2.4.1. Introduction

This section examines the DCF as both an operational mechanism and an explanatory tool at the firm-level. Three documents as primary sources were used in examining the DCF including a review paper. Numerous secondary research sources were also utilised to supplement the findings.

2.4.2. Overview of DCF

The DCF gained traction in the 1990s (Shuen et al., 2014;Barreto, 2010) and established academic recognition through the Strategic Management Journal in the 'Dynamic Capabilities and Strategic Management' seminal paper by Teece et al. (1997). The framework's definition, as per this paper, highlighted the capture of wealth creation and competitive advantage by firms in the ecosystems of rapid technological change (Teece et al., 1997). Its conceptual understanding began as the creators of the framework posited that firms operating in ecosystems that require competitive elasticity or long run advantage are not aided by 'textbook' traditional strategic management frameworks; these traditional frameworks include competitive forces or strategic conflict (Teece et al 1997;Warner & Wäger, 2019).

2.4.2.1. Resource-base-view vs Dynamic Capabilities

The DCF is an expansion of the resource-based-view (RBV) and is considered the foundational analytical model on which the DCF is developed. RBV essentially argues that the firm's long-term sustainable financial performance is dependent on its tangible and intangible resources (Shuen et al., 2014); it also emphasises the application in vertical integration and diversification within strategies (Teece et al., 1997). These resources create sustainable value as competitors are unable to replicate them. The protection of these resources is imperative and as such the resources should also be valuable, rare, inimitable and non-substitutable (VRIN) (Ambrosini & Bowman, 2009). The RBV further explains that through the sustainability of these heterogeneous resources, firms can be profitable in equilibrium, therefore resulting in a static perspective (Barney, 2001). The RBV framework doesn't accommodate for the updating of future resources

to accommodate dynamic environments, and therefore although DCF is an extension to the RBV, it also constitutes a major change to the professional practice as the firm's resource stock is required to change overtime (Barreto, 2010).

Within the definition of dynamic capabilities, 'dynamic' refers to the firm's ability or capacity to renew its existing capabilities to ensure congruence within the volatile and changeable business environment. This often requires innovative responses that are adaptive to rapid market and technological changes. 'Capabilities' is an emphasis on the role of management in aligning a strategy that can adapt, reconfigure and integrate: both external and internal skills, technologies, resources, and institutional competencies to meet the requirements of a volatile business environment.

2.4.3. The Evolved Constructs of DCF

Since the inception of the Teece et al. (1997) paper up until 2007 there had been approximately 1 500 papers which utilised the DCF (Barreto, 2010). The DCF has therefore evolved through several conceptual, simulative and empirical studies with several authors contributing to the field (Eisenhardt & Martin, 2000; Winter, 2003; Wang & Ahmed, 2007; Barreto, 2010;Menghwar & Daood, 2018). Barreto's (2010) review paper on the DCF presents the contributions from the several authors and proposes the following definition to overcome the limitations highlighted in the research domain:

"*A dynamic capability is the firm's potential to systematically solve problems, formed by its propensity to sense opportunities and threats, to make timely and market-oriented decisions, and to change its resource base.*"

The above definition can be broken down into four constructs:

- The tendency to identify threats and opportunities;
- Changing of the resource base applicable to the firm;
- To make decisions that are market-oriented; and,
- To make decisions timely.

The first two constructs are aligned with Teece et al. (1997) and its associated capacities, and the second two are illuminated through past research (Barreto, 2010). The definition proposed by Barreto (2010) and the one which is adopted in this research serves the dual purpose of making the DCF more operationalisable for future empirical research and addresses the opaqueness and complexity (highlighted as limitations) through the simultaneous adoption of the four constructs. However, there remain several concerns relating to the pragmatic operationalisation of the DCF as we are dealing with what Barreto (2010) refers to as 'unobservable constructs' and he as such recommends that a multi-variable approach is utilised for each construct. This can be conducted through a survey methodology or case study as further suggested by Barreto (2010), which can further elaborate on the sensing, seizing and transformation capacities. Yeow et al.'s (2017) research allows for these constructs to be captured through the operational actions in line with the dynamic capacities. The strength of dynamic capabilities in comparison to competitors is emphasised by Teece (2017) to have strong capabilities throughout all the dynamic capacities; therefore translating to strong operationalisation actions (Yeow et al., 2018;De Mendonca & De Andrade, 2018;Warner & Wäger, 2019).

2.4.4. Dynamic Capabilities Framework Explanatory Concepts

The DCF in a way transcends specifically identified business cycles, phases, and processes, to provide a framework that essentially examines several dimensions of the firm to identify the distinctive firm level competences and capabilities (Teece et al, 1997). These competences and capabilities which provide a firm with a competitive advantage are identified through three classes of factors, namely: **processes, positions,** and **paths** (Teece et al, 1997). In short, the essence of a firm's competitive advantage and dynamic capabilities is determined by management and organisational **processes**, which are the routines of current practices and learning within the firm. These **processes** are shaped by the firm's strategic (internal and market asset) **position**, which is its specific resources such as: technological knowhow; complementary assets; patents; customers; and its relationship with external actors, such as contractors and co-developers. The **processes** are further moulded by the firm's available strategic **paths**, which are the evolutionary and co-evolutionary attendant alternative paths available to the firm (Teece et al, 1997). It is important to note that within the DCF, strategic assets are distinct from a firm's fixed assets, which can typically be bought off the shelf and thus cannot be an explanatory variable for a firm's competitive advantage. Rather, the strategic assets are those competences and capabilities

within a firm that are institutionally built rather than bought from the market, and which are difficult if not impossible to replicate or imitate (Teece et al, 1997;Barreto, 2010)). As such, the DCF relies on a firm's distinctive processes, (strategic asset) positions and path dependencies to explain competitive advantage.

2.4.5. The Practice of Dynamic Capabilities Framework

As previously noted there is a large focus on intangible resources, also emphasised in the exploration and production (E&P) industries, rather than on a firm's physical resource base (gas, solar panel locations, oil, mineral deposits or ore bodies); the focus is on organisational capabilities which includes management as well (Shuen et al., 2014). This results in a change in practice for organisations that want to adopt the DCF. Zahra et al's. (2006) suggested methodology for the creation and evolution of dynamic capabilities is improvisation, imitation, and trial & error. This is in line with the concept of creating tacit knowledge in the Global South through: learning by doing, using and interacting (DUI) (Lundvall et al., 2009); therefore, emphasising the suitability of DCF in the context of South Africa. Additionally, the concepts of imitation, and trial and error are relevant in the theory of catch-up through secondary innovation (Wu et al., 2009). The DCF may then aid firms in the Global South with an approach to develop tacit knowledge as well as firms, with the requisite strategic intent, to catch-up through secondary innovation.

Therefore, the DCF is applicable to use in Global South countries as well as for emergent strategies within a dynamic landscape; and being applicable to DT which is known to have disruptive characteristics (Vial, 2019). Therefore, the DCF is adopted in this research. This incorporates aspects from concepts such as open innovation (Chesbrough, 2017), secondary innovation (Wu et al., 2010) and catch-up theory (Lee & Malerba, 2017) to aid in building dynamic capabilities and implementing DT.

2.5. Operationalising Digital Transformation through Dynamic Capabilities

Yeow et al. (2017) conducted a longitudinal analysis on a European fashion company that augmented, over a five-year period, their core 'business to business' model into a 'digital business to customer' model. It was determined that as an organisation embarks on a new digital strategy, tensions emerge due to misalignment between the current resources and emerging strategy. This

study resulted in the development of a three phased alignment model with that of the dynamic capacities of the organisation. These three phases include: **exploring, building and extending**, and are applicable in the operationalisation of a digital strategy (Yeow et al., 2018).

Yeow et al. (2017) further emphasised that digital strategy alignment is necessary as organisations face the difficulty of digital strategy articulation in the context of a dynamic environment, also highlighted by Shuen et al. (2014) in the E&P industry.

Therefore, alignment is fluid and a process that continuously aligns to the moving emergent strategic target; and is an iterative process which is impacted as the organisation's skills develop (Yeow et al., 2017). In addition, a digital strategy is multifunctional and requires simultaneous changes in information technology (IT) and, development and reconfiguration of resources across several processes in the organisation. Digital strategy is therefore inherently multifunctional according to Yeow et al. (2017). Yeow et al. (2017) define aligning "as a set of actions", they further note that digital strategy may require changes which "…take place beyond individuals" and therefore apply the aligning process at an organisational level.

Past investments in processes and resources associated with IT and business may create dependencies which make it difficult for companies to create new resources or processes in support of the emergent strategy (Yeow et al., 2018), this is further highlighted by the barriers raised by Vial (2019). This creates tensions that arise between the struggle of continuing with current processes and supporting the new digital strategy through the creation of new processes (Teece et al., 1997). Teece et al. (1997) further highlight that paradoxical approach which requires organisations to explore both exploitation of current strategy and exploration of emergent strategy should be followed. This paradoxical tension is more likely to be accepted by an organisation that exhibits dynamic capabilities (Yeow et al., 2017). The DCF focuses on strategic change which is fundamental in the research of IT alignment; even though DCF may be common across organisations it still may be idiosyncratic in its details (Yeow et al., 2018;Warner & Wäger, 2019;De Mendonca & De Andrade, 2018).

2.5.1. Dynamic Capacities

The sub-activities as part of the dynamic capacities (sensing, seizing and transforming) are pivotal organisational actions which impact the manner in which the alignment process unfolds (Shuen et al., 2014) especially when embarking on a digital strategy (Yeow et al., 2018; Ellström et al., 2021). The micro-foundations of dynamic capabilities was explored by the seminal author (Teece, 2007) and Yeow et al. (2017) further elaborated on the sensing, seizing, and transforming as well as their operationalisation sub-actions:

- **Sensing** – is the process of identification, assessment, co-development, and development of environmental opportunities inclusive of technology. This is conducted in relation to the needs of the customer. Sensing can be operationalised through scanning, learning, and calibrating. *Scanning* is the firm's attempt to acquire information to explore and understand opportunities in the markets, including creating new markets or new business models. Strategic tools such as scenario planning (P. Schoemaker, 1995) can be used to enhance scanning by providing insight into possible risks, opportunities and additional insights of different scenarios. *Learning* is the firm's efforts to acquire additional insight and to monitor and assess potential opportunities. *Calibrating* is the efforts of the firm to further review, make sense, and to refine previous efforts which were made with regards to the chosen opportunities.
- **Seizing** – involves selecting, designing, and committing as operationalisation actions. Seizing are the firm's efforts to capture value from the opportunities identified through the sensing capacity. *Designing* are the firm's efforts which focus on the creation and planning of new firm structures and business processes. *Selecting* are efforts of the firm to choose between the different design options and additional potential opportunities. *Committing*, are the firm's efforts to make decisions on the execution of the chosen design as well as decisions with respect to the choices of: services, business model, partner, and/or processes.
- **Transforming** – refers to efforts made by the organisation to change its resources to align with the emergent strategy. This dynamic capacity is operationalised by creating, leveraging, releasing, and accessing actions. *Leveraging* is the action which aligns current resources with building new capabilities in support of the new strategy. *Creating* refers to

the formation of new resource, structures and processes which complement each other to create new products/services or capabilities. *Accessing* is making use of external capabilities to achieve internal requirements (capabilities). This practice is further emphasised by the concept of open innovation (Chesbrough, 2015) and specifically focuses on outside-in innovation. Finally, *Releasing* is cutting back on current resources which do not support the current strategy.

2.5.2. Dynamic Capabilities Process

Yeow et al. (2017) applied the operationalisation actions of dynamic capabilities to their developed process of exploration, building and extending:

- **Exploration** – is the process phase in which the organisation 'explores', scopes or searches for opportunities. Opportunities are identified and a strategic commitment is made.
- **Building** – the organisation focuses on designing and changing its processes and resource base to support its committed strategy.
- **Extending** – as the capabilities develop new alignment issues arise or additional effort is required. This requires further development on the building phase, focusing on improving the new capabilities and processes developed within the organisation.

Their findings were that within each of these processes an element of sensing, seizing or transformation may exist. However, their application maybe different or in different proportions as these phases focuses on different periods in the DT process.

The sensing, seizing, and transforming capacities may not all always occur in sequence. For example, in the Yeow et al. (2017) case study it was necessary for the chief executive officer (CEO) to transform the structure and create (transform) a Head of Digital position before seizing opportunities in the build phase.

2.5.3. Integration of Process and Capacities

Figure 3 is the adaptation of Yeow et al.'s (2017) research findings. Each of the phases may incorporate a singular or combination of dynamic capacities and these capacities are achieved through individual or multiple operationalisation actions.

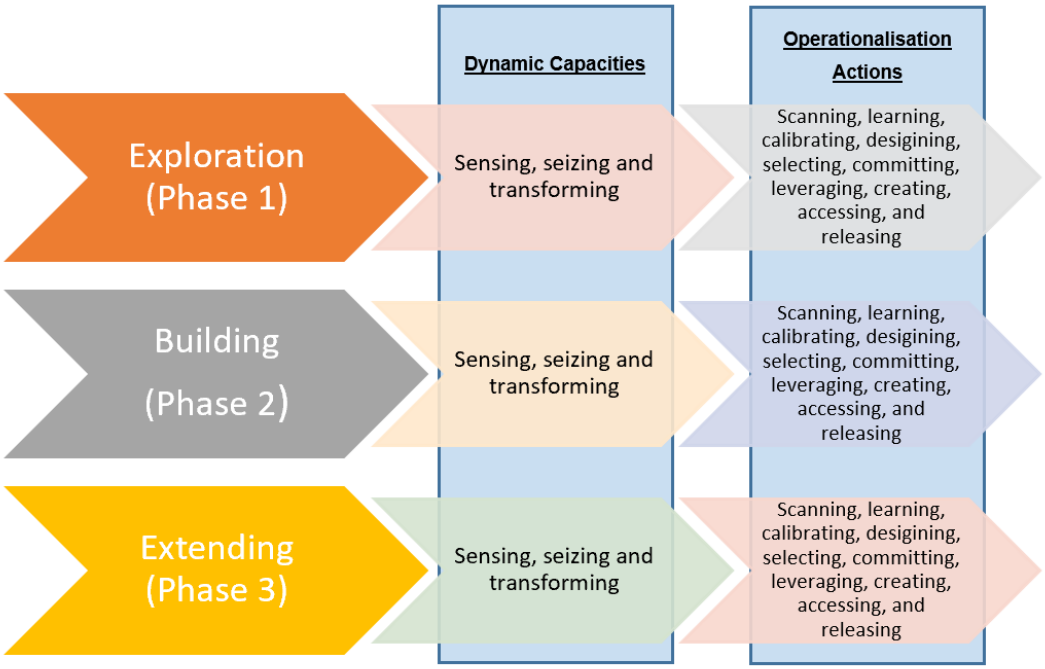


Figure 3: Adaptation of the research findings from Yeow et al. (2017).

Even though the operationalisation of dynamic capabilities in DT is highlighted in the literature, **the operationalisation of dynamic capabilities in DT in the mining sector is not clear from this literature review. This is therefore highlighted as a research gap in this research report.** These operationalised capabilities is tested against the enablement of DT in the South African mining sector as part of this research.

2.5.4. Strategic intent and capabilities

It is important to note that operationalisation of these capabilities are guided by the overarching firm's strategy as highlighted by Goffin & Mitchel (2016) in their Pentathlon Framework and by Teece et al. (1997) in the importance of strategic paths. This strategy or emergent strategy may

guide areas of focus within the organisation or in entirety. An example could be the golden ratio and strategic focus area of investment for the organisation, this could be broken into different innovation pursuits by the organisation (Nagji & Tuff, 2012):

- Core Business – enhancing current services and/or products for the current customers
- Adjacent Business – leveraging the current core to expand into a business that is new to the organisation
- Transformational Business – creating inventions and breakthroughs for markets that may not currently exist.

The golden ratio is the percentage of innovation investment in to the above 3 areas (Nagji & Tuff, 2012) and DT can be applied collectively or individually as per the organisations strategic intent (Yeow et al., 2018).

2.6. Conceptual Framework

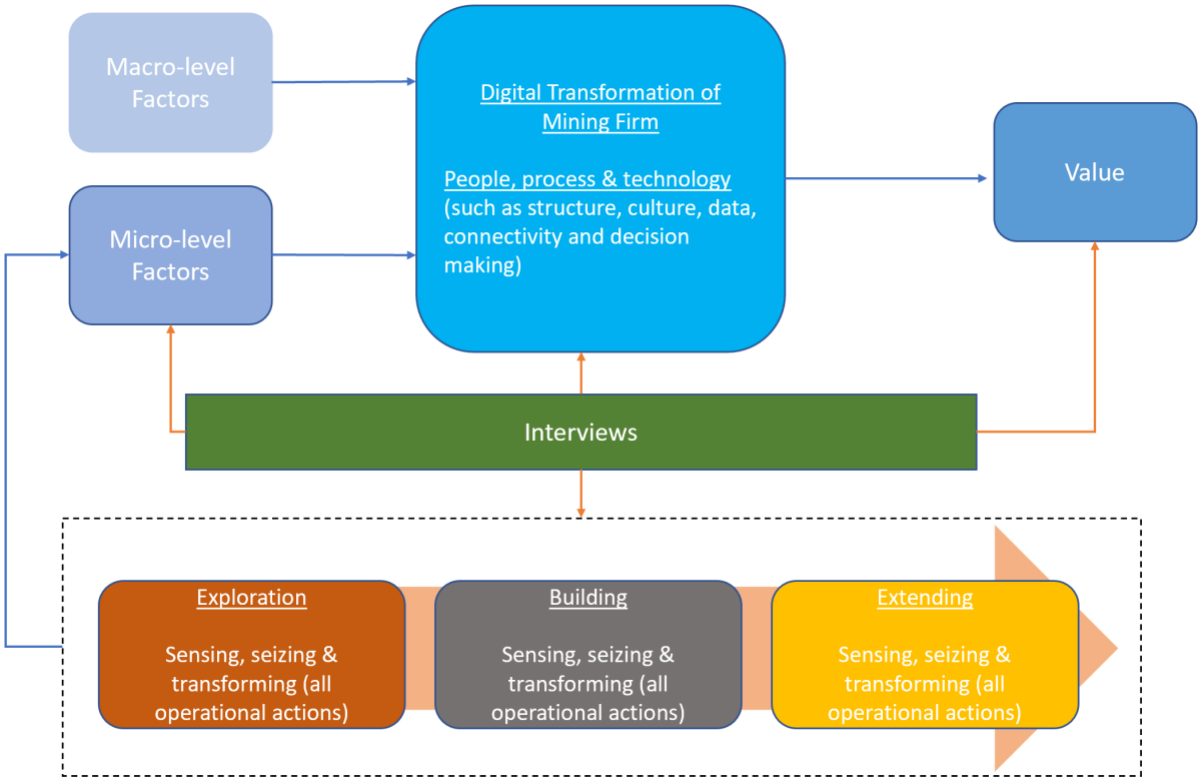


Figure 4: Conceptual framework (author's own development)

Figure 4 highlights the conceptual framework of this research proposal and incorporates the findings from Teece et al. (1997), Yeow et al. (2017), Verina & Titko (2019), Liu (2017) and is also applicable to other secondary findings in this research proposal. Verina & Titko (2019) argue that DT is affected by drivers that can be internal or external, which in turn affect the people, process and technology that then yield results, this is also similarly highlighted by Young & Rogers (2019). The external drivers on the firm has been adopted as macro-level factors and the internal drivers as micro-level drivers (Liu, 2017). It is these micro-level drivers which can be aligned to a new emerging DT strategy by applying the exploration, building and extension operationalisation actions through the application of the dynamic capacities of sensing, seizing, and transformation (Yeow et al., 2018). The new micro-level factors transform the people, processes, and technologies to support DT which results in value realisation or competitive advantage for the South African mining firms. Semi-structured interviews as explained in the next chapter will be utilised to unpack the conceptual framework's components. The sub-component definitions of the conceptual framework can be found in *Appendix 2: Summary of Digital Transformation and Dynamic Capabilities Theory,* this is utilised to assist with aligning the thematic analysis with the conceptual framework.

2.7. Propositions

Research question

How could dynamic capabilities enable digital transformation in the South African mining industry to ensure and sustain value realisation?

Research sub-question 1

How could dynamic capabilities enable digital transformation in the South African mining industry?

Proposition 1: It is proposed, based on the literature, that dynamic capabilities enable a firm to digitally transform by implementing new capabilities aligned with the firm's strategic intent. These capabilities are created through a phased approach such as 'exploration', 'building' and 'extending' which embed the process of enacting dynamic capacities through dynamic

operationalisation action. These operationalisation actions enable components that affect or comprise of DT, such components include, organisational culture, organisational structure, changes in leaders, development of employees, etc. These new capabilities enhance existing capabilities that enable the emergent strategy.

Research sub-question 2

How could digital transformation enable and sustain value realisation in the South African mining industry?

Proposition 2: It is proposed (based on the literature) that DT can create new or enhance existing value realisations avenues which affect people, process, and technology. Additionally, research highlights that improvement in data and connectivity leads to better decision making which enhance new or existing value. The DT components either impact value directly or result in solutions or further developments that enable and sustain value. This enablement and sustainability are further affected by change in processes, methodologies and frameworks that ultimately impact tangible and intangible components of value.

It is important to note that the enablement of these propositions is dependent on following a process. For example, the adoption of technology may not be successful if there is no leadership buy-in (Kane et al., 2015;Prasad & Junni, 2016) or extensive change management within the organisation (Rosenbaum et al., 2018). These two criteria can be seen later as themes that emerged as a part of embarking on a dynamic capabilities process. Similary, there are factors that affect the enablement and sustainability of value such as (not limited to) the capital intensity required to deploy the technology (Gao et al., 2019); as well as implementing a value realisation framework (Love & Matthews, 2019). Therefore, the converse applies to the research propositions, certains factors/themes if not conducted correctly may not result in DT or the sustainability and enablement of value realisation.

2.8. Conclusion

This literature review utilised several primary and secondary peer-reviewed papers to highlight and review the concepts of DT as well as the DCF. A more adept definition of DT was established

for this research as well as an in-depth review of the operationalisation of DT through the DCF. A conceptual framework is derived by combining macro and micro level factors together with the concepts of DT and the operationalisation of the DCF. Research propositions for the research questions were proposed based on this literature review. The next section highlights the methodology and research strategy that will guide the establishment of outcomes to the research questions incorporating the above literature review.

3. Research Strategy and Methodology

3.1. Introduction

This research is rooted in the pragmatic paradigm. A paradigm or worldview provides a basic philosophical and methodological orientation and approach to the assumptions or beliefs of the research (Creswell & Creswell, 2018). Pragmatism is a paradigm that is concerned with actions, experiences, situations and consequences and there is thus an overarching concern with applications and solutions to problems (Creswell & Creswell, 2018). As such, rather than pursuing absolutism through 'truth' or 'reality', pragmatism focuses on 'what works' (Weaver, 2018). The choice of pragmatism as the paradigm of this research is rooted in the pursuit of pragmatic and solution orientated applications of the findings, in the hope that they will have an impact both on management studies and innovation studies generally, but also on DT in the mining sector of South Africa.

From an epistemological and ontological perspective, pragmatism is not bound by a singular philosophical system or conception of reality (Weaver, 2018). Pragmatism is seen as a *via media* of positivist and post/anti positivist meta-theoretical perspectives as there are no *a priori* models, propositions, or assumptions that shape knowledge (Brandi & Elkjaer, 2011). As such the dualities of reality within the contrasting philosophical orientations of, for instance positivism and interpretivism, are avoided by the pragmatic paradigm (Brandi & Elkjaer, 2011). Within the epistemology of pragmatism, the distinctions between the knowledge of the practitioner and the knowledge of the researcher are considered both complementary and necessary within management studies research (Brandi & Elkjaer, 2011) which makes it a viable paradigm for the innovation studies research that was conducted in this paper. In addition, pragmatism can draw from both qualitative and quantitative assumptions when undertaking a research project, resulting a paradigm that favours a wide array of research designs, methods, techniques and approaches to data collection and analysis (Creswell & Creswell, 2018;Mouton, 2001). Pragmatism, according to Brandi & Elkjaer (2011), emphasises that absolute certainty about knowledge is impossible, and thus embraces a "…[F]allibilistic epistemology in which experience develops through action and thinking in the process of inquiry, critical thinking, or reflection".

Consequently, within the pragmatic paradigm it can be argued that epistemology and ontology distinctions are not separate philosophical categories (Simpson, 2019). Although the pragmatic paradigm has largely been overlooked in business and management research, it offers significant scope for engaging with the dynamics associated with human and social practices and processes within innovation studies (Simpson, 2018). As such, by using pragmatism this research has sought to provide practical and operational insights that are potentially transferable to other mining firms and/or asset intensive industries.

Instead of relying on either inductive or deductive reasoning, it is within the pragmatic paradigm that the researcher will move between induction and deduction (Morgan, 2007). The deductive reasoning starts from the theoretical base and the associated propositions, in this case DCF and DT, and thereafter draws conclusions from the data. In contrast, inductive reasoning uses the data as the point from which new insights and frames are determined (Joffe, 2012). As such, the dualistic deductive/inductive approach to reasoning, formed the basis of the thematic analysis conducted during this research, this is discussed in more detail in the Data Analysis section below. The pragmatic paradigm makes use of the most suitable methods of research, which may be qualitative, quantitative or a mixed methods approach. Due to the broad nature of DT and dynamic capabilities, the study could have benefited from a mixed methods approach, however for the purposes of this research a qualitative approach was deemed more appropriate due to time and resource constraints.

3.2. Research Strategy and Design

The research made use of an embedded, single-case design. The embedded, single-case design involves several units of analysis which occur at more than one level (Yin, 2018). The pragmatic paradigm allowed the requisite flexibility and reflexivity in selecting a research design (Kaushik & Walsh, 2019) and therefore the embedded, single-case study is appropriate in terms of the chosen research paradigm. The research design was deemed suitable in terms of answering the research questions as it provided insights into the DT journey and strategy as well as the dynamic capabilities of The Firm identified in South Africa, which can then be used to extrapolate findings to other similar mining firms in the country, and beyond, as well as possibly other asset intensive industries. The decision to use an embedded single-case study design, and not a multiple case study design, was informed by the research done by Gao et al. (2019) on DT in asset intensive

industries. The paper used several mining firms and partner firms to define the single case study iteratively, through the shared contexts of the mining firms and the partner firms (Gao et al., 2019). This research intends to follow a similar approach but will use a single mining firm, the Firm, and multiple Partner Firms The request by the firm was that no additional data other than the form of interviews were provided.

In this regard The Firm is the primary unit of analysis and the various levels of responsibility within The Firm, such executives, managers, operational and end-users of digital products, would be the identified sub-units of analysis. Furthermore, the Partner Firms, that are assisting the identified mining firm with its DT journey, are also classified within the sub-units of analysis. Thus, in summary, the primary unit of analysis is the identified mining firm in South Africa, The Firm, and the sub-units of analysis are twofold: on the one hand the levels of responsibility within The Firm are sub-units that provide depth to the single case study design, and the Partner Firms provide breadth to the research.

The embedded, single case-study of an identified mining firm in South Africa was deemed feasible owing to the researcher's access to the primary unit of analysis, as well as the identified sub-units, time constraints in terms of the requisite timeframe for completion of this research report as well as access constraints to additional firms. In addition, permission and access was granted by The Firm for purposes of the study. Furthermore, The Firm has adopted a DT strategy and has been on a DT journey since before 2015, which makes it a viable and valuable case study.

The Partner Firms that formed part of the study are firms that have been part of or contributed to the DT journey of The Firm. These will include solution partners, technology implementation partners, culture strategists and business improvement partners.

3.3. Selection of Participants

The embedded, single-case study design was based on a mining firm in South Africa, The Firm, as the primary unit of analysis. The Firm was selected due to its size, scope, and significance in the mining industry in South Africa, as well as its active and transparent pursuit of DT strategies. The Firm is also hypothesised to be representative of other mining firms that are operating within the nuanced macro environment of South Africa and has been on a DT journey for a relatively

long period of a time. In addition, The Firm was willing to share information by allowing the researcher to conduct anonymous interviews with various levels of employees as well as with Partner Firms. Permission to collect information from the interview participants was obtained in writing from the chief executive officer (CEO) of The Firm.

The various sub-units (different levels of responsibility) that comprise the depth of the research were determined to provide a more holistic sample of interviewees and to avoid selection bias that would have occurred if only members of the executive, for instance, were interviewed. The decision to engage with four levels of responsibility provided a more in-depth understanding of DT within The Firm and whether dynamic capabilities enabled the process, as well as determine the value realisation from DT. The four levels of responsibility included:

- *Executive level:* The executive level provided detailed insights into the overall strategic intent and strategic direction of the firm, which serves as the foundation for the decision to pursue DT. In addition, this level provided details on the broad dynamic capabilities that enable the DT process.
- *Management level:* The management level within the firm provided insights into the strategic consequences of DT approaches and processes, as this level is responsible for driving the strategies determined by the executive level. In addition, the management level has the most direct observations into the dynamic capabilities within the firm.
- *Operational level:* The operational level, such as plant or equipment personnel, provided a tactical overview of the firm's DT processes, as this level is responsible for operationalising the processes within the business units (BUs) of the firm.
- *End-user level:* The end-user level, people who use the product but are not included in the above 3 categories and could include subject matter experts, was instrumental in understanding the operationalisation of dynamic capabilities in pursuit of DT strategies.

In addition to the above, emphasis was placed on additional personnel in the IT and digital function as well as the core business operational function as highlighted in Yeow et al. (2017). Misalignment as well as progress occurs during the integration of these two department during the DT process (Yeow et al., 2018). It was determined that this aligned with the findings relating to The Firm.

The various sub-units that comprise the breadth of the research, engagement with the Partner Firms provided a broader perspective of the DT process, that went beyond The Firm and its subordinate sub-units. The Partner Firms were selected for the subject matter expertise on DT in the mining industry, as well as their in-depth knowledge of the capabilities, both ordinary and dynamic, that are necessary to pursue a DT strategy.

This is an example of convenience or nonprobability sampling in which the participants in the interview are selected due to access and availability (J. Creswell, 2009). This method of sampling was selected due to the time constraints of the research and assisted in preventing unnecessary delays in seeking out additional participants.

3.4. Research Methodology

The research approach that was used within this study is the qualitative approach, which focussed on semi-structured interviews with the abovementioned sub-units of analysis within the embedded single-case study.

The qualitative approach of the research took the form of semi-structured interviews of the various sub-units of analysis as identified above. The questions were initially developed before the start of the research and were refined and adjusted as necessary. Follow-up questions were also asked when required in order to increase the breadth and/ or depth of responses (Roberts & Hyatt, 2019). The content of the interviews was developed in accordance with academic literature as outlined in the critical literature review in Literature Review as well as from deliberation with academic experts within the Master of Management in Innovation Studies. There was also a focus on directing questions to answer the operationalisation actions as also highlighted in Literature Review of this research. *Appendix 1: Interview Protocol for semi-structured interviews* provides an overview of the semi-structured interview questions that guided the research.

3.4.1. Data Collection and instrument: semi-structured interviews

The primary research instrument used for data collection within this research were semi-structured participant interviews. Interviews are a common data collection method within qualitative modes of inquiry (Roulston & Choi, 2018). Semi-structured interviews are a dominant

qualitative data collection method, as they allow researchers to explore and gain insights into the subjective realities and viewpoints of participants (Evans, 2017). The semi-structured interview data collection technique was deemed appropriate for this research paper as it provided perceptions, interpretations, and understandings of the relationship between dynamic capabilities and the enablement of DT from various stakeholders within the mining industry in South Africa, as well as the relationship between DT and the enablement of value realisation within the same. This data collection method proved invaluable in gaining the insights and lived experiences of the DT journey within The Firm as well as the subjective understanding of dynamic capabilities and value realisation amongst. The semi-structured interview questions and sequencing were open-ended and often led by the participant rather than the researcher (Roulston & Choi, 2018). Further, follow up questions (also known as probes) were formulated in relation to the answers and discussion of the participants (Roulston & Choi, 2018). Throughout the course of the interviews, various follow-up questions and tangential discussions emerged, which provided valuable depth and breadth to the scope of the answers to the questions.

The interviews were conducted online to mimic as closely as possible the in-person format within the limitations of the Lockdown Regulations in South Africa (South African Government, 2021) as well as to reduce the risk of exposure to the Covid-19. With permission, the interviews were audio-recorded and then transcribed by the researcher and supplemented by the observational notes made by the researcher during the interview process. Standard interview protocols were be observed, and all participants were asked the same set of questions although there were some nuances in the sequencing and/or framing and/or probing of each question. There were no noticeable concerns during the interviews and all participants provided permission through signed consent forms.

3.5. Data Analysis

The data analysis method for this research was conducted in terms of the qualitative approach and used a thematic data analysis for analysing the data from the semi-structured interviews. The data collected in the process of the qualitative data collection method was coded utilising ATLAS.ti 9 which is a computer-assisted qualitative data analysis software, the decision to use this is expanded on in The decision to use Computer Aided Qualitative Data Analysis Software (CAQDAS) section below.

3.5.1. The data analysis process

The process followed to analyse the interview data can be seen in Figure 5 which was adapted from in Creswell & Creswell (2018) and Evans (2017).

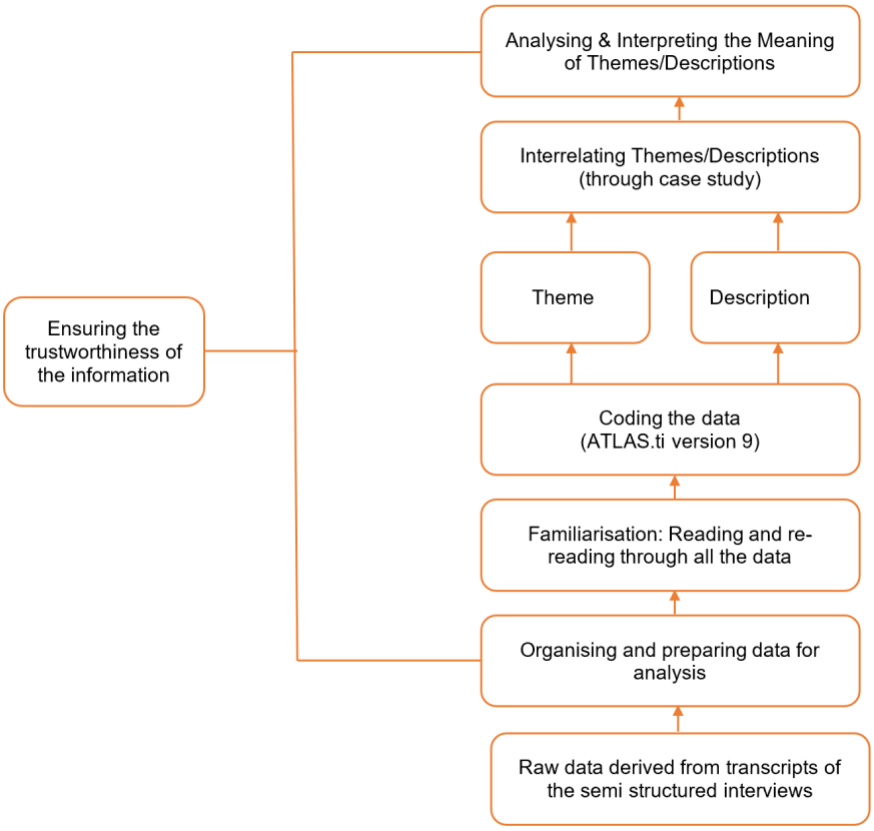


Figure 5: Data analysis of the interview data adapted from Creswell & Creswell (2018) *and* Evans (2017)

All participants provided signed consent for permission to use the data as well as record the interview for transcribing purposes. The interviews were conducted on Microsoft Teams[5], all participants (both employees and partners) had active directory accounts[6] which allowed the interviews to be conducted abiding to the organisation's IT policies as well as automatically

[5] Microsoft Teams form part of the Microsoft 365 software package suite and provides users with virtual space to virtually hold meetings and includes video conferencing features (Microsoft 365, 2020).
[6] An active directory account are accounts within The Firm's domain (Microsoft, 2021a). The Partner Firms are provided with active directory accounts so that they had access to The Firm's systems, could integrate more easily and be more efficient. The partners were permitted similar access to employees.

translated through the Microsoft Streams[7] which was the embedded system at the time. In addition, a message as per Figure 6 below was displayed during the recording:

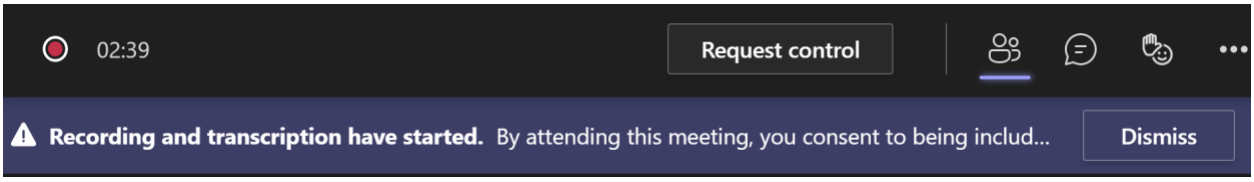


Figure 6: Consent message that was displayed during the Teams recordings

This resulted in a transcription video text track (VTT)[8] file which was accessible through Microsoft Word. However, the transcriptions were not accurate, consisted of time codes, metadata, and extra lines (as seen in Figure 7) which required analysis and deletion by the author. The author chose not to use any external services or software to protect the privacy of the participants and The Firm.

```
NOTE Confidence: 0.8277515

1d49aba0-b269-4fda-8b16-76e9e85e2bcb
00:00:02.710 --> 00:00:05.510
I see the has is it showing is

NOTE Confidence: 0.8277515

78780869-a7e5-40bb-8682-8da0858a2c95
00:00:05.510 --> 00:00:07.996
a recording on your side 'cause

NOTE Confidence: 0.8277515

4c9a6ddd-9551-4572-a870-893d8e08fa37
00:00:07.996 --> 00:00:10.546
it's saying pending on my side.
```

Figure 7: A snippet from a VTT transcription file

[7] Microsoft Streams in a secure Enterprise Video service by Microsoft 365 that allows organisations to safely upload, share and view recordings (Microsoft, 2021b)
[8] A VTT file is a text file that contains information from a video file including the transcriptions, descriptions, and meta-data (Fileinfo.com, 2021).

3.5.2. Transcription of interviews

The process of transcribing the interviews from audio, into VTT, and then into the final format was long and laborious owing to the decision to manually do the transcriptions rather than to outsource or use software online. This decision was made to ensure the privacy of the participants, The Firm as well as the Partner Firms. In addition, by doing the transcriptions manually, it afforded the researcher with an opportunity to get acquainted with the raw data, remove identifying features, as well as ensure the integrity and accuracy of the transcription. As noted by Morris (2018), the importance of ordering, labelling, storing and documenting the transcriptions was a key focus during the transcription phase of this research. Furthermore, the linguistic divergences between oral and written text were also kept in mind during the transcriptions process (Brinkmann & Kvale, 2019), and are reflected in the quotes used in Data Presentation.

3.5.3. The decision to use Computer Aided Qualitative Data Analysis Software (CAQDAS)

The decision to use CAQDAS for this study is embedded in the need to analyse a significant quantity of qualitative data that was derived from the 14 interviews conducted. Given the scope and depth of the interviews, the amount of data derived was deemed untenable to analyse using archaic and traditional interview analysis. CAQDAS assists in the management and coding of collected data (Lucas, 2018) which was extremely useful given the significant number of codes that were identified both deductively and inductively during the interviews. In addition, the ability of CAQDAS to illustrate relationships between codes, themes and clusters of meaning through conceptual maps was essential for analysis and answering the research questions (Seale, 2011). ATLAS.ti[9] 9 was selected as the CAQDAS for this study as it was most easily accessible to the researcher.

ATLAS.ti is a workbench CAQDAS initially developed in the late 1980s that systematically assists in structuring, organising, and storing the data acquired from structured and semi structured interviews (Paulus, 2018). ATLAS.ti was a significant analysis tool during the data analysis phase

[9] Archive for Technology, Lifeworld and Everyday Language. text interpretation (Paulus, 2018).

of the research and has assisted in identifying, describing, and organising the constellations of meaning within the interview dataset.

3.5.4. Familiarisation and Coding

Following the completion of the transcription, a process of familiarisation and immersion with the data was an essential first step to ensuring that the researcher engaged with and gained insight into the dataset from the interviews conducted (Terry et al., 2014). This included a level of familiarisation gained during the transcription as noted above, and then an intensive reading and rereading of the transcripts preceding the coding phase. The next analytical step focused on the coding of the interview data using ATLAS.ti 9 as noted above. Coding, according to Brinkmann and Kvale (2019), can either be concept driven, data driven or both. Concept driven coding is a process of coding in which the researcher develops the codes in advance and then deductively applies them to the collected data (Brinkmann & Kvale, 2019). In contrast, data driven coding is an inductive process of developing codes while reading and re-reading the collected data (Brinkmann & Kvale, 2019). Joffe (2012) notes that there is little point in not drawing on the naturalistically occurring themes evident in the data itself, and therefore proposes the utilisation of both the deductive concept driven coding process as well as the inductive data driven process. Through the coding process, it was determined that the emergent clusters of meaning fell both within the DCF operational action codes and outside of the theoretically determined codes. As such, the nascent codes and themes were both deductively and inductively determined. This is illustrated by the tables in the Presentation of the Findings section in Chapter 4 below.

The coding process favoured complete coding over selective coding, in that all data deemed relevant to the research question was coded (Braun & Clarke, 2013), and a process of selectivity took place during the thematic analysis.

3.5.5. Analysing the data using thematic analysis

Thematic analysis in its simplest form refers to the qualitative process of analysis that primarily focusses on identifying, organising and interpreting data obtained the text of the rich qualitative dataset (King & Brooks, 2018). The emergent patterns of meaning derived from the abovementioned codes were iteratively delineated into the themes, which captured and identified

recurrent and distinctive significant patterns in the coded data in relation to the research questions (Castleberry & Nolen, 2018). Two core processes were used during the thematic analysis process, firstly, defining themes inductively and deductively and secondly, organising the themes, the latter ensured that the structure of the themes represented the conceptual relationship between the themes (King & Brooks, 2018). The themes, as with the codes, were continuously reviewed to ensure they were relevant to answering the research questions in a structured narrative manner (Bhattacherjee, 2012).

Chapter 4: Data Presentation, is the presentation of the codes and emergent, pertinent quotations were selected in support of the identified themes. This was done in relation to each of the research questions individually. Chapter 5: Discussion of Results finalises the thematic analysis by engaging with the identified themes in relation to the supporting literature in terms of each research question.

3.5.6. Ensuring trustworthiness

The process of ensuring trustworthiness of the analysis process was ongoing during each progressive step. This research followed the methods of trustworthiness outlined by Nowell et al. (2017) which included but was not limited to: keeping the raw data in organised archives; keeping detailed notes of the hierarchy and development of codes and themes; and, thick descriptions of the analytical process. The reliability and validity are deliberated in section 3.7 Reliability and Validity below.

3.6. Ethical Considerations

This research ensured that it subscribed to the ethical standards as noted in the University of the Witwatersrand ethical standards which subscribes to the Singapore Statement (University of Witwatersrand, 2021). This research obtained approval from the Wits Ethics Committee in February 2021. Furthermore, this research strictly adhered to the ethical considerations regarding plagiarism and the accurate attribution of sources. The following ethical considerations with regards to human participants in the study have been highlighted:

- Ethical consideration regarding data collection included ensuring the agreement of gatekeepers of the Firm that provided access to the participants. Within this research this included the figures of authority within the identified mining firm. In this regard, a letter was drafted, as per Creswell's (2009) recommendation, that included the anticipated time required, as well as the potential impact and outcomes of the research.
- The issue of confidentiality of participants was also a primary ethical concern in this research. Where confidentiality refers both to the identity of the participants and the information obtained through the interviewing processes. In this regard, the participants were informed before the interview of what would happen to their data. All participants were assured that the data will be kept in strict confidence, and that no-one other than the researcher will have access to the data (Roberts & Hyatt, 2019). Each participant was assigned an identifier alphabetical code to protect their identity (Roberts & Hyatt, 2019).

3.7. Reliability and Validity

The reliability and validity of this research is concerned with the qualitative methods used within the study.

In terms of the qualitative methodology the reliability and validity of the research results were in line with the quality criteria for qualitative research as noted by Korstjens & Moser (2018):

- *Credibility:* In quantitative research it is considered the equivalent as internal validity. Credibility is concerned with 'truth-value', and the strategy used in this research to ensure credibility was the use of data triangulation. Triangulation refers to the use of numerous sources of data during analysis to enhance the credibility and enrich the understanding of the research being conducted (Hastings, 2012). The data triangulation was achieved using various data sources i.e., the different levels of the identified research firm as well as the addition of the partner firms.

- *Transferability:* Is established using thick description of the results of the research. In this regard, the research provided details and descriptions of the contexts of the interviews rather than using pure data.

- *Dependability & Confirmability:* There will be a thorough audit-trail of all the steps taken throughout the research project and included the process of ensuring trustworthiness as discussed in section 3.5.6: Ensuring trustworthiness.

3.8. Conclusion

In conclusion, this research is rooted in the pragmatic paradigm. A qualitative method was adopted due to the resource and time constraints of the study. The research design is an embedded, single-case study, of an identified mining firm in South Africa (The Firm) as well as its identified DT partners (Partner Firms). In this regard, the unit of primary analysis is The Firm identified as well as several sub-units of analysis were identified within the levels of responsibility in The Firm and the Partner Firms. The selection of participants was identified as being convenience sampling due to time and access constraints. The semi-structured interviews was the primary data collection method and was conducted with 14 participants from the Firm as well as the Partner Firms. The data analysis procedures for the qualitative data was adapted from Creswell & Creswell (2018) and Evans (2017) but also made use of several other methodology resources. The ethical considerations as well as the reliability and viability of the chosen research methodology was also deliberated. The next section will present the data obtained by executing the above research strategy and methodology.

4. Data Presentation

4.1. Introduction

This chapter documents the study outcomes which were acquired by the techniques and methods outlined in Research Strategy and Methodology. The key informants and primary sources of information are the participants, who were interviewed online to reduce the risk of exposure to the Covid-19 virus. Each interview was scheduled for sixty minutes. ATLAS.ti 9 was utilised to codify themes according to the conceptual framework and research question outlined in Literature Review. Additionally, inductive themes that were derived during the initial analysis were also codified.

The findings are presented through quotations, narrative, graphical and tabular formats (Bhattacherjee, 2012). Participant quotations are documented as close to verbatim as possible, however filler words such as “ah”, “um”, etc, and identifying features were removed. When, identifying features were unable to be removed, it was replaced by a term within square brackets. The quotations are extracts from the transcriptions of the participants.

4.2. Participants’ Demographic Profile

Fourteen interviews were conducted which included nine direct employees of The Firm and five employees from three Partner Firms that were integral in the DT process of The Firm. Participants were from various organisational roles with varying titles. Thus, the participants were categorised into executive, managerial, operational and end-user levels, as seen in Table 1, in accordance with Section Selection of Participants. Table 1 further highlights the effort which was required during transcription by illustrating a reduction in the page numbers from the original VTT.

Table 1: Overview of the participants.

Number	Participant	Level	Organisation	Original VTT Transcript Page Numbers	Edited Transcript Page Numbers

1	Participant A	Executive	Partner Firm 1	146	15
2	Participant B	Manager	Partner Firm 1	105	10
3	Participant C	End-user	The Firm	83	9
4	Participant D	Manager	The Firm	73	7
5	Participant E	Executive	The Firm	134	13
6	Participant F	Executive	The Firm	101	9
7	Participant G	End-user	Partner Firm 2	133	11
8	Participant H	Manager	Partner Firm 3	91	8
9	Participant I	Executive	The Firm	124	10
10	Participant J	End-user	Partner Firm 2	107	10
11	Participant K	Operations	The Firm	141	14
12	Participant L	End-user	The Firm	139	14
13	Participant M	Operations	The Firm	135	12

14	Participant N	Operations	The Firm	130	11

All participants have worked at the Firm for a minimum of 3 years and have participated either directly or indirectly in the DT journey with varying additional years of professional experience. A few participants have been involved since the conception of the DT journey. Hence, it was considered that all participants had the required experience and knowledge to provide insight for this research.

4.3. Presentation of the Findings

The tabular results from the participant interviews are presented in this section, which then leads to the sections that analyses the findings based on the research sub-questions. The interviews were semi-structured and certain responses resulted in follow-up questions by the researcher which provided supplementary in-depth insights and additional data beyond the scope of the question. The questions were structured to avoid bias and to obtain answers that reflected the participants' views, lived experiences and knowledge, resulting in answers that reflected both deductive and inductive themes. Therefore, the structure of the questions resulted in multiple combinations and/or different themes of the conceptual framework across the various participants for each question. Based on this, the analysis below is presented per research sub-question rather than engaging through the analysis per interview question. The analysis is guided by the conceptual framework and the DT journey of The Firm. The nature of the semi structured interviews; and following a research question and narrative approach resulted in multiple themes being demonstrated simultaneously. Not all quotations have been listed in this chapter, the aim is to provide an overview of The Firm's approach in relation to the research sub-questions, in a concise manner. Hence, tables of inductive and deductive themes (Table 2 and Table 3) have been established to indicate the complete set of themes as well as the frequency of occurrence analysed using ATLAS.ti 9 per participant. However, the frequency of occurrence may not necessarily relate to importance but rather the way they were derived, such as through a specific probing question or the participants specific knowledge. Table 2 are the deductive themes which were based on the conceptual framework and the literature review on dynamic capabilities and DT. These definitions are further highlighted as part of *Appendix 2: Summary of Digital*

Transformation and Dynamic Capabilities Theory which was used as a guide during the analysis. Table 3 are the inductive themes obtained through the analysis of the interviews.

Table 2: Deductive themes based on conceptual framework and literature review.

	P[10]-E Total = 33	P-F Total = 34	P- I Total = 31	P-D Total = 21	P-H Total = 23	P- C Total = 12	P- J Total = 23	P-B Total = 21	P-N Total = 21	P-G Total = 22	P-M Total = 32	P-K Total = 26	P-L Total = 24	P-A Total = 19
Accessing Total = 61	0	4	8	3	2	1	11	4	6	5	5	4	3	5
Building Total = 55	5	2	4	4	9	2	8	5	2	5	3	3	0	3
Calibration Total = 7	1	1	0	0	2	0	0	2	0	1	0	0	0	0
Committing Total = 9	2	0	1	1	1	0	1	1	0	0	0	1	1	0
Connectivity Total = 23	2	1	4	1	1	1	1	2	4	1	2	1	1	1
Creating Total = 28	4	4	4	1	2	0	1	2	0	1	2	4	2	1

[10] Where P in both Table 2 and Table 3 represents the respective participant.

Data **Total = 22**	3	1	4	2	1	1	2	1	2	0	1	1	2	1
Decision **Total = 23**	3	1	3	3	1	1	1	1	2	0	2	2	2	1
Designing **Total = 15**	4	1	1	1	1	1	2	0	0	2	1	0	0	1
Exploration **Total = 48**	9	6	3	3	2	1	3	2	1	3	3	3	4	5
Extending **Total = 32**	4	0	5	4	1	2	3	4	2	0	3	3	1	0
Higher-level Impacts **Total = 24**	2	4	1	2	3	2	3	2	0	0	1	2	2	0
Learning **Total = 20**	9	1	3	1	1	0	0	0	1	1	1	1	0	1
Leveraging **Total = 44**	1	4	4	3	1	1	4	3	6	1	5	4	4	3

New Employees and Changes in Employee's Roles and Skills **Total = 45**	4	1	4	0	3	0	5	1	8	4	4	6	4	1
Organisational Culture **Total = 65**	11	3	10	9	3	5	2	2	0	3	5	7	5	0
Organisational Performance **Total = 35**	11	1	4	5	2	2	2	1	1	3	0	2	1	0
Organisational Structure **Total = 46**	5	1	6	5	1	2	4	3	4	2	6	5	1	1
People **Total = 31**	5	2	4	2	0	0	0	2	1	1	4	5	4	1
Process **Total = 51**	1	3	8	4	8	0	4	3	3	1	6	5	3	2
Releasing **Total = 6**	0	0	1	0	0	1	2	0	1	0	0	0	1	0

Scanning **Total = 17**	4	1	3	2	1	1	0	1	1	1	1	0	0	1
Selecting **Total = 7**	2	0	2	0	1	0	0	1	0	0	0	1	0	0
Technology **Total = 38**	6	2	5	5	4	1	0	1	2	1	5	4	2	0
Value **Total = 92**	6	19	10	5	7	3	3	6	5	9	6	6	5	2

Table 3: Inductive themes obtained through the analysis of the interviews.

	P-E Total = 33	P-F Total = 34	P-I Total = 31	P-D Total = 21	P-H Total = 23	P-C Total = 12	P-J Total = 23	P-B Total = 21	P-N Total = 21	P-G Total = 22	P-M Total = 32	P-K Total = 26	P-L Total = 24	P-A Total = 19
Agile Total = 7	0	0	4	0	1	0	0	0	0	0	1	1	0	0
Analytics Total = 9	1	0	0	2	0	0	0	3	1	0	0	1	1	0
Automation Total = 3	0	0	0	0	0	0	0	0	0	2	0	0	1	0
Bottom line Total = 4	1	1	1	0	0	0	0	0	0	0	1	0	0	0
Business Excellence Total = 4	1	0	0	0	1	0	0	0	0	0	2	0	0	0
Business Improvement Total = 28	1	1	1	3	4	2	1	4	2	0	1	3	3	2
Business Resilience/Sustainability Total = 3	2	0	0	0	0	0	0	0	0	0	1	0	0	0
Capabilities Total = 61	5	5	7	6	5	6	7	2	3	0	4	3	5	3
Change Management Total = 29	2	3	2	1	3	1	0	1	1	3	1	5	4	2

Competitive Total = 4	1	0	0	0	0	0	0	0	0	0	1	1	0	1
Constraints/challenges Total = 35	0	0	9	0	5	1	4	4	3	3	2	0	2	2
Covid Total = 4	1	0	1	0	0	0	0	1	1	0	0	0	0	0
Develop Skills Total = 35	10	1	7	1	2	2	1	1	1	3	2	1	2	1
Development and Changes Amongst Leaders Total = 19	5	4	1	0	1	1	0	1	0	2	1	2	0	1
DevOps Total = 1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Experiment Total = 2	1	0	0	0	1	0	0	0	0	0	0	0	0	0
Foresight Total = 10	0	0	0	0	1	3	0	0	2	2	1	1	0	0
IM & Innovation Total = 5	1	0	0	1	0	0	0	0	0	0	2	0	1	0
Incremental Innovation Total = 4	1	0	1	0	0	0	0	0	0	0	1	0	0	1

Innovation Manager **Total = 1**	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Integrated Operation Centres **Total = 10**	2	0	2	0	0	0	0	0	1	0	0	3	2	0
Lean methodology **Total = 2**	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Leap Frog **Total = 1**	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Led by CEO **Total = 8**	0	2	0	0	0	0	0	1	2	0	0	1	1	1
Mindset **Total = 18**	3	0	2	4	1	1	0	1	0	3	2	1	0	0
MVP **Total = 2**	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Open Innovation **Total = 1**	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Operational Technology **Total = 3**	2	0	1	0	0	0	0	0	0	0	0	0	0	0
Qualitative and Quantitative **Total = 50**	1	15	5	1	2	2	3	2	2	7	3	2	3	2

Robotic Process Automation Total = 14	2	2	0	1	4	0	0	1	0	0	3	1	0	0
Scale Total = 5	1	0	0	1	1	0	0	0	0	0	0	0	2	0
Start-up Culture Total = 15	2	0	4	0	2	0	0	0	0	0	3	1	3	0
Strategy Total = 37	1	4	2	3	5	4	3	4	2	1	4	1	1	2
Technical skills Total = 11	1	3	0	2	0	0	1	0	0	0	1	1	1	1
Technology Total = 38	6	2	5	5	4	1	0	1	2	1	5	4	2	0
Unlearning Total = 1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Value Chain Total = 14	1	0	3	3	0	0	0	0	1	0	3	2	1	0
Value Realised & Value Realisation Framework Total = 9	0	6	0	0	0	1	0	0	0	1	0	0	0	1

4.4. Analysis Pertaining to Research Sub-question 1

"How Could Dynamic Capabilities Enable Digital Transformation in the South African Mining Sector?"

This sub-section will link the dynamic capabilities actions with the enablement of DT in The Firm through a journey of dynamic processes.

4.4.1. Exploration

Exploration is the process phase in which the organisation explores, scopes or searches for opportunities. Opportunities are identified and a strategic commitment is made. This is the earliest phases that The Firm embarked on.

4.4.1.1. Organisational Culture – Development and Changes Amongst Leaders

Contrary to the observations of most of the participants, who assumed that the commencement of the DT journey began in 2017 (the year solutions began to be initiated), the actual journey started in 2015 (therefore covering a six-year DT journey), as was indicated by an executive participant from The Firm that has been on the DT journey since its conception. In 2015, the executive committee, together with a group of millennials[11], embarked on a journey to learn and understand what leading organisations were doing as well as what technologies were available at the time. The millennials brought in a new culture and way of thinking during these workshops as highlighted by an executive in the quotation below:

- *Participant E: "…remember in that [workshops] we also had millennials for a particular reason, because we knew that we, in our generation, we were taking ourselves to a space of discomfort because these new technologies we didn't understand them. And yet the youngsters, they are playing in that space*

[11] Millennials refers to a generational group, or archetype, born between 1981 and 1996, who are considered to have been part of the fast paced technological, economic and social shifts during their formative years (Dimock, 2019). This was significant as the millennials were part of the next generation within The Firm and therefore were less attached to the archaic processes, technologies and ways of thinking that had long defined asset intensive industries like mining.

already and therefore part of this journey is understanding and the realization that value is very much created by everybody in the organization, it's everybody's responsibility."

This illustrates how the leaders, during the *exploration* phase, *learnt and scanned* the environment which resulted in changes in the leadership *culture.*

This process assisted in changing the 'mindset' of the leaders and was a pivotal point in The Firm, which was filtered across the organisation and mentioned and discussed by eleven of the fourteen participants. Furthermore, multiple participants mention that the DT journey was because of the 'foresight' of The Firm's leadership. As noted, below, by a manager from a Partner Firm and an operational participant, respectively:

- *Participant H: "…the executive team had the foresight to embrace you know, I think that's an important factor. You know that certainly contributed to the success of The Organisation's digital transformation. I really believe that"*

- *Participant N: "And I think that insight or foresight from our leadership is what started the whole digital initiative."*

The above is an indication of the necessity of executive level foresight to initiate the requisite mindset change amongst the leaders of an organisation, resulting in a top-down, cascading change across The Firm.

4.4.1.2. Competitive Advantage and Organisational Performance

The CEO of The Firm was an active participant of many mining platforms, both locally and internationally, which resulted in continuous exposure to new technologies that could potentially give The Firm a competitive advantage, as note below by an executive:

- *Participant F: "Yeah, so I think it was obviously led by our CEO, I think he is the, let's say, the champion of this. Obviously I think it is in his nature as he goes around in his mining sort of experience and interaction with other mining companies. The Mining Council visits overseas. I think he realised that that is one of the things that we as The Organisation must embark on. So it was started by him."*

This mindset shift amongst the leaders as well as the exposure of the CEO resulted in The Firm embarking on a DT strategy that focused on competitive advantage and business improvement. This strategy was then initially led by the CEO, who *accessed* external actors to *learn* and *scan* the dynamic macro-environment. There was a top-down drive to obtain a competitive advantage and advance the performance of the organisation year on year, as noted, below, by three operational participants and a Partner Firm participant, respectively:

- *Participant M: "I think in doing that they to enhance efficiencies. Either reduce cost, increase safety, etc. But to sort of also get that competitive advantage within the market."*

- *Participant N: "I think from my perspective, the initiative was more of a top-down initiative where the CEO saw, I think, potential in in digitalisation. Specifically, I think that a lot of the research showed that companies could get up to 5% improvement in their performance, be it in the in, the revenues or efficiencies"*

- *Participant K: "…it would have started when our, CEO, who's very visionary. So, he had this vision to, like you said, the 4IR was upon us, but he wanted The Organisation to be at the forefront of the mining industry in terms of embracing and leveraging 4IR for competitive advantage"*

- *Participant A: "One, to be relevant in the future, but two, also to give them a competitive advantage but what emanated was that there was also a target that was set at some point, to say, from all these efforts they would like incremental 5% year on year improvement."*

The above illustrates how the DT journey drive sought to ensure a competitive advantage specifically as well as improve organisational performance in The Firm generally.

4.4.1.3. Accessing and Leveraging Capabilities

The Firm, as a mining organisation, required digital skills as well as an understanding of the potential application areas for these skills, to obtain a competitive advantage as noted above. The Firm *accessed* and appointed external experts, who were considered leaders in their field, to *scan* and *select* opportunities within the various BUs. This process initially resulted in approximately 500 identified opportunities that could potentially utilise digital technologies to add value. These opportunities were categorised to be executed in different phases, under the banner 'do now, plan

now and dream now". This banner also evolved and changed over the course of the journey. This narrative is exemplified by the following interview quotations from an executive, an operational and a partner participant respectively:

- *Participant I: "OK, we basically went and we searched for an improved partner who could help us. So we had all these things, 500 and something of opportunities, we shared. Most of that with the market so we went out to the people we believed were the leaders in digital thinking in our industry and we basically selected a vendor, selected a single partner to help us on this, to assist us on this on this journey…It's not going to be 'Oh, now we know we never need to revisit strategy', you know? So, so, they sort of then also had this view of I think it was* - Do now, plan now, dream now **-** *you know that was sort of the same theory, and so we said, 'we continually want to have this'. Refresh of where we are. What we do next might take advantage of something that might have matured."*

- *Participant M: "…sort of road map was built, and it gave them a big sort of view or for larger long term road map view of you know, doing things. I think when this initially started there was something, I can't remember exactly, but it was "do now, plan now, dream now". It was something like that, so those are the sort of phases in terms of doing this and I think as time progressed and the program matured, that also sort of evolved and changed as priorities got identified and more experience was gained."*

- *Participant A: "…an assessment was done through two different vendors, where based on the outcomes, one when there was then chosen to do the rest of the sites that hadn't been assessed and coming out of those assessments was to say: what are the potential opportunities for digitisation at each of those operations? And a pipeline was then developed of initiatives that could be executed for each of those operations, and it was done over horizons of time."*

The Firm decided to test the market for a strategic partner that could start assisting with the execution of the DT strategy based on the potential opportunities that were identified, thereby, accessing capabilities. An expert in DT was chosen through a competitive bid process as noted below by an executive participant and a Partner Firm participant, respectively:

- *Participant I: "Actually, that it was a different partner who assisted us to do these assessments, this partner was to mainly assist us with implementation."*

- *Participant A: "So after the assessment, I suppose, from what I understand the business, felt it did not have sufficient capacity/capability to run with the digitisation plan, or road map or suggestion that had*

been put before them. So therefore then they went onto an open, competitive bid where several vendors were invited to then, I suppose, compete against a predefined scope. So they took only a limited number of initiatives from the total scope so that to enable them to compare. And yeah, and based on that process, picked a vendor to assist them with the journey"

An internal champion was then ***leveraged*** and appointed to lead from within The Firm with this strategy and to manage the strategic Partner Firms as well as constantly ***scan*** externally for more technology and skills (potentially indicating another sub-level of exploration within the organisation), as noted below by an executive:

- Participant F: "…the champion, internal champion, and then that champion looking outside for maybe outside people assisting us with both the technology and the skills."

The need to access external capabilities and leverage internal capabilities was an essential step of the exploration phase of the DT journey within The Firm, and it provided a holistic and realistic reflection on what was needed to pursue the DT strategy.

4.4.1.4. Change Management and Employee Development/New Skills

The Firm started driving change management and therefore further ***committing*** to their DT journey. Change management was conducted throughout the organisation utilising multiple techniques, as well as developing their current employees in the process. It is important to realise here that dynamic capabilities or operational actions are occurring at different levels. An example, from a strategic level The Firm is ***committing*** to their DT journey, but from an employee or trade union perspective they are ***learning*** and ***scanning*** this environment which is potentially new to them. The change management efforts by The Firm, as well as employee development, are highlighted by some examples below:

- Sending large numbers of employees, from various levels of The Firm to attend Singularity University (SingularityU) programmes[12] each year as discussed by two of the executives:

[12] SingularityU, now called Singularity Group, is a multinational organisation that is committed that seeks to assist both individuals and organisations to understand and apply technology to solve various modern challenges, this is achieved through their hosting of various events, programs and summits (Singulaity Group, 2021).

- *Participant I: "So, we did quite a lot of work with Singularity University. We had these things called 'exponential technology workshops'. You know we have for two or three days with that, take people and they just be people talking about what you know, exponential technology and all these new technologies. It was just to open people up from where they from [and] what they were used to."*

- *Participant E: "…and that allowed people to go in various parts of the world just to see others who are leading in these areas and then exposing the rest of the organisation by allowing them to participate in the Singularity University. You know, uh, what do they call it? Is it a conference? Conference."*

Committing, learning, and scanning are the operational actions that are at the heart of the initiation of a DT journey, and ultimately serve to empower internal capabilities that can be leveraged at a later stage. By participating in events, such as those at the SingularityU, The Firm was able to determine what technologies were out there, start building the knowledge, developing the necessary skills, to ultimately bring their commitment into fruition.

- The CEO engaged with the trade unions to ensure that they were included as part of the DT journey, to align them with what was the purpose of the DT journey, and to address any potential fear there may be. The following was noted by an executive:

  - *Participant F: "I think the first thing that comes to mind is obviously the [trade] unions and let's say on the lower level where they see this whole journey as may be a bit of a threat in terms of replacing jobs and so forth and I know that CEO way back had a special sort of station to engage with the unions to say 'what is the purpose of this and shouldn't see it as a threat and so forth'."*

Change management has been at the forefront of the DT journey and was an essential aspect of ensuring employee buy-in, particularly amongst lower-level employees who could perceive that DT threatened their livelihoods and their positions in The Firm. As such, employee development and new skills formed part of the DT strategy, through knowledge acquisition at conferences hosted by the likes of SingularityU; workshops within the organisation; and engagement with trade unions to allay fears of redundancy and provide assurance of skills development amongst lower-level employees. The role of change management and the upskilling and development of employees is further expanded on in the next section under building.

4.4.2. Building

The organisation focuses on designing and changing its processes and resource base to support its committed strategy as a result of the exploration phase.

4.4.2.1. Change Management and Employee Development/New Skills

The continuation of the theme into the ***building*** process is twofold: to illustrate that multiple themes/actions occur throughout the dynamic processes; and to illustrate the importance The Firm placed on change management and employee upskilling. There were knowledge sharing sessions where employees transparently engaged internally to understand potential opportunities that can be utilised in other areas of the business, as noted by a Partner Firm participant:

- *Participant B: "Followed on from that we did do more detailed businness unit assessments where we did find additional initiatives that we wanted to run, and that's really what kind of spearheaded that journey of implementing things that are [on a] continuous basis. What really did stand out from me is also that kind of [knowledge sharing workshops] did with the CEO for The CEO, we brought the teams together and everyone could have visibility of what everyone has been implementing. So I think around embarking the journey: It is really quite structured at the beginning, selecting those 18 initiatives, with more being added overtime, and then culminating in those regular sort of [knowledge sharing] events that everyone could share, and show and see: this is what we've achieved, this is how we're progressing and this is the good stuff that we've done to actually show progress against this data that was selected initially."*

Knowledge sharing formed a seminal part of the DT journey and was a means of building the internal knowledge base that had been acquired externally and internally. That was skills development and followed multiple processes, including outside-in knowledge building and the diffusion of knowledge within The Firm. Through this active and transparent building process, facilitated by change management strategies, dynamic capabilities were institutionalised across all levels of The Firm.

4.4.2.2. Changes in Organisational Structure and Enterprise Processes

As part of the DT journey, The Firm started building internal capabilities to continue with this digital drive which most likely went through a ***designing*** phase as a result of the ***exploration*** process.

There were several new structures *created* and changes in processes to empower the employees to *learn* or sub-*create* solutions or optimise solutions/processes across The Firm, as represented in examples below:

- A business excellence function was created to improve enterprise processes as well as training employees in lean[13] methodology to drive *organisational performance*. By training so many employees in lean methodology the improvement in processes could permeate throughout The Firm:

    - *Participant E: "…whereby within business excellence we had to start looking at how we drive organisational excellence, organisational performance. By looking at how we transform a lot of the things that we were doing, we had to bring in new ways of looking at how we deal with processes that had been imbedded in redefining those processes and with that we created the structures that we created that enabled sprints to be done with multiple disciplinary teams…Lean yellow belts[14]. So, hold a whole group of individuals, hundreds and hundreds throughout the whole organisation, were skilled around lean [methodology] and therefore there to qualify to get your certification you have to go through this training and then become a yellow belt."*

- The importance of innovation and information technology was identified and *designed* to support the journey. As a result, an innovation function was *created* and combined with the IT function and was moved to report directly to the CEO. Therefore, instead of IT reporting to the financial director or chief financial officer, it had direct line to the CEO. These functions were fundamental as they had specific focus on enabling the DT journey as noted below by a manager and executive participant, respectively:

    - *Participant D: "…from an IT perspective, we formalised the Innovation Office. As part of a partnership with I [innovation] and [IT] and it really changed from what used to be information*

[13] Lean, sometimes lean six sigma, is a methodology in production which constitutes a set of practices that are implemented continuously to reduce or eliminate 'waste', as well as any organisational activities that do not provide value but consume resources, and ensure productivity and sustainability (Khaba & Bhar, 2018).

[14] In lean six sigma methodology there are several coloured 'belts' that serve various functions, in the case of a 'yellow belt', this is a person identified by the organisation to educate and share knowledge of the lean six sigma processes within the organisation their colleagues (Lenarduzzi & Taibi, 2016).

management to innovation and information management with specific focus on enabling the digital transformation from an IT perspective but most importantly, the organisation also went about staffing from a business perspective, so the digital value chains, you know, are structures that have been established outside your IT domain which further, you know, supports, you know, the whole intent in terms of embedding the whole digital mindset throughout organisation. So that it doesn't get perceived to be an IT driven initiative, but it is a business-driven initiative that IT enables."

- *Participant E: "Well, at the outset it was important that we developed new structures that were going to be supportive of this journey. One of them was within the area of [IT], where also we made sure that we created a structure called innovation and [IT], because they talk to each other. And you had to elevate that. You have to elevate that position, the head of that area, to one whereby in the past [IT] used to report to the Finance Director, this was so important, it was so strategic for the organisation, that it was important that the individual reported directly to the CEO. So that it is seen as a very strategic imperative to achieve that. The other one that was around business excellence."*

As evidenced from the above the organisational changes to the archaic design of The Firm formed an imperative part the building phase of the DT journey. It highlights the need for the building of internal capabilities to support and facilitate the change necessary for DT which is further supported by learning and sub creating in pursuit of the optimisation of solution and processes.

4.4.2.3. Agile and Start-up Methodologies

The Firm *committed* to new methodologies which is pivotal in the DT journey, and additionally aided employee development as well as directing processes towards value. Agile and start-up methodologies were implemented and changed the way The Firm implemented solutions (change in *organisational culture*). The Firm *accessed* the skills of the implementation partner to bring in the skills and *develop current employees* to execute solutions by following agile processes as noted below by an executive:

- Participant I: "So, I mean, part of the partners responsibility was to bring on people that could train our people on agile methodology: what does it mean to be a scrum master[15] or what does it mean to be this and this, you know, sort of just hold their hands and take them through that whole process. I think

[15] A scrum master is often classified as a "*servant leader"* within the agile methodology literature; a scrum leader is a central figure in implementing and sustaining the scrum and serves several functions from promoting the scrum to removing obstacles to facilitating the team, and (Shastri et al., 2021).

there was where the organisation bought into the whole concept of agile and sort of start-up way big time."

The leaders further implemented start-up methodology and employees were taught the concepts as well as the leaders enhancing their knowledge by learning through the attendance of conferences and applying learnings in The Firm. It was also about defining value so if the aim was to achieve motion, then don't necessarily focus on defining a car maybe focus on defining roller skates. These concepts were mentioned below by two executives:

- *Participant I: "So, they also took people on. You know on like mine management for example, to a conference or of startup, way, you know and dished out books to everybody talking about startup way you know,and how do you do. So there was a lot of sensitisation and a lot of sort of showing people and repeating"*

- *Participant E: "We had to bring in other lean practices, you know, that we had to the Start-up way of doing things, we had to think very much like entrepreneurs, how would an entrepreneur start up a new company. They don't spend time to defining the car, they get on that they define, they get on the roller skates instead and start moving forward because if it's about mobility"*

It was further highlighted that these concepts changed the culture of the organisation as business owners within The Firm could learn and develop solutions simultaneously. Again, it is noticeable that dynamic capabilities may be multi-tiered where people begin to learn and scan at a solution level as compared to learning and scanning from a strategic perspective. This is noted through an extract from one of the executives:

- *Participant I: "I think part of the way of doing that was using agile methodology because if you use waterfall methodology, it's very hard for people to do a complete design if they don't have that knowledge and that capability, but when you doing Agile and you've got sprints, and you do MVP*[16]*'s [minimum viable products] people learn as they go along. You know, so they so they do something small -they learn there OK. What is the next step? They learn more. OK, so they don't have to know all of it up front."*

[16] MVP – minimum viable product (Ries, 2017)

The commitment to agile and start-up methodologies was inculcated across The Firm, amongst leaders and junior employees and sought to shape the culture of the organisation within the DT journey.

4.4.2.4. Higher-level Impact

Accessing and *committing* to certain technologies resulted in *creating* a new organisational structure that benefitted the work life of employees. An example of this can be seen in one of the digital initiatives within the organisation which involved *accessing* external skills and then *leveraging* internal skills to eventually support this. This digital initiative was robotic process automation (RPA)[17], which was aimed at automating manual repetitive tasks. This resulted in reducing menial, tedious, and administrative tasks which employees were working on. This automation therefore created work capacity for employees to focus on problem solving and adding more value to the organisation. In addition, there were employees that were trained to support the initiative which resulted in further *development of employee skills*. This higher-level impact through the implementation of RPA was noted by two executives, a manager (partner), and an operational participant, respectively:

- *Participant E: "…some of our processes, whether their HR[18] or finance, where their tedious, repetitive work where we're bringing robotics now, software robotics, which are basically doing a lot of this work, you know that was done that was always tedious. They don't sleep, they don't take leave, the kids don't get sick. So, this thing working at the background, really taking a lot of menial, tedious, tedious work away from very skilled individuals and therefore invariably bringing more, I would say, productivity to those individuals where now they can focus on really problem solving"*

- *Participant F: "…maybe, typically the financial sort of environment where the routine type of work can be done with technology and the people might not be reduced, but they could spend their time more on making more value for the company."*

[17] RPA is a practice of automation of manual repetitive business processes by software/digital robots to improve efficiencies and reduce costs (Santos et al., 2020).

[18] HR – human resource

- *Participant B: "You know a lot of things I see in the RPA space that was done, there was also run awhile back, which is still maybe running at this point in time, around picking up automating some of them were administrative tasks, etc. Hopefully that has refocused, you know, some of peoples more administrative efforts into other time that they can use more practical usefully, right?"*

- *Participant M: "OK, so I can give you a good example of this. I think when we started to do RPA it was done by an external consultant. But the moment it showed value, and a decision was made to sort of, let's say, scale the program. The decision to scale obviously means it becomes 'business as usual' and internal people were identified to support this, and they were upskilled in that area to be able to support it"*

The higher-level impact of the DT journey was particularly noticeable in automation of manual repetitive tasks, which ultimately freed up capacity amongst employees who could then focus on driving and creating value to The Firm in more tangible ways. As such, although the automation processes may not have directly and explicitly brought quantitative value, it provided scope for capacity amongst employees to engage with value driven initiatives as well as potentially improved their work environment by reducing or eliminating menial and tedious work.

4.4.2.5. Operational Technology and Technology Integration

Due to the asset intensive landscape of the mining industry significant operation technology is required to be implemented to provide connectivity for data to flow such that it can be analysed. The Firm, therefore, had to commit to significant infrastructure that that was required to improve the connectivity of data which allowed for the organisation to design solutions that improved decision making as note below by an executive:

- *Participant I: "It's other than people,capabilities -it's organisational capability and its infrastructure. It's the back bone. You know the mining industry in particular never invested much in in networks. You know there's the backbone having - it's a bit like at your house. You know if you've got fibre, you know you can do this. You can talk online, you can do online meetings, you can download stuff, you don't need your DSTV decoder anymore. You know you've got that bandwidth,so so that was almost one of the first I'd call it capabilities that we needed to put in place was it was a refresh of your entire IT backbone -infrastructure back bone. It's all fun saying we're going to put sensors in and we had to do all these things, but if you don't have the bandwidth to get all that data and the other platforms and tools to put it in the cloud to do the analytics on, you know,so you need it to put both physical*

infrastructure and also you know digital infrastructure in place. OK, you know? As platforms to build these things on"

This further highlights a significant constraint on the DT journey within asset intensive industries, which for the most part have archaic infrastructure which is tedious and costly to replace. Furthermore, the need for additional technologies to ensure DT integration may have been part of the reluctance of asset intensive industries to digitally transform, and the reason many within these industries lag.

4.4.2.6. Scaling by Accessing External Capabilities

It is important to note that even though an initial strategic partner was appointed, The Firm began to grow and *scale* their DT journey by *accessing* capabilities and solutions through multiple vendors, therefore accessing a wide range of industry knowledge. Hence, embracing a concept such as open-in innovation (Chesbrough, 2017) to improve the DT process that The Firm embarked on, as noted by one of the Partner Firm participants:

- *Participant H: "So I think that the organisation has been investing in the, you know,when they approached us, we weren't the only digital transformation out capability, you know. And then there's also other solutions that were available. It appeared to me that the organisation almost invested in a variety of consultants in a way or solutions"*

These initiatives resulted in both enterprise and operational solutions some of which focused on understanding the current operational value chain, improving the service management processes within the organisation, creating analytics centre of excellence, etc. The additional solutions created a dynamic environment which then required more dynamic actions such as *accessing* external expertise and *leveraging* employees through development. Learning management solutions were even created to train employees so that they can be *leveraged* and integrated within the business. The scaling of these solutions involved the training of *people*, changes in *process* and the integration of *technology* as noted by an executive, two end-users and a management participant respectively:

- *Participant E: "Understanding the value chain now by and large, the value chain in mining is normally very 'siloed', very compartmentalized and therefore, one is not able to see how the impact of one part of the value chain has an impact on another part of the value chain"*

- *Participant J: "My role was to create visibility in the service management space through the introduction of probably of, I would call it, forefront technology in the service management space. To use their technology to introduce ServiceNow*[19] *into the environments to sort of radically replace the way we were doing service management. So, my role was really, because of my understanding of the technology and my experience, was to sort of implement it and bring sort of the knowledge that I had into the organisation and implement it."*

- *Participant G: "Because ultimately from a qualitative [perspective] it can improve, for example, if you look at a learning management solution that is linked to your SHEC [safety, health, environment, and community] environment or your sustainability environment you can improve the tracking and training for compliance training, which basically leads to improved health and safety of your organization and your staff."*

- *Participant D: "if you look at if you look at the business cases around [digital program], there was almost an intent in terms of improvement on the rand per tonne from a from a core business perspective, and there was also there was a large component of that based on visualisation to enable transparency in terms of our core value chain to empower decision-making at a tactical level…*I think it depends what the organisation already has and what it needs to be supplemented with. If I look at the organisation right, or the example that we've gone through here, I think obviously there was, if we look at the analytics centre of excellence and we look at data science capabilities, I think a lot of the initiatives in the end do require that sort of capability to make them successful and also to get that analytical evaluation of the value cases and the value realization to truly align and prove those value cases, right? So, for me a sort of data science angle is probably imperative. Similar what the analytics centre of excellence, having that analytics engine to drive the numbers can come up with this and analytics platforms and to drive that is essential"

The need to scale by accessing external capabilities was an important component of the DT journey, particularly as those specific skills were not inherent in the internal capabilities of The Firm. Once those skills were brought in and transferred to internal employees, The Firm was able to leverage those skills to further scale projects organisation wide.

[19] ServiceNow is an IT Service Management (ITSM) platform (ServiceNow, 2021) that was utilised to improve The Firm's enterprise IT management service.

4.4.3. Extending

As capabilities develop new alignment issues arise or additional effort is required. This requires further development on building phase, focusing on improving the new capabilities and processes developed within the organisation.

4.4.3.1. Creating new Organisational Structures and Developing Strategy

The Firm began to mature in their DT journey and certain roles which were tested by the implementation partner were created within The Firm at each of the BUs. These roles were Digital Leads that were responsible for identifying problems and creating potential digital solutions as part of their day-to-day job, as noted below by an executive:

- *Participant I: "So I think the one of the biggest ones was to introduce a new role at every business unit. Call it a [Digital Lead] So to put an owner of sort. So there was always from the start, but when we started the assessments, there was somebody probably in business improvement that owned the digital journey. But then there was a new role created for every mind of a person who had a bit more technical technology background but also operational background to, you know, to really be that link between the technology and the operation and drive it at the operation because we initially had sort of a central team driving a lot of it, even a central business optimisation team not belonging to particular business units so but actually putting in, you know that was also driving it, but I think putting in place an Owner at every single mine helped a lot. I think that was to me one of the biggest. Probably a very big contributor."*

This again, reiterates the different levels of dynamic capabilities where these individuals could potentially explore, build, and extend at more micro-level at the individual BUs.

During the latter part of the DT journey, The Firm had *accessed* many skills and there was a constant drive to internalise these skills as noted by one of the managers from a Partner Firm:

- *Participant B: "So, if I look at the roles of maybe a [digital lead], where in the past you might have had a vendor site lead operating there, there's now permanent positions that have been internalised, and actually start building some of that skill internally, right? And even on the data science side of things, yes, I think there are some open positions that potentially might be filled externally, but again there is a drive to get internal people to go and hold those positions and actually grow those positions and*

develop that skill set. Even with the analytics centre of excellence, right? Yes, it is run by external people as part of their team as well or within their team, but at least there's an element of developing some of that skill internally now, which I think is really, positive, right?"

As the DT journey matured, the strategy developed further. For example, there was emphasis to visualise the value chain and then later on the need to create integrated operational centres to improve decision making. This resulted in embedding employees who operated in various areas to be combined in a single area to collectively make *decisions* to improve the performance of the business as emphasised by an executive:

- *Participant E: "How can we all in the one room see the value chain? So that everything we have one version of the truth of what is happening in the organization and how do they reconstruct the way the teams that have been working in silos can sit together in one room, see the value chain, and be able to work together in running and managing the value chain with the view of understanding all the critical points of this value chain. So that a decision that is done hit in one part of the value chain, the other party can actually see, you can actually work with your other teammates within that team"*

These operational centres required to be led by strategic thinkers that understood the business and therefore people within the organisation had to be further developed *(develop employees skills)* and appointed for these positions as they were not readily available in the local market. This resulted in a new way for work for the organisation as well as embedding these activities into the day-to-day business, as pointed out by an operational participant:

- *Participant K: "What do we call the [value chain personnel] else you're not going to find someone that's done this before. So our approach was actually initially to second people into that role. And we do that at [the business unit] and I know they did that [at the other business units], right? So we went on a rotation system where perhaps your senior geologist would be seconded for a month. Your senior metallurgist would be seconded for a month because that particular role that [value chain personnel] needed to be someone that understood the entire value chain. OK, and our experience actually was that the guys that are involved in production, in your production meetings, the senior guys most of the time had a good perspective on it… But to get that deep expertise in all of it all areas like, let's say*

what's happening in a plant SCADA[20] system, that's very sophisticated specialised skills. So fundamentally it's a leadership position as well as a value chain position, that's what we learned here."

The move from a centralised and executive driven journey to a more decentralised and all-encompassing approach was an essential step in extending the DT of The Firm. However, even the role of digital leads in a more decentralised approach evolved and changed as the DT journey matured, and the expertise that was developed internally began to mature and grow therefore capacitating internal employees to take a more active role. Furthermore, the internal employees were the most fit for purpose in terms of scaling DT initiatives across The Firm, due to their sophisticated and embedded understanding of the mining value chain and their industry knowledge of The Firm's operations. This required a level of cooperation and centralisation (at each BU) by means of operational centres, but these comprised of digital leads and operational expert employees rather than taking a traditional top-down approach. That way traditional knowledge could be leveraged for fit for purpose solutions.

4.4.3.2. Releasing the Old and Accessing the New

Vendors that were not expanding their knowledge base in line with emerging trends and technologies had to be replaced by vendors that understood the needs of The Firm. Some of which included infrastructure, cloud, and security vendors. The Firm had to equip itself not only with internal new skills but additionally with their vendors and partners as noted by one of the executives:

- *Participant I: "IT is largely an outsourced environment, right? Ultimately, the digital stuff is supported by the IT organisation or by the IM organisation, and we found that a lot of those partners you know they became a little bit redundant because their skills didn't transform together with what we were doing. Whether it be from networks whether it be from cybersecurity? Whether it be from the types of technology, you know, they were still in the old mining mindset and an old technology so they didn't transform themselves. You know the support people. So I think when you building it was you can find skills and people are learning and and it's accepted that they are learning. Then once you've built it, those people that built it, not necessarily the people that are going to maintain it. So I think the people*

[20] Supervisory Control and Data Acquisition (SCADA), is an operational system consisting of elements of both software and infrastructure that provide real time monitoring and control, data processing to enable smarter decision making, as well as to communicate system issues in order to lessen or eliminate industrial machinery down time (Inductive Automation, 2018).

you know, particularly some of the some of the partners we had, they should have invested in upping their capabilities as well, which they didn't. I would say they had they ended up with capabilities that we couldn't use."

Partner Firms formed an important part of the DT journey, across all three phases, but it remained essential that the relationship with the vendors remained dynamic and continued to provide the requisite support through each phase. As the strategy and needs of The Firm transformed, so did the requirements of the Partner Firms.

4.4.3.3. Innovation

As previous mentioned the innovation and IT function was created initially to drive the DT process. As The Firm started to mature through the DT journey it started to focus and trialling more innovative concepts such as open innovation. This illustrates The Firm's desire to further integrate forward thinking capabilities into the organisation as well as constantly equipping itself to be ahead of the curve in terms of *learning* and *scanning* the dynamic macro-environment. This is achieved by utilising *accessing* and *leveraging* dynamic operational capabilities through the concept of open innovation as discussed by one of the end-users:

- *Participant C: "…build organisational practices for continuous scanning of the environment, anticipate changing, probing into new markets. That is what we're trying to achieve with open innovation with our innovation management team. And number three regularly assess the dynamic managerial capabilities that our leaders possess…So now we are mandated to look at cutting edge solutions, so we'll have visibility of the Gartner Hype Cycle*[21] *and continuously track it and find ways to bring in those solutions through open innovation so the whole strategic flow or structure of that organization of that department or function changed completely from what it was before…Open innovation is taking internal ideas to the outside world to be solved and also taking external ideas into the organization to be implemented."*

Innovation remains at the centre of pursuing competetive advantages through dynamic capabilities, and by extension was an extension to the IT department of The Firm but will also be essential for driving new forms of value and value realisation through the DT maturation journey.

[21] The Gartner Hype Cycle is graphical depiction by Gartner of the market penetration and maturity of technologies, innovations, and applications, indicating how these may solve business problem or offer new business opportunities (Fenn & Raskino, 2018).

4.4.4. Conclusion Research Sub-question 1

It is indicative that through The Firm's DT journey that dynamic operationalisation actions were embedded, sometimes explicitly and sometimes implicitly, to enable DT. The analysis followed a narrative approach and highlighting themes along the journey. It was evident that dynamic actions lie across the different dynamic processes as illustrated by Figure 8 which represents all interaction between all occurrences of dynamic actions and their respective dynamic processes, identified through this research.

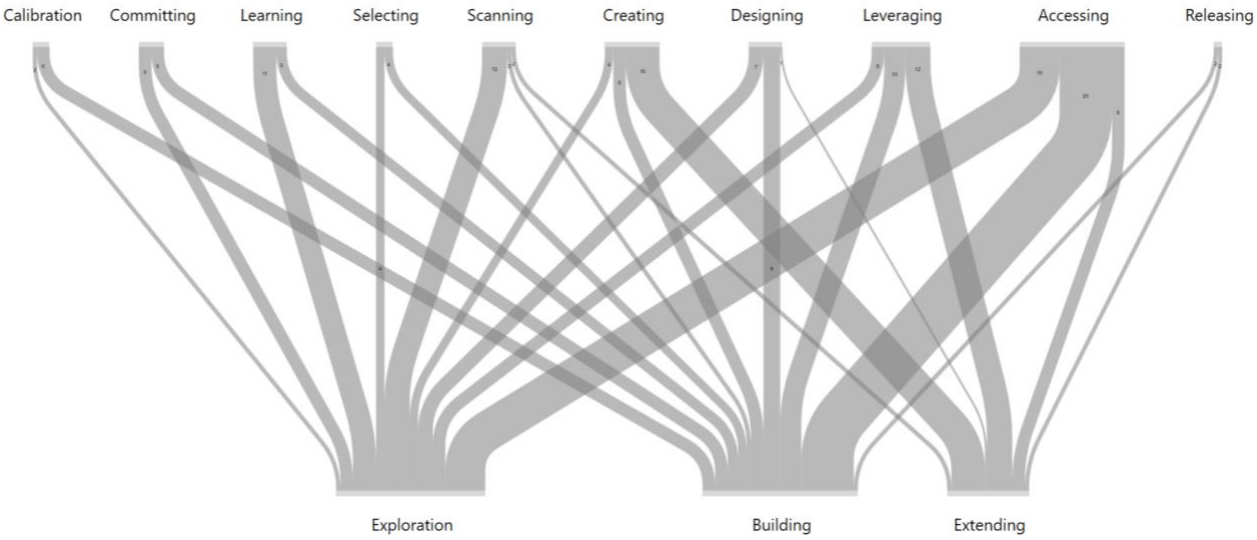


Figure 8: Sankey diagram illustrating the operational actions were active/utilised across the various dynamic processes

All occurrences of the above respective dynamic processes are then illustrated in Figure 9 to represent their relationship in developing subcategories or subcomponents of DT. These components are key and are a result of the DT process, which in this case was enabled through dynamic operational actions and initiated through The Firm's strategy.

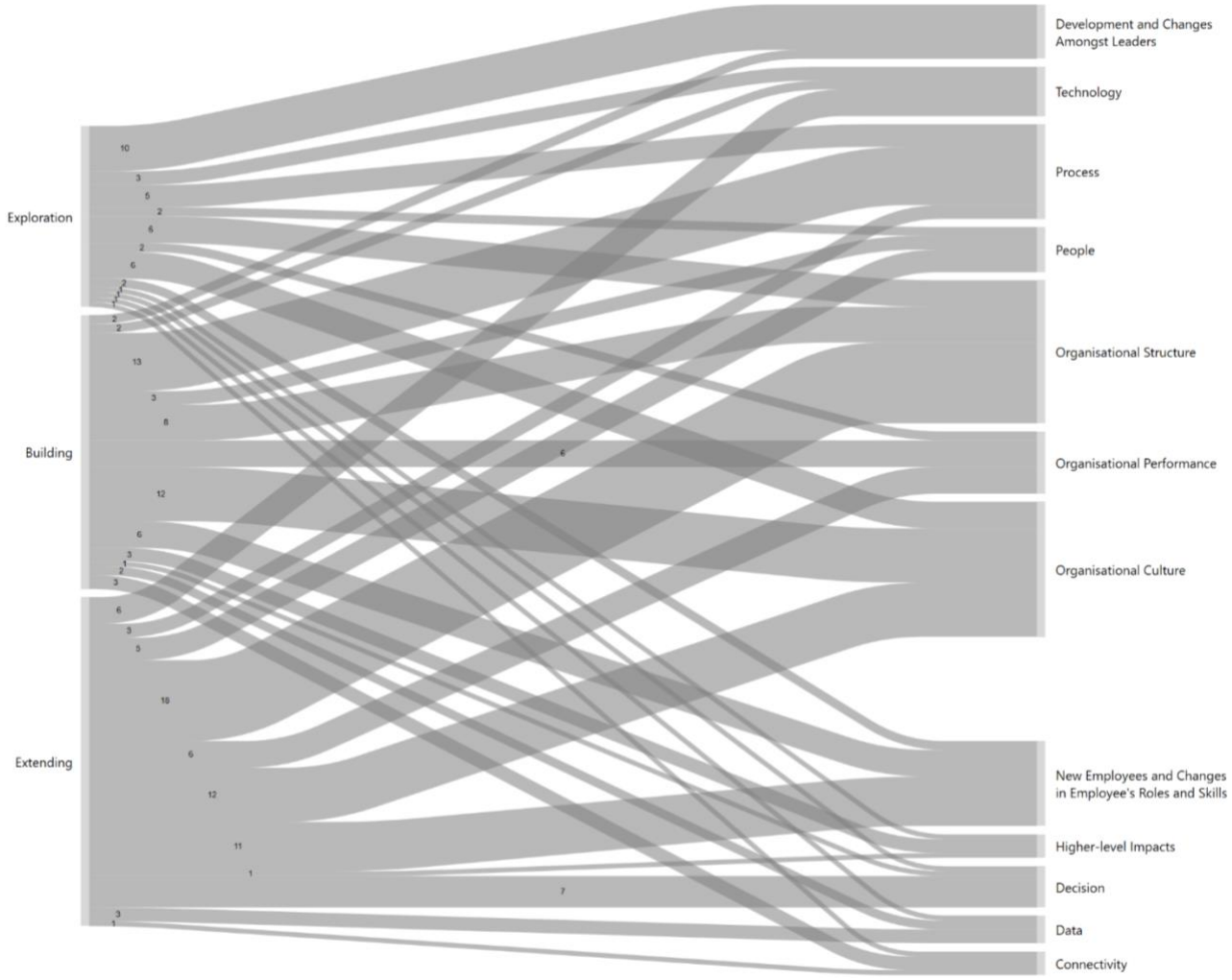


Figure 9: Sankey diagram illustrating that dynamic capabilities has enabled multiple digital transformation aspects at various phases.

Therefore, the first sub-question is deemed to have been answered as follows:

How could dynamic capabilities enable DT in the South African mining industry?

Proposition 1: It is proposed, based on the literature, that dynamic capabilities enable a firm to digitally transform by implementing new capabilities aligned with the firm's strategic intent. These capabilities are created through a phased approach such as 'exploration', 'building' and 'extending' which embed the process of enacting dynamic capacities through dynamic operationalisation action. These operationalisation actions enable components that affect or comprise of DT, such components include, organisational culture, organisational structure,

changes in leaders, development of employees, etc. These new capabilities enhance existing capabilities that enable the emergent strategy.

Based on the presented data in this chapter and which is further represented by the Sankey diagrams, dynamic capabilities can enable DT in the South African mining industry, through a process of dynamic operationalisation actions which is overarched by exploration, building, and extending dynamic processes. These actions and processes are directed to achieving subcategories of DT which enable the DT journey. These findings support the initial research proposition.

4.5. Analysis Pertaining to Research Sub-question 2

"How Could Digital Transformation Enable and Sustain Value in the South African Mining Industry?"

4.5.1. Mining Industry is Capital Intensive

The concept of value brought about interesting discussions during the interviews with all but one participant agreeing that the DT process has resulted in value in the organisation. This participant argued that the costs associated during this journey was too high and the monetary investment may have not be realised. Even though the participant did not provide significant evidence, this is indicative of the nuance in the mining industry where the capital requirement for digital infrastructure is significantly higher than are industries such as banking for example (Young & Rogers, 2019). The contradicting participant's response is noted below when asked the question has the DT journey realised value. It is essential to note that the participant only underlined the monetary aspects of DT, and this is not the case with all the other participants.

- *Participant N: "I'd say no, to be honest with you. I'd say no. I think the reason why it hasn't is because I think we underestimated the capital intensity of the digital transformation. And the reason why that is true is because of what you said in the beginning. So, the difference between digital transformation in for example, other industries such as banking, is largely in the centre gathering process or data gathering process. So how banks gather data is by spending, I wouldn't say a lot of money, 'cause I I've seen now the whole app development solution, app development life cycle looks like and how much the costs are, and from that you are able to get a lot of information on people. A lot of*

transactional information on an individual, how their trading patterns look like, so that's that. Whereas with mining, and I, I suspect manufacturing also suffered the same fate, that the effort of getting your centre at your centre level ready is this so capital intensive. You need to buy hardware? If your cell phone costs 20,000 rands you can get as many measuring points or data from an individual as you need. But with mining you need to buy sensors, you need by cable gateways, DAU's[22] *, so it becomes a lot more capital intensive and I think we're at the point now where we are now trying to manage a solution lifecycle management, especially around costs and understanding our licensing models and also trying to see how we can best get the value out of our solutions, so I think it's a work in progress, but so far I don't think we have broken even from our investments so far."*

The capital intensiveness of the DT process in asset intensive industries is arguably the reason why mining companies lagged behind the initial DT surge, and continue to play catch up on DT. A cost-benefits analysis, such as the one highlighted by the participant above, that relies solely on value as a derivative of profit does not provide the nuanced picture of the role DT plays and will continue to play in the mining industry in South Africa and beyond. Constrained and narrow definitions of value, confined by rand per tonnage and profit margins, are not a useful metric of holistic value to The Firm. What follows is a discussion on the broadened parameters of value, qualitative and quantitative value.

4.5.2. Qualitative and Quantitative Value

Majority of the participants agreed that there are two aspects to value that ought to be considered and that is enabled by the DT journey, this included quantitative and qualitative benefits - some participants referred to this as soft and hard benefits. This concept is thought-provoking as much of The Firm referred to quantitative benefits/hard benefits as factors that include increases in throughput, revenue, bottom-line, a reduction in costs and other effects on monetary efficiencies; some of which noted below in the response from an executive:

- *Participant F: "Yeah, so let's let's now first talk about the the. It's now either the hard or the soft let's call it the hard value, that is where the monetary value where you can put it in the bank.It's a rand it's a dollar. So let's start with that first. So the value for me. Obviously there's a couple of value levers or*

[22] Data Access Units (DAU) is a physical device (infrastructure) which enables the retrieval and transfer of data from data sources to areas of data storage or use (Huawei, 2021).

drivers and, and first of all it is your throughput. The more you can produce,the higher the value. Then secondly,it is at the cost that you can produce it.The cheaper you can produce that same volume volume or more, the more money you can pocket.I think there's part of the value is also another element is your capital. Also need to look at your Capital Management, your capital efficiency so those are the for me the main hard value drivers which makes you richer or poorer…If I can go to the let's say the softer value. It is in your culture. It is in your people and so forth and I think everybody wants to be part of organization where first of all a vision. There's value in a vision. There is value in your values. There's value in your culture there is value in. do you make a meaningful contribution and so forth. So, I think that's the softer side of value and there I think there is a whole list of things that we can discuss In my opinion you can put it into two categories the monetary, almost hard value, and then the softer value. "

As part of this some may have included safety. Safety was important but it was not clear whether it was qualitative or quantitative. Such a response can be seen below when the executive was further asked about safety and its catagorisations:

- *Participant F: "Yes, so, obviously I think you can almost put it in in both categories. So first of all you need to operate safely, otherwise you will not be able to make money and so forth. But you can also put it on the value side. It's also value of the company to say OK,we don't do any work if we can't do it safely and again on the softer side is that everybody wants to work in a safe environment.*

Other responses on value alluded to by another executive (quantitative/hard benefit) and an operation participant, respectively. Note the response of culture or mindset highlighted by the operational participant and its importance in realising value. This aspect can be categorised as a soft/qualitative benefit:

- *Participant E: "Obviously with that being said it's about how do you also improve the bottom line, because with that you can differentiate yourself with that you can really drive yourself in the quartile of the cost curve."*

- Participant M: "*OK, so ultimately I think that, value realisation is based on, directly impacting the bottom line, so either from a throughput so cost revenue or profit perspective, right? So it's either impacting the bottom line specifically from cost revenue, let's say throughput and… Ultimately, all of those sort of have an impact on profit eventually… However, when I was at [operations], I think one of the one of the key focuses in terms of understanding value was also sort of, let's call it a digital mindset, or that's what they called it in [operations]. So the cultural and the cultural element in terms of mindset and that*

journey as well having peoples mind change in my opinion, is also an important part of releasing the value, because if you spend loads of money to digitally transform, but the people who are meant to use the solutions don't, then we fail."

Soft or qualitative benefits refers to a wide range of aspects such culture, legislative compliance, improved working environments, capacity release, changes in organisation culture/mindset, improved foresight, creating data visibility, etc. After the initial interviews, it was clear that The Firm, focused on both qualitative and quantitative value, with some initiatives purely implemented on qualitative value as seen below by the response from an end-user (Partner):

- *Participant J: "I think it obviously the first. I mean it's like you do know all of these things, but obviously in terms of the KPIs and there's distinct benefits in terms of the direct benefit. So, for me that there are definitely ways to, in terms of the ones that can be measured, qualitative and quantitative, and in terms of where they realised Value lies within the organisation. So in particular, particularly on this one, and the quantitative benefits actually weren't really the motive for doing the project, it was more round the qualitative benefits in terms of creating the direct access to visibility, and moving, empowering, the organisation in terms of information and data and that was to me, for this project, and that was the value realisation in terms of giving the organisation the ability to have the right data in front of them to be able to manage the services."*

The above serves to illustrate how a broader conception of value is required to pursue DT within the mining sector, as a narrow monetary definition does not cover all the benefits that can be derived from transforming an organisation. All participants, except one, agreed that value is both qualitative and quantitative and has been realised. In addition, participants mentioned that The Firm's DT journey brought value as they were able to navigate the Covid-19 pandemic.

4.5.3. Value in the Approach and Methodology

As previously highlighted The Firm implemented new ***processes*** of deploying technology such as following agile methodology and the start-up way. These new techniques allow for solutions and testing of ideas to be developed quickly in the direction of producing a solution, thus enabling, and sustaining value. One of the executives mentioned that there are initiatives that have been going on for three years that have added value and are continuously being enhanced to add more value and that is because of the agile and incremental approach that is being utilised. Additionally, the methodology allows for employees to engage with ***designing*** solutions that they are not

knowledgeable in as they can start small and *learn* along the journey and decide what to do next when the first sprint is complete and then continue to learn and develop knowledge:

- *Participant I: "The other thing is running with this stuff you could see value, but because it's agile and incremental, it's not like you can ring fence an initiative and go "It's now started and ended, and this is how much value." So, some initiatives were started three years ago. They still going. So they've had value, but they continually being enhanced so you continue to spending more money enhancing them for further value - that is also then proof that people do see value effect that they still spending money on those initiatives…it's very hard for people to do a complete design if they don't have that knowledge and that capability, but when you doing Agile and you've got sprints, and you do MVP's people learn as they go along. You know, so they so they do something small -they learn there OK. What is the next step? They learn more. OK, so they don't have to know all of it up front."*

This change or introduction of new deployment methodology changes the way The Firm, thinks and realises value. It is continuous, it is iterative, it allows employees to experiment, and learn. Furthermore, value realisation is not a linear process but is rather multi-dimensional, continuous and requires constant revision not only of the process but on how value is defined.

4.5.4. Enabling and Sustaining Value

There are several initiatives that have enabled value in The Firm, either qualitatively or quantitatively, some of these initiatives or aspects are highlighted below, which were most likely *designed* and *created* utilising *agile* and/or *start-up* methodology:

- Legislative compliance – there are digital initiatives that assist with governance or standardisation across various BUs. This can be in simply ensuring that compliance it done accurately, which could potentially relieve reputational damage. An example is noted below by a partner participant:

  - *Participant H: "…sometimes it helped with governance or you know, making sure that something is done according to schedule on at the right time.You know, aligning process or standardising process so that everything is done the same way at different BUs etc. So that's also a nice thing*

is that the governance sometimes relieving reputational damage. So for instance if your B-BBEE[23] *stuff isn't done accurately."*

- Improved working environments, capacity release and cost savings – There are initiatives that realised both qualitative (*higher-level impact)* and quantitative (*organisational performance)* benefits and this value was realised or observed in relatively short periods of time. This can be seen in the RPA example demonstrated by a partner participant:

    - *Participant H: "So I would say from I think it was March 2018 where we initially started with our three PoCs [Proof of Concept] and I think towards the end of the year the six PoCs may have been in place,so over that span of time. I wouldn't say that we started reaping the initial rewards,but we wouldn't have been able to attest to, you know,we need to see it over a year. We need to have seen the robots working over here to see the full years return of investment, but I think with over a period of six months, people would immediately be impacted by the capacity release. People who were suddenly being able to be relieved to do either more meaningful work and they could have been a cost savings immediate depending on the process as they would have been cost savings realized, but not significant. You know you need time to see to see the the full benefit you know in terms of financial returns…I have seen people with a, I think you know you exhibited that in the [knowledge sharing sessions], people that are extremely skilled that were doing menial work have have now you know they're doing the right work at their skill level. Not here just to say that just the administrative people you know had to reinvent themselves. We've also given the people that were extremely skilled, and we've relieved them from doing stuff they should never have been doing."*

- Initiatives realising value through stockpile management and diesel tracking (*organisational performance)*. As discussed, below, by an end-user there has been significant quantitative value realised on just two initiatives to the value of over 61 million rand. This is demonstration of direct monetary return on investment:

    - *Participant C: "Yes, it has. I can mention a few initiatives that I've been directly involved in the implementation. Number one: It was the stockpile management that saved one of the business*

[23] *Broad-Based Black Economic Empowerment (B-BBEE)* refers to a policy and legislation package that seeks to "…advance economic transformation and enhance the economic participation of black people in the South African economy" (Department of Trade and Industry, 2021).

units, about 41 million. And there's diesel tracking that's saving one of the BUs over 20 million and there's other initiatives of which [person's name] is directly involved, such as RPA that are saving their business some value. So, value has been realized in organization through these initiatives."

- An enterprise service management system was implemented. It also changed the culture (*organisational culture)* of how service management is executed, previously the help desk would have to physically take calls, they now focus on the management on the service as call are now logged digitally. This information was provided by an experienced IT partner that work at various organisations who further discusses that there has been value realised and poor service as reduced as seen in the dialogue below:

    - *Participant J: "Yeah, absolutely. I mean just I mean the transformation in The Organisation in the last three years has been epic. I have worked for lots of organizations, just the networks that we've laid down at the BUs and the speed at which we do work. The fact that we can even think about doing VM and cloud backups at the BU sites is seriously, seriously amazing…we added massive amounts of technology, and I think obviously it helped that there was a huge budget and that was approved. But, having said that, I think the value realization is an absolute yes. I mean, just in the [service management] space, … in terms of the number of calls they used to get for escalations on bad service prior to putting ServiceNow… so the guys had moved from taking calls and speaking to people and so on to more managing the service management service. In other words, they monitor, they manage, they escalate. They are involved in major incident management as opposed to every day today call that comes in."*

    When asked if the calls are being logged digitally the partner's response was:

    - *Participant J: "Yeah yeah. That's a big change."*

- Improvements in equipment availability and higher-level impact. There has been implementation of semi-autonomous mining drilling equipment. Which has improved the operational environment of the operator as well as eliminated a risk associated with injury. In addition, the machine health and efficiency is improved, which can be translated into monetary value, another qualitative and quantitative initiative as noted by an end-user:

- *Participant L: "I'm gonna keep on with drill story cause it's now a trend. If we take out a personal - if you've been in a drill on a drill block before its horrible place to be- so you significantly increase that person's value of living by taking him out of the machine. If he can sit in an office in an air-conditioned environment away from high walls, away from dangerous situations away from dust, noise. So, from an occupational health and safety point of view, that is a significant increase in value and the other side of that is, is that the machine takes care of itself. It's not reliant on a person, so you create that monetary value on that side as well. But the value is two-fold…you have a reduction in downtime. Let's call it unnecessary downs because of human error, so you typically don't have on a drill example. Again, you don't have a situation where a person leaves a rod in a hole and then you have to go and dig it out for example, or you don't overload engines, or you don't have a person ignoring warning signals etc etc. The machine takes care of that. OK, so the uptime you gain is essentially in machine health and machine efficiency."*

- Improvements in the human resource's (HR's) onboarding process which focused on automation of the associatied required administration, resulted in the reduction of paper and created additional capcity for the HR personnel. This capacity release allowed for HR personnel to focus on other non-administrative HR related matters, as noted by an end-user:

  - *Participant J: "Yeah, I think so I think so, for example, in the HR on-boarding. The point of that was to allow the HR Admin guys to really focus on less paperwork and more interaction with candidates. So we automated a lot of the stuff and by doing that we freed up some valuable time so that the HR guys could deal with real HR issues and move them away from admin related tasks. So that was that to me is quite is quite a difference where we created space for the HR guys, during the on boarding process, to now focus on actual HR issues as opposed to admin HR issues."*

- As previously mentioned, through the implementation of new methodology employees are able to experiement and test solutions and they may have gained skills from lessons learnt. In addition to this The Firm has improved their learning and development strategy which allow employees to enrol in courses or degrees at leading institutions that relate to new technologies or in line with the organisation's digital drive, as discussed by an operational participant:

- *Participant K: "And some skills would transfer, but in certain instances, it would need to be supplemented, and I suppose that's why the organization would have adapted their learning and development strategy. So you've got these courses, for example that talk to machine learning, analytics… You can do an analytics masters at MIT Online and yeah, so I think we adapted our learning offerings as well to pull the gap."*

As evident from the participants The Firm has initiated several initiatives that are in line with enabling and sustaining value in The Firm.

4.5.5. Value Realisation Framework

The Firm has developed a value realisation framework (VRF) that guides the tracking and approval process of digital initiatives. They initially *accessed*, the framework through their partner firm as discussed below by an operational participant:

- *Participant K: "Feasibility studies and scoping is done largely by the internal owners of the project. [the partner firm] were more in terms of facilitating the process, the formats all of that. Yeah, feasibility is the right word. They would help a lot too actually in giving a framework, so I think that's the value they brought where you could have a grade [category] like that. So, I would have an idea for fragmentation. What [the partner firm] would do quite well is they would give you a framework of how do you scope this; what are the key items that needs to be in your scope; what's going to be the business case; how do you determine the business case and calculate the NPV; and all of that. So, they did well with that. Although we had we have those skills, but I think they just packaged it into a framework very well."*

A Partner Firm participant did mention that this is a 'work in progress' and that will develop over time, however this work in progress seems in line with their agile and start-up methodology:

- *Participant A: "So, it is a framework now. A work in progress I suppose. I think for me the key thing is, again culture plays a role here… You're running a marathon, not 100-meter sprint. And I think that needs to be appreciated also. So yes, there is a value realization framework, I think it will mature overtime, as people go through the digitization journey, engage in different initiatives, the framework should improve with that."*

During the interview, with an end-user, the VRF was highlighted as an important capability that will guide the process of tracking value:

- *Participant C: "Other capabilities include our business analytics, visibility on the emerging technologies, the signals and trends, access having access to revised Gartner hype cycles to ensure that we are always up to date with what's happening in the world. Now, having such visibility will help us identify potential disruptive and radical solutions that can be deployed in our operations, and that will potentially result in value. And the most important thing is having a value realization framework that will guide the process of value tracking."*

Another important aspect when discussing value with a managerial participant, it was highlighted again that the realisation of value is not only monetary from a business case perspective:

- *Participant D: "I think given the context given from a from a business case perspective, if you if you have any intent in terms of improvement on rand per tonne,your benefit realization has to speak to exactly that.You have to realize some efficiencies in how you go about effecting your value chain and you also have to realize some cost savings where there's been savings in terms of elimination of waste within your your value chain.As well as as well as you know,improved efficiencies around how you get to the same answer.Now getting to it quicker and much faster and safer as well by leveraging digital."*

  Author: *"OK, so it's not only monetary, hey [Participant]?"*

  Participant D: "No definitely not only monetary, definitely not. Because the whole thing with Digital Transformation is to a large extent, it's a paradigm shift in terms of how business is done... So it's not only about monetary value realization when you look at the full end to end returns on it."

4.5.6. Conclusion: Research Sub-question 2

Analysis from the participants indicate that initiating a DT journey in the mining industry/organisation requires significant capital to ensure that there is technology integration and base infrastructure to ensure data flow.

From the examples above, The Firm's DT journey has enabled value. They are also more equipped to sustain value as there has been employee capacity being released from menial task, reduction in costs, improvement in equipment availability, improved operator safety, improved service delivery, improvements in culture, etc

An interesting comment made by an operational participant demonstrated their belief in that the process and learnings from this digitalisation and innovation journey has enhance the thinking of employees in The Firm to better position the organisation for future growth and potentially demonstrates the sustained longevity of the business through new ways of sustaining value:

- *Participant K: "So what I see as deriving a lot of value from these experiences is as we go out into the market now trying to find new assets, I feel our thinking around Business optimization, orebody optimization, value chain end to end value chain optimization, our thinking around it has been enhanced through the lever of digitalization and innovation. So I feel we will be in a better position when we grow our business."*

In addition, to this there are stronger HR process for onboarding; new technology deployment methodologies which enhance the employees learning and ability to experiment; and improvements in The Firm's learning and development strategy which further supplements the knowledge of employees in the organisation.

The combination of the changes in processes to enable this drive, the deployment technology to provide solutions and improve ways of work has enable employees to focus on value adding solutions as well as improving culture and knowledge to enable and sustain the growth of The Firm. During the analysis it was noted that several components of DT interacted to enable or sustain value (qualitative and quantitative) as highlighted in this section and illustrated by Figure

10.

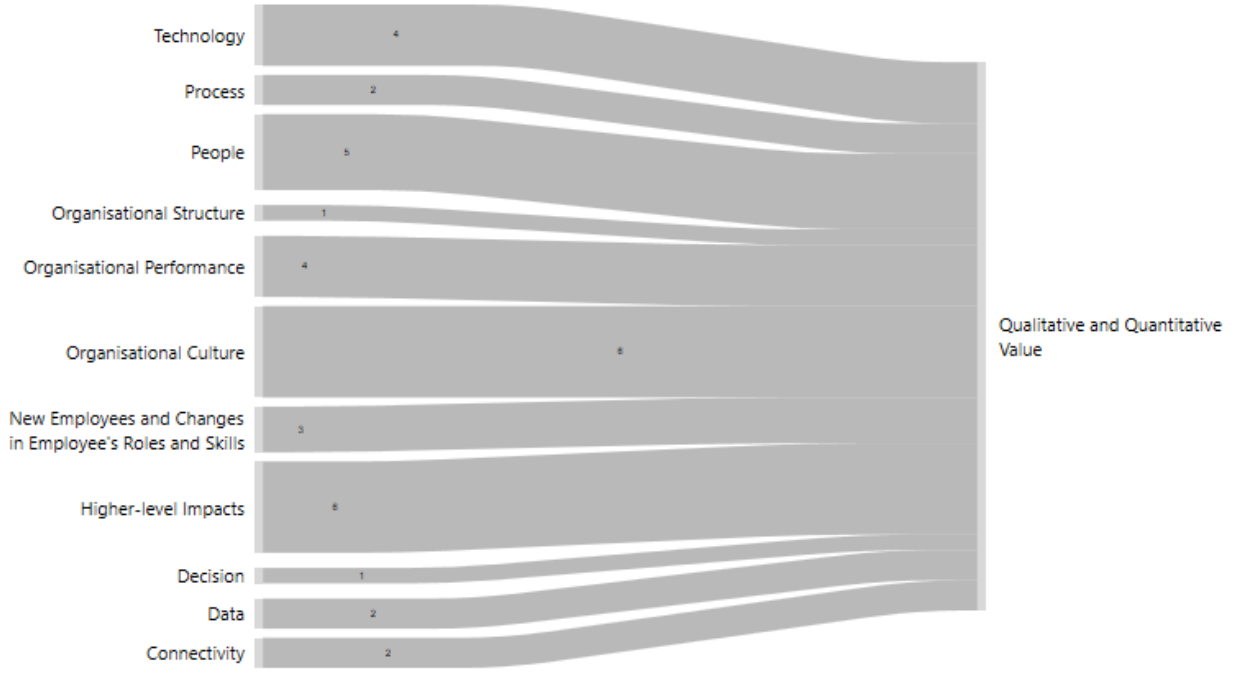


Figure 10: Sankey diagram illustrating the components of digital transformation which has enabled or interacted with both tangible and intangible value as per the codifications in ATLAS.ti 9.

Proposition 2: It is proposed (based on the literature) that DT can create new or enhance existing value realisations avenues which affect people, process, and technology. Additionally, research highlights that improvement in data and connectivity leads to better decision making which enhance new or existing value. The DT components either impact value directly or result in solutions or further developments that enable and sustain value. This enablement and sustainability are further affected by change in processes, methodologies and frameworks that ultimately impact tangible and intangible components of value.

The Sankey diagrams and data demonstrate findings in support of the initial research proposition. This is noticeable that changes in components of digital transformation result in both qualitative and quantitative value.

4.6. Conclusion

This chapter documented the data obtained through techniques and methods outlined in Chapter 3. The primary source of data was interviews of participants from The Firm and three

Partner Firms. Several quotations were presented in the data which were codified utilising CAQDAS. The quotes presented were according to the narrative and are not the absolute number of quotes or themes obtained during the research. The frequency of both deductive and inductive themes per participants were tabulated in this chapter. It can be deduced that both The Firm and Partner Firm participants provide data in support of the two research propositions. In the next section, this data is discussed together with the theory obtained from the literature review.

5. Discussion of Results

5.1. Introduction

This chapter examines the results analysed in Chapter 4. The discussion is guided by the conceptual framework and propositions which was developed through the literature review process. This framework embeds DT, dynamic capabilities, and macro & micro-level concepts which forms part of the thematic analysis. The framework aided in establishing a deductive approach which formed part of a guided process in which the interview questions were created (Appendix 1) and how the analysis was initiated (Appendix 2). A further inductive approach was applied to demonstrate additional findings obtained from the chosen participants and The Firm. The comprehensive list of deductive and inductive themes is discussed as part of the overarching themes highlighted in Chapter 4 and this Discussion. The results from the interviews create an opportunity to establish the correlation between the theoretical literature and practical domain in the South African mining sector, in line with the pragmatic paradigm. These findings are discussed as themes in relation to the research sub-questions. These themes are also intertwined and may not exist in isolation or without some of the other mentioned themes, for example; changes in organisational culture may be as a result of change management and agile methodology. In addition, some themes highlighted during the deductive and inductive process may be represented within other themes. Each of the themes are noted in this Chapter as being important and was enabled through dynamic capabilities operational actions which further impacted or enabled the DT journey which translated into organisational value.

5.2 Research Sub-question 1: Discussion

How could dynamic capabilities enable digital transformation in the South African Mining Industry?

It was proposed, in Chapter 2, that dynamic capabilities enable a firm to digitally transform by implementing new capabilities aligned with the firm's strategic intent. These capabilities are created through a phased approach such as 'exploration', 'building' and 'extending' which embed the process of enacting dynamic capacities. These new capabilities enhance existing capabilities that enable the emergent strategy. This chapter will review the analysis in Chapter 4 as part of

several themes. These themes form part of the process that enabled digital transformation, but the converse may also be arguable, if some of these themes were not conducted then the organisation may have not been successful.

5.2.1. Dynamic Capabilities

During this research, the concept of dynamic capabilities was examined through the lens of a process, as illustrated by Teece (2007) and Yeow et al. (2018), where the sensing, seizing and transforming dynamic capacities are expanded through operationalisation actions. For the purpose of this research, it was the operationalisation actions that were utilised to examine the process of The Firm during DT journey. The dynamic capacities formed mere categorisations or groups of the operational actions, as all operationalisation actions related to one of the three dynamic capacities (Yeow et al., 2018). The DT journey of the firm was analysed through the exploration, building, and extending dynamic processes, as phases in The Firm's journey.

5.2.1.1. Dynamic Capabilities Process and Operational Actions

According to Yeow et al.,(2018), firms that enable a digital strategy through dynamic capabilities follow a process of exploring, building, and extending. These dynamic processes are represented as (Yeow et al., 2018):

- Exploration - is the process phase in which the organisation explores, scopes or searches for opportunities. Opportunities are identified and strategic commitment is made.
- Building - the organisation focuses on designing and changing its processes and resource base to support its committed strategy.
- Extending - as capabilities develop new alignment issues arise or additional effort is required. This requires further development on the building phase, focusing on improving the new capabilities and processes developed within the organisation.

It was clear that The Firm, embarked on a process of exploration, building, and extending by enacting the dynamic operational actions. Similarly to Yeow et al.,(2018), there is significant interaction between the operational actions and the dynamic processes; and the dynamic capabilities processes and themes that enable DT within The Firm, this is respectively highlighted in Figure 8 and Figure 9.

5.2.2. Development and changes amongst leaders

The leadership started the journey in 2015, which was a pivotal moment in this DT journey. They *accessed* knowledge through external expertise which created an opportunity to *scan* and *learn* the macro-environment and embedded millennials in their workshops to *learn* from the younger generation. A strategy of business improvement utilising digital technology was *designed*, *selected,* and *committed* to drive through the entire organisation. Internal skills were *leveraged*, in combination with *accessing* numerous external expertise as well as the *creation* of new structures, and in few instances *releasing* non-contributing capabilities. We see this early development play an imperative role by the commitment of leadership through a journey of continuous change management, which was conducted throughout the dynamic processes. This leadership commitment is important and effective during organisational transformational processes as note by Prasad & Junni (2016).

5.2.3. Change Management

The importance of change management was essential and was *committed* on several levels by The Firm, initiated by its leadership. The ability to adapt to changes in The Firm is imperative as noted by Kane et al.(2015), several changes and or decisions were made that enablement various components of the DT journey of The Firm (which was further under-pinned by several operational actions) including but not limited to:

- The CEO initially led the journey. It was evident from interviews with the Partner Firms and employees from various levels of the Firm, that CEO led this DT journey. This was essential for organisational buy-in as employees are more confident in a digital journey when led from the top, as highlighted by Kane et al., (2015).
- Engaging the trade unions. The CEO had several engagements with the trade unions which resulted in a level of transparency of the DT journey as well as eliminating any potential fear regarding redundancies and job security. These trade union engagements were imperative in the context of the South African mining industry as the trade unions have a significant influence on the organisations in which they represent employees (van der Westhuizen, 2020)

- The high level of awareness of the strategy to optimise the business and achieve a competitive advantage amongst employees and partners of The Firm which is imperative in an organisational digital transformation process (Jöhnk et al., 2020). This clear strategy that was driven by the leaders together with digital technology integration provides the ability to reimagine the business from a digital perspective (Schwertner, 2017). This is further enhanced by enabling the employee base to learn and grow as highlighted in the next bullet point.
- The leaders committed to investing in sending employees to SingularityU sessions on a continuous basis to enhance the culture and change the mindset amongst employees in The Firm. These sessions would have exposed employees to several *learnings* such as: a new way of thinking, new exponential and disruptive technologies (Singulaity Group, 2021). Hence, enhancing The Firm's ability to reimagine digital solutions to new and arising problems (Schwertner, 2017).

These are some of the engagements noticed during the DT journey. It is evident that change management was essential, conducted at large scale, and driven by leaders in The Firm. It may be argued that many themes in this research or the DT journey has a whole may have not been successful without the implementation of change management (Rosenbaum et al., 2018).

5.2.4. Changes in Organisational Structure

The Firm went through numerous structural changes which were imperative in its DT journey, as similarly noted by Matt et al. (2015). Some of The Firm's structural changes are noted below:

- *Accessing* numerous consultants and external expertise to enable the transformation, the importance of this is seen in the concept of open-innovation and is known as outside-in innovation (Chesbrough, 2015;Chesbrough, 2017) especially when an organisation is embarking on 'exploring' activities (O'Reilly III & Tushman, 2004).
- *Creating* a business excellence department to ensure that processes are optimised through lean methodology.
- The *creation* of an innovation department to enable the DT journey.
- Changes (*creating*) of the reporting structure of the innovation & information technology (IT) function to report directly to the CEO.

- The *creation* of new roles to sustain and improve the journey and *leveraging* internal capabilities to take over from consultants or to co-create solutions.

Vial (2019) also notes that structural changes within organisations is associated with DT when embarking on such a journey.

5.2.5. Skills development of Employees

Employees in the organisation were provided with the opportunity to learn and develop, this may overlap with other themes, but the upskilling and development of employees is essential in the transformation of organisations (Vial, 2019). Some of these examples are noted below:

- Sending employees to SingularityU conferences as previously noted.
- *Learning* through knowledge sharing sessions, which may also be a form of change management in line with knowledge sharing concepts that can be seen in 'hackathons' events, as elaborated by Tenório et al.(2019).
- *Learning* of new processes through *accessing* of external expertise and partnerships (Stachová et al., 2019).
- Access to new digital courses that were at reputable international universities.
- Improving the learning capacity through a new embedded learning management system.

5.2.6. Agile and start-up Methodology

The DT journey required new methodologies to bring about digital solutions that were new to the employees but also in a way that employees could learn and add value. Agile methodology was *accessed* through The Firm's strategic partner, and the start-up methodology (Ries, 2017) was *leveraged* through The Firm's leadership and facilitated through change management techniques such as providing literature and teaching employees. These changes in methodology/processes affected the way people/employees implement technology. As highlighted in Chapter 4 employees can test value and learn at the same time through iterations which is an effective deployment method as highlighted by Goffin & Mitchel (2016) and Aghina et al., (2018) especially when there are uncertainties in the scope of work (SoW) or when the SoW evolves, as was noted

above when an interviewee stated that that some initiatives were still being developed 3 years down the line.

These process provide a new framework for The Firm to operate in as well as to ensure that governance processes are in place as required by South African listed companies according to the King IV act (Giles, 2017). It may be further argued that The Firm is an agile organisation as these five characteristics were established during the interviews, and are recommended by Aghina et al., (2018):

1. **Strategy** – The Firm's 'north star' of business optimisation and obtaining competitive advantage was pervasive across the participants.
2. **Process** – Several processes were optimised, with the purpose of learning and reiterating.
3. **Structure** – Structures were optimised and introduced to facilitate a common goal.
4. **People** – The talent system was reviewed; new roles were created, and employees were skilled.
5. **Technology** – Several technologies were implemented in support of streamlining the organisation, such as the service management system.

These five characteristics were enabled through dynamic capabilities operational actions through the process of dynamic capabilities processes.

5.2.7. Changes in Organisational Culture

The Firm went through a transformation in several areas as highlighted by some of the previous themes and as a result of this journey a shift and change in organisational culture was noticeable during the DT journey as determined by the interviews and further supported by Vial (2019). Some of these culture developments are noted below:

- Mindset – The majority of employees and Partner Firm participants made mention of the mindset, which emphasises the change in the way people think.
- Leadership foresight – Several participants highlighted the foresight of the leaders, and this was imperative in the dynamic environment to ensure the sustainability of The Firm.

- New way of deploying initiatives – This has changed the way employees deploy initiatives, learn, experiment, and think of realising value
- Employee and leaders learning new things – The Firm has embedded a culture of learning, experimenting, and 'exploring'. There are also new structures which were embedded through dynamic capabilities process which also enable non-strategic levels of exploring, building, and extending. For example, the digital leads at the BUs can explore, build, and extend for individual projects or programs at that specific BU. This was enabled through the strategic drive of exploring, building, and extending.
- Higher-level impact – Several initiatives have released capacity from many employees, allowing them to focus on more purposeful work, this may lead to a more impactful organisation (Craig & Snook, 2014).

5.2.8. Summary

As evidenced by this research and supported by the case study, dynamic capabilities can enable DT by embedding a dynamic capabilities process which is underpinned by dynamic capabilities operational actions. These processes enable changes in the organisation, as noted by the various themes, which encompasses DT and are applicable in the South African mining industry.

It is noted that the journey was initiated and led by the leaders of The Firm, embarking on an enterprise large scale change management process which embedded several changes in the organisation. There were organisational structural changes as well as new processes and methodologies embedded into the organisation with a strong intent to upskill and train the employees of The Firm.

These themes are highlighted above and implemented through a journey of dynamic capabilities processes through enacting several operational actions as show in Figure 11 which is an adaption of Figure 8 and Figure 9. Figure 11 illustrates the multi-interaction of operational actions with dynamic capabilities processes which similarly interacts/enables several themes that encompass The Firm's DT journey. These were themes that were highlighted during the analysis and are shown in Chapter 4.

The analysis of these themes compacted and embedded into several themes and represented by Figure 12 which is a concatenation of Figure 11.

Based on these findings it is proposed that dynamic capabilities can enable DT in the South African mining industry by:

- Embarking on a journey of exploration, building, and extending dynamic capabilities processes. These processes are enabled through dynamic capabilities operational actions such as: scanning, learning, calibrating, designing, selecting, committing, leveraging, creating, accessing, and releasing. These operational actions are continuous during the process and can be categorised into sensing, seizing and transformation dynamic capacities.
- Enabling several changes in the organisation through this dynamic capabilities process and operational actions these changes include but are not limited to:
    - Development and Changes Amongst Leaders
    - Change Management
    - Changes in Organisational Structure
    - Driving Skills Development of Employees
    - Implementation of Agile and Start-up Methodologies
    - Changes in Organisational Culture

These changes ultimately affect The Firm's people, process and technology which encompasses and enables the DT journey.

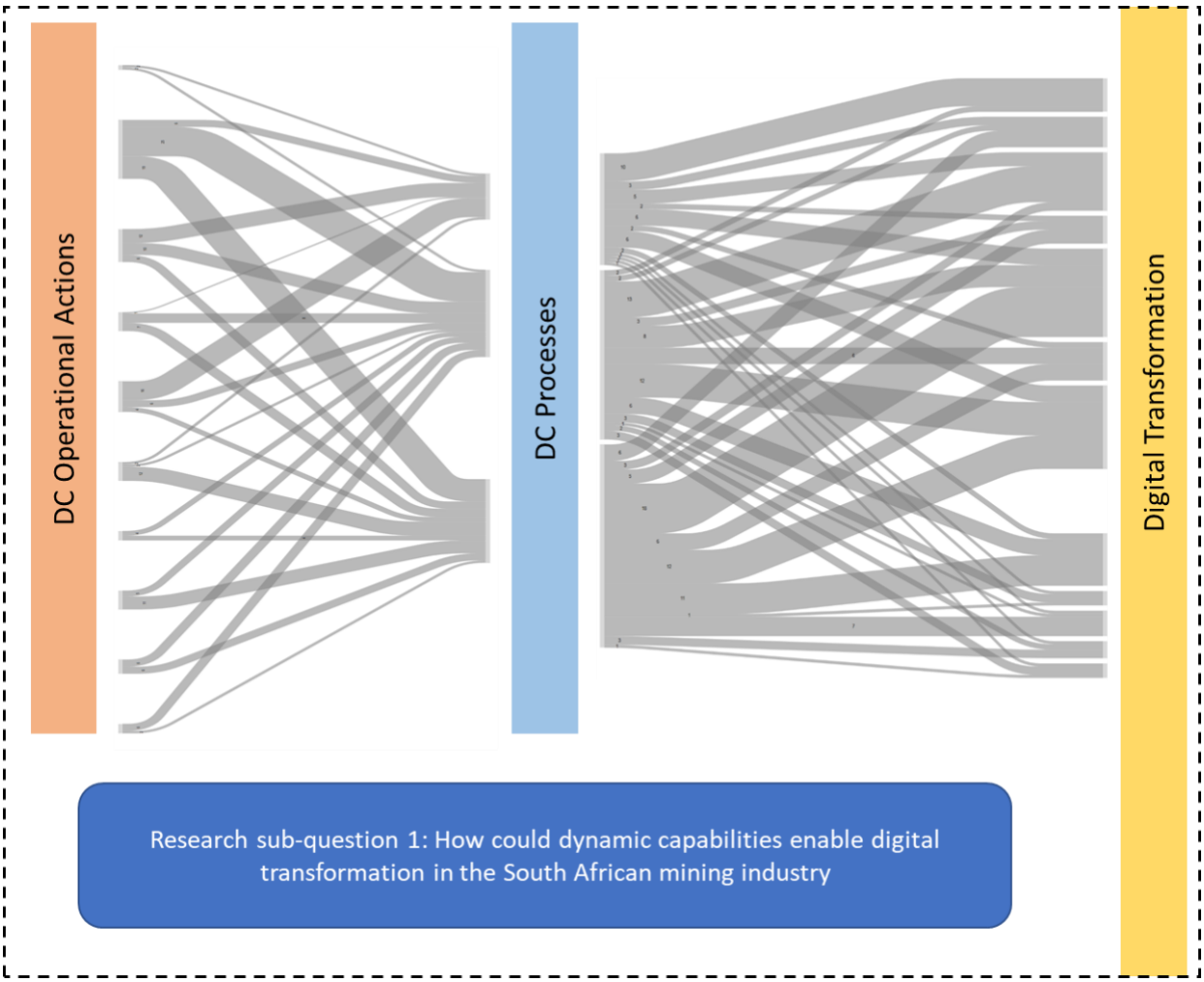


Figure 11: An adaptation of Figure 8 and Figure 9 which demonstrates the interaction between dynamic capabilities operational actions, dynamic processes and digital transformation.

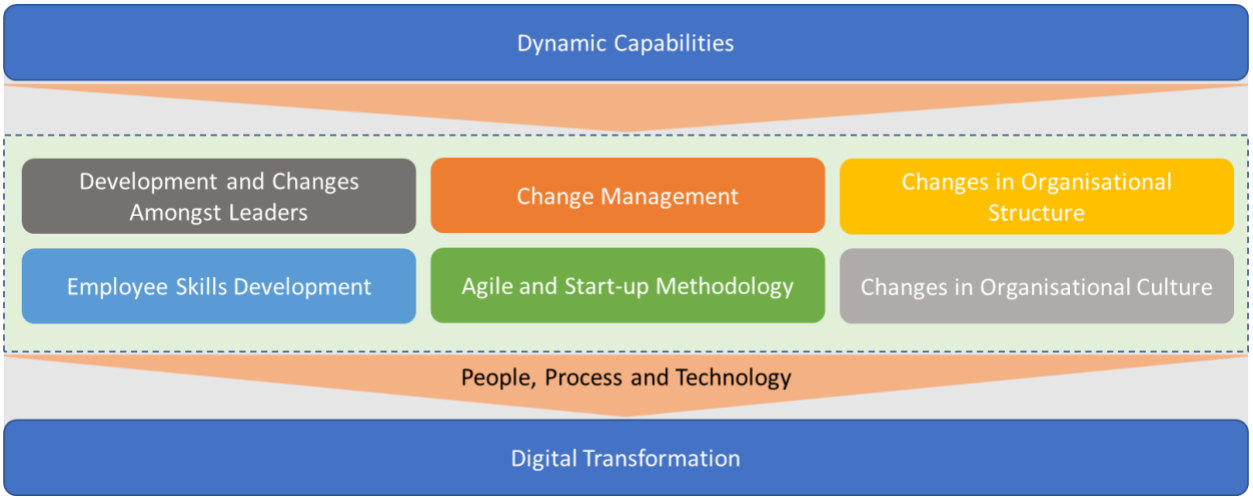


Figure 12: Further analysis of Chapter 4 resulted in a concatenated interaction of Figure 11.

5.3 Research Sub-question 2: Discussion

How could digital transformation enable and sustain value realisation in the South African mining industry?

It is proposed, based on the literature, that DT can create new or enhance existing value realisations avenues which affect people, process, and technology. Additionally, research highlights that improvement in data and connectivity leads to better decision making which enhances new or existing value. It is further proposed that value maybe be noticeable in these 12 areas but not limited to: education, workforce development, safety, transparency, supply chain management, reduces environmental impacts, innovation standards, operational excellence, alternative investments, lowering innovation hurdles and business intelligence (Young & Rogers, 2019); some of which have been highlighted in this research.

It is essential to note that The Firm was driving a strategy of business optimisation and competitive advantage, which may be considered as the strategic value of The Firm. Therefore, all the themes in 5.2 will also be applicable in this section as it was the strategy of The Firm to deliver DT to achieve business optimisation and competitive advantage. However, there were several additional themes that were visible from the analysis of the participant interviews. These additional themes have a direct implication on the enablement and sustainability of value.

5.3.1. Capital Intensity of the Mining Industry

The capital intensity of the mining industry requires significant infrastructure such as operational technology (OT) and associated technology integration to ensure that there is connectivity for data to flow which can result in potential decision making solutions (Young & Rogers, 2019). This was noted by participants during the interviews with an end-user (in section 4.5.1) comparing the high capital intensity in mining to the lower capital required in the banking industry. This capital intensity adds additional financial requirements on the mining industry as the initial access to data is higher and therefore the requirement to build solutions requires significant initial investment or foundational infrastructure (Gao et al., 2019). An executive, in section 4.4.2.5, goes as far as stating that this is a capability and is the backbone for this transformation journey and was an initial investment that The Firm had to make. Therefore, this infrastructure can be seen as an enabler to realise value through DT solutions and may be costly which has to be taken into consideration when evaluating the RoI. The infrastructure will also then be required to sustain these digital solutions (Gao et al., 2019) and therefore sustaining value. This infrastructure can be seen as the technology, connectivity, and data components of DT (Young & Rogers, 2019).

5.3.2. Qualitative and Quantitative Value

All but one participant defined value in The Firm as both qualitative and quantitative value. This may also speak to the change in mindset and *culture* in which employees and leaders (*people*) need to look at value beyond pure monetary RoI. These tangible and intangible concepts of value were embraced by The Firm, this is emphasised by the example of the service management solution that was implemented purely for qualitative purposes. These intangible benefits may also result in significant quantitative or monetary value as pointed out by an operational participant, where there is strategic benefits and improvement due to enhanced thinking because of employees being on this DT journey which can translate to future growth for The Firm. Therefore, value can be enabled at both qualitative and quantitative levels (Love & Matthews, 2019).

5.3.3. Value in Technology Deployment Methodology

The Firm adopted two new approaches to deploy technology: the Start-up Way (Ries, 2017) and large scale agile methodology (Fuchs & Hess, 2018). Agile methodology may result in solving

problems and creating valuable solutions especially when there is uncertainty in scope (Goffin & Mitchel, 2016;Aghina et al., 2018). The Start-up Way, focuses on creating a minimum viable product (MVP) which focuses on the minimal effort and function to reach the first phase of a product (Lenarduzzi & Taibi, 2016). These concepts allow employees of The Firm to focus on experimentation and developing solutions that test value and then re-iterate to obtain more value, a concept also supported by Zahra et al. (2006). Therefore, allowing The Firm to explore solutions that they would have never thought of in a lean manner and improving the team performance over a period of value which may translate to increased and sustained value (van Dun & Wilderom, 2021). Value deployment can be seen as part of the process and people component of DT, technology could also potentially be used to aid these components.

5.3.4. Value Realisation Framework

Love & Matthews, (2019) highlight the importance of realising expected benefits from digital technology and the limited attention given to 'how' this technology can deliver value. These authors emphasis the need for a structured *process* of value which assists in enabling the management of benefits. This structured process can be seen in The Firm, through the implementation of a VRF which focuses on both qualitative and quantitative value similar to Munir et al.,(2018) and Kuna, (2014) where key performance indicators (KPIs) are used to asses value through qualitative and quantitative indicators. So, value is understood as both tangible and intangible in The Firm and is managed through a structured process. As highlighted in Chapter 4, some of these quantitative and qualitative KPIs include, but are not limited to:

- Revenue
- Cost
- Throughput
- Equipment Availability
- Safety
- Capacity Release
- Legislative Compliance
- Improved Working Conditions

Several of these KPIs have also been highlighted by Gackowiec et al. (2020)

5.3.5. Summary

The themes that are analysed as part of the first research sub-question are also imperative for the second research sub-question as they enabled the DT which enables The Firm's strategy of optimising the business and achieving competitive advantage. In addition to the strategic objective, there are additional themes that have been highlighted that focuses on value, these themes may have been enabled by other themes such as change management or changes in organisational culture and structure, etc. These themes also ultimately affect people, process and technology, which are components of DT which enable and sustain qualitative and quantitative value in The Firm.

The capital intensity of the operational technology and technology components are significant in the mining industry which is a significant 'back-bone' for a DT and enables and sustains the digital solutions that add value.

New technology deployment methodologies were implemented which enhanced the way employees experiment and test value as well as reiterate solutions to enhance value.

The concept of tangible and intangible value was applied by The Firm, therefore enabling multiple avenues of value, the focus of not only quantitative value enables a more strategic and forward-thinking organisation that can sustain business growth.

In addition to the above, the organisation deployed a VRF which focuses on realising value and therefore sustainability of value within the organisation. Therefore, a strategy was deployed and solutions enabled that follows a defined framework with the objective of sustaining and realising value through several KPIs. Some of these KPIs are unique to South Africa, such as the B-BBEE legislation (Botha, 2017), RPA solutions, and operator safety which is governed by the MHSA (Mine Health and Safety Council, 2018). It was also emphasised by the engagement with trade unions, as noted in the previous section, which have a large impact on the South African mining industry (van der Westhuizen, 2020).

Based on these findings it is proposed that DT can enable and sustain value in the South African mining industry by:

- Embedding infrastructure that enable and sustains digital solutions.
- Implement digital solutions in an agile and start up way.
- Implementing solutions that drive both qualitative and quantitative value.
- Ensuring that these solutions are following a structure framework with the focus of realising value.
- Focus on the problems which are specific to the country such as safety, engaging with trade unions and abiding to specific legislation.

All of which have an impact on people, process and technology. It is also noted that there are several components that enable DT that enable and sustain value as seen in Figure 13 which is an adaptation of Figure 10.

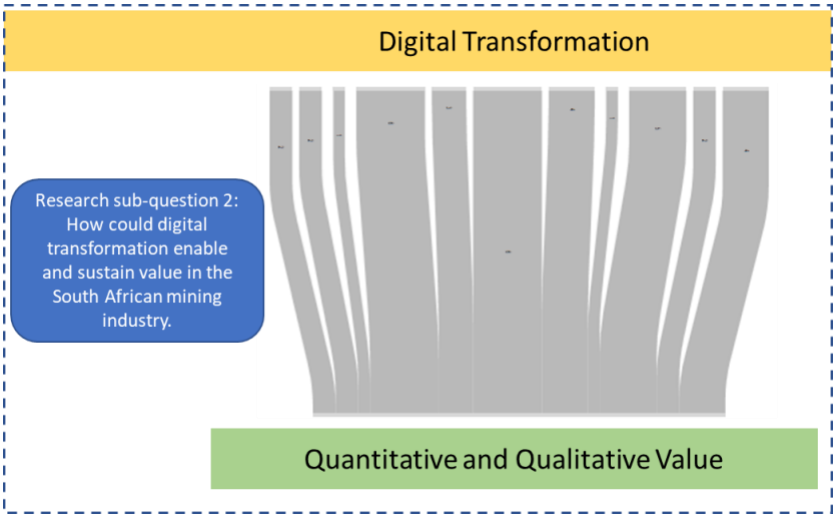


Figure 13: An adaption of Figure 10, illustrating those multiple themes/components of DT some of which highlighted in section 5.2 also enable and sustain value.

5.4 Innovation, Transparency, and Inclusivity

Two additional themes which were evident within the analysis of the research were innovation and transparency, which potentially plays an important part in this research.

5.4.1. Innovation

There were several aspects of innovation embedded in this research which was enabled through dynamic operationalised actions these include the follow:

- **Incremental Innovation** – The strategy of business optimisation and achieving a competitive advantage was visible through improvements of the current business, it was indeterminable during the research whether the business implemented a golden ratio which additionally includes adjacent and transformations businesses or business models (Nagji & Tuff, 2012; Goffin & Mitchel, 2016). The importance of developing dynamic capabilities for incremental innovation is further highlighted by Mikalef et al. (2019) utilising data analytics which is also applicable to this research.
- **Agile Methodology and Experimentation** – The Firm implemented agile methodology and start-up methodology, which is different deployment techniques that are important to realise value (Ries, 2017) or when the scope of the projects are uncertain which is typical in innovative projects (Goffin & Mitchel, 2016; Aghina et al., 2018). The experimentation of scope and value as previous highlights demonstrates aspects from secondary innovation where there is assimilation of technology (Wu et al., 2009; Wu et al., 2010) as well as innovative techniques such as doing, using and interaction (Lundvall et al., 2009) which is also further supported by Zahra et al.(2006).
- **Open Innovation** – The concept of outside-in innovation was established through the analysis by the significant effort placed on *accessing* external expertise to drive progress within the organisation. It was also noted when one of the end-user participants (Section 4.4.3.3) mention that they are trying to implement new solutions through open-innovation (Chesbrough, 2015; Chesbrough, 2017).

Reviewing literature also demonstrates results such as commonalities between dynamic capabilities and innovative capabilities (Breznik & Hisrich, 2014). Lee & Kelley (2008) proposes that dynamic capabilities is required to implement and manage innovation; and Zheng et al. (2011) linking dynamic capabilities to innovation performance. Therefore, this research may be argued to have significant components of innovation embedded within the components of DT, value realisation as well as the dynamic capabilities.

5.4.2. Transparency and Inclusivity

This theme has emerged through the analysis process, even though it was not articulated as such during the interviews it was evident inductively that The Firm was transparent and inclusive throughout the journey, this is evidenced in by the following albeit not limited to:

- **Change Management** – from strategic to initiative levels, different hierarchy of employees as well as participants from Partner Firms were aware of The Firm's intention. Leadership was transparent in their process (Parris et al., 2016)
- **Knowledge Sharing Sessions** – there were several knowledge sharing sessions where employees shared digital solutions between different BUs. This transparency and inclusivity resulted in potential scaling of solutions across The Firm and enhanced responses, knowledge and sense-making amongst employees (Al Balushi, 2021)
- **Trade Union Engagements** – as noted previously, trade unions have a significant influence in the South African mining industry (van der Westhuizen, 2020) and The Firm placed an emphasis on engaging with trade unions where the CEO initiated and led talks with the trade unions to ensure that there is buy-in as well as potentially eliminating fear amongst employees and the trade unions (Cirillo et al., 2020).

The theme of transparency and inclusivity has emerged in this analysis and may provide a future area of study to analyse and evaluate its effects on undertaking a DT process, potentially as a sub-component of organisational culture.

5.5 Macro-level Factors and Embedded Dynamic Capabilities

5.5.1. Macro-level Factors

Figure 4, highlights the importance of the macro-environment on the DT journey of The Firm. Through this research and the analysis of the of the interviews it was evodent that the macro-environment interacts with the dynamic operational actions which translate to micro changes that enable DT. This is noted as follows:

- The leaders of The Firm initiated workshop sessions which included millennials to scan and learn the macro environment and technologies, this eventually translated into a micro-level strategy which was focused on business optimisation and competitive environment.
- The Covid-19 pandemic influenced how the firm accessed and leverage technology.
- Employees accessed macro level knowledge of technologies and business models through SingularityU Conferences.

As a result of this analysis the conceptual framework has been amended to illustrate the effect of macro-level factors on dynamic capabilities which internalises into micro-level changes that enables DT, as seen in Figure 14

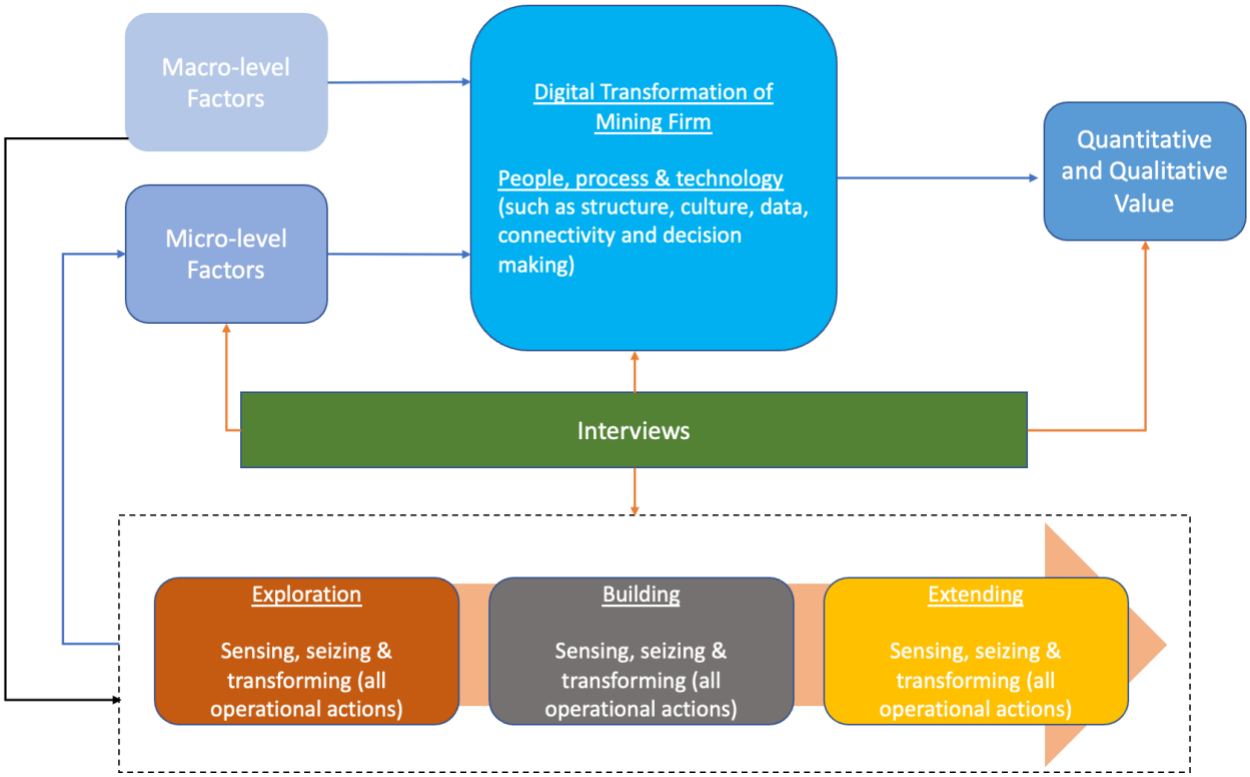


Figure 14: Updated conceptual framework which includes the influence of macro-level factors as well as the components of value.

5.5.2. Embedded Dynamic Capabilities

The research and theory highlight dynamic capabilities at a strategic level but through this analysis it was evident that during this process The Firm developed capabilities that enabled it to perform dynamic capabilities processes at a sub-level as noted by:

- Adding digital leads at the BUs may allow for non-strategic levels of exploration, building and extending beyond the over-arching strategic level.
- Whilst the firm was potentially building or extending, certain employees were exploring at SingularityU events and could have potentially initiated a sub-component of dynamic capabilities processes within their divisions or departments.

Based on this the conceptual framework is further enhanced to create a sub-component of dynamic processes as a result of the strategic dynamic capabilities process, Figure 15.

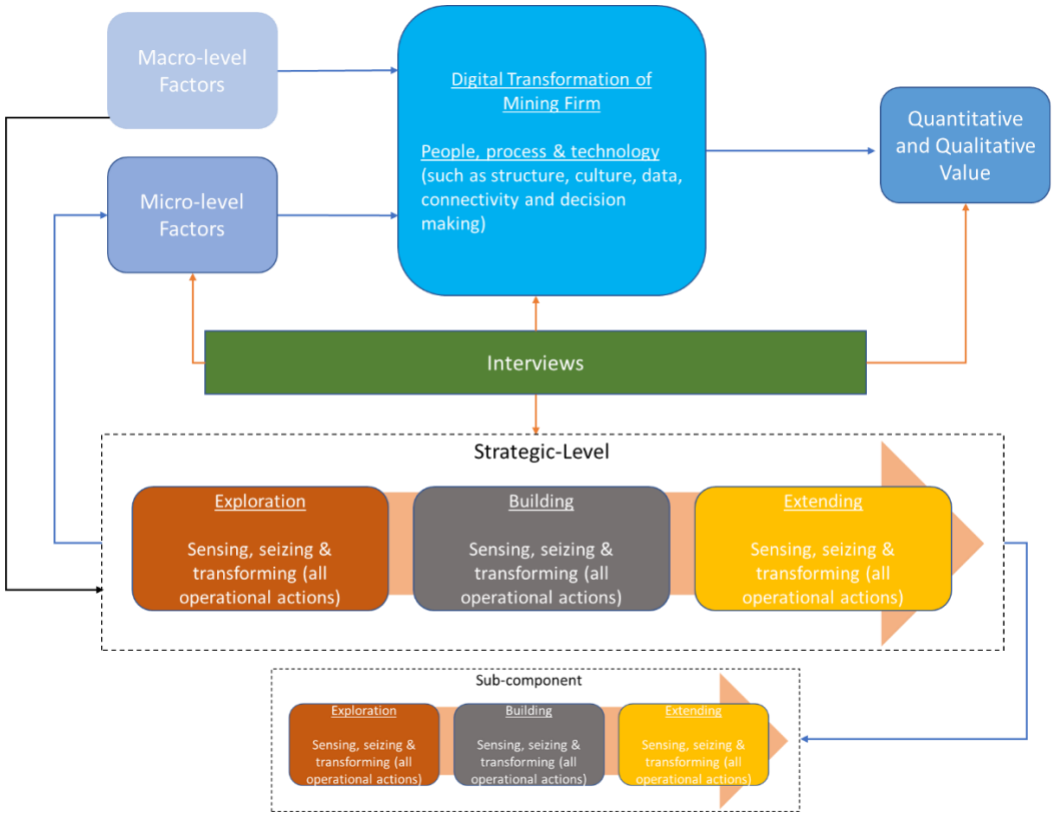


Figure 15: Dynamic capabilities processes at a strategic level can enable capabilities that allow for dynamic capabilities processes to occur throughout the organisation as sub-levels outside the strategic level.

5.6 Conclusion

This chapter examined the analysis of the participant's data which was conducted in Chapter 4. The discussion was structured according to the research sub-questions and concatenated the inductive and deductive themes which was supported with existing literature and theory.

The application of dynamic capabilities can enable a DT journey through following a process of exploration, building, and extending. During these phases, several operationalised actions are conducted to enact themes which enable components of which encompasses the DT journey. The concatenated analysis resulted in the following themes that were enabled through dynamic capabilities actions which further enabled the DT:

- Development and Changes Amongst Leaders
- Change Management
- Changes in Organisational Structure
- Driving Skills Development of Employees
- Implementation of Agile and Start-up Methodologies
- Changes in Organisational Culture

These themes are not to be seen in isolation and incorporated several other inductive and deductive themes as part of the Chapter 4, and the complexity of some of them and their detailed effects may require future research such as change management and organisational culture. These themes may impact throughout the organisation and have an effect on the second research sub-question. Therefore, the above themes are also necessary to enable and sustain value and there is an opportunity for future research to analyse to what extent do they enable and sustain DT and value.

In a similar manner concatenation of themes which enabled and sustain value were highlighted and supported by literature. These themes were as follows:

- Capital Intensity of the Mining Industry
- Qualitative and Quantitative Value
- Value in Technology Deployment Methodology

- Value Realisation Framework

These concepts were all applied in the South African mining industry which included country specifics such as B-BBEE legislation; operational governance according to the MHSA; abiding to the King IV Act which is a requirement of a Johannesburg Stock Exchange (JSE) listed organisation; and engaging with trade unions. Further findings regarding innovation, transparency, macro-level and sub-level components were identified through the analysis.

A South African mining organisation could enact dynamic capabilities operational actions through a process of exploration, building and extending, to enable themes that encompasses or further enable components that enable DT which in turn enables and sustains value in the organisation, as noticed by The Firm. This flow of enabling and sustaining can be seen in Figure 16 which is an adaptation of the Sankey diagrams in Chapter 4.

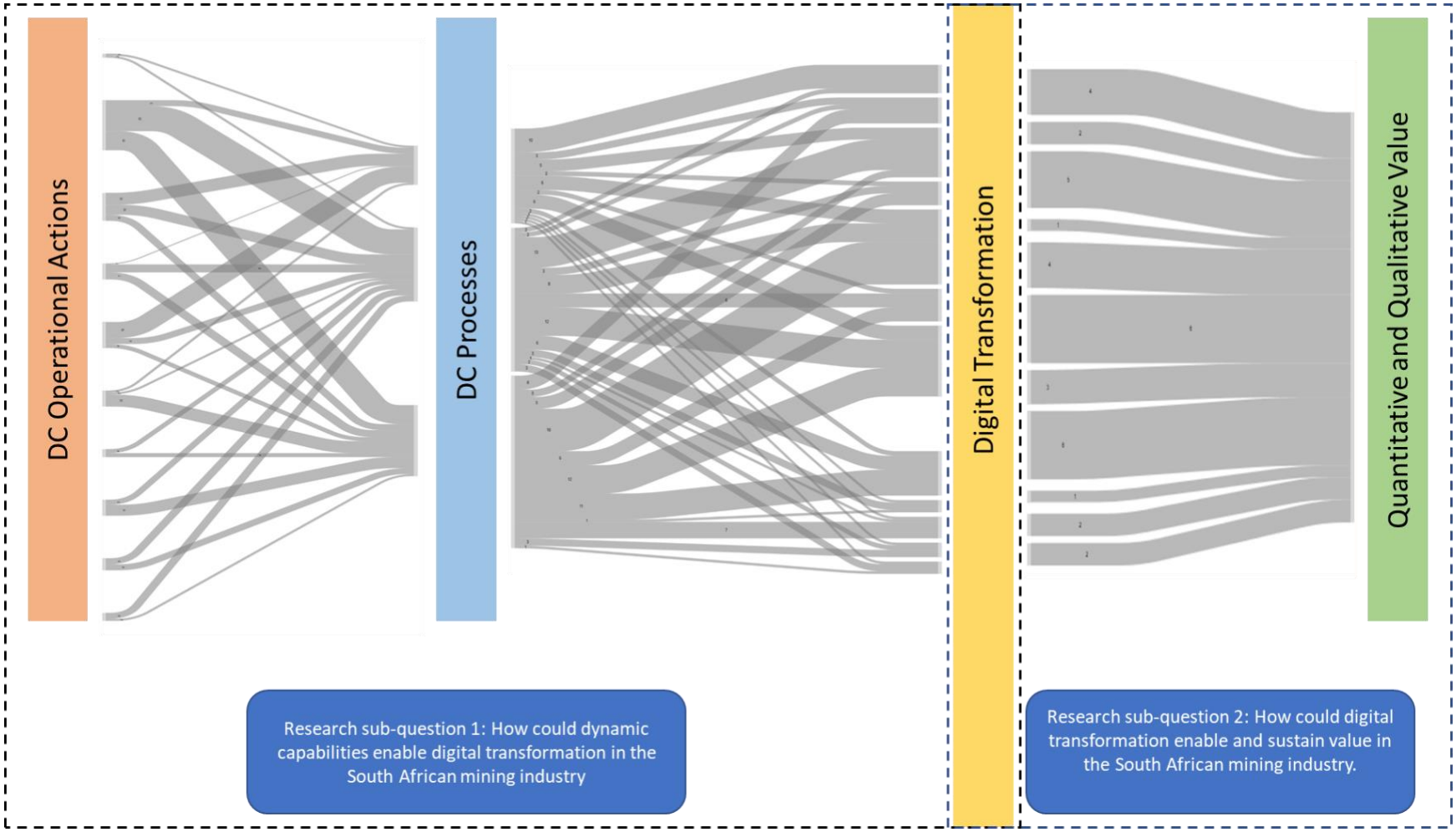


Figure 16: A combination of Figure 8, Figure 9 and Figure 10 to demonstrate the flow of how dynamic capabilities concepts interact to enable components on digital transformation which in turn enables and sustains value.

6. Conclusion

6.1. Introduction

A qualitative thematic analysis was conducted on the enablement of DT through the execution of dynamic capabilities processes by embedding dynamic capabilities operational actions. The effects on the sustainability and enablement of value as a result of DT were explored. Two research sub- questions were analysed by evaluating several inductive and deductive themes through the analysis of semi-structured interviews from multiple participants. These participants included employees at various levels and functions in The Firm as well as individuals from different Partner Firms with industry knowledge. All participants were part of The Firm for at least three years, including individuals from the partner firms[24], whilst the DT journey was in process and maturing. The interviews resulted in multiple questions based on responses from the base set of questions and were scheduled for an hour with each participant. Both deductive themes and inductive themes were analysed and obtained respectively through the utilisations of CAQDAS. This software provided the capacity to seamlessly evaluate several themes as well as their frequency and interaction which each other. Through the analysis and evaluation of these interactions, it was possible to highlight and concatenate themes that enabled and/or sustained DT and value in the South African mining industry through a process of dynamic capabilities. The operational actions were visible in each of the dynamic processes and each of these processes enabled several components of DT, which resulted in value and brought about major findings of this research in relation with theory and literature.

6.2. Major Findings

Research question

How could dynamic capabilities enable digital transformation in the South African mining industry to ensure and sustain value realisation?

[24] The individuals from the Partner Firms had also been engaged with The Firm for at least three years.

Research sub-question 1

How could dynamic capabilities enable digital transformation in the South African mining industry?

Proposition 1: It is proposed, based on the literature, that dynamic capabilities enable a firm to digitally transform by implementing new capabilities aligned with the firm's strategic intent. These capabilities are created through a phased approach such as 'exploration', 'building' and 'extending' which embed the process of enacting dynamic capacities through dynamic operationalisation action. These operationalisation actions enable components that affect or comprise of DT, such components include, organisational culture, organisational structure, changes in leaders, development of employees, etc. These new capabilities enhance existing capabilities that enable the emergent strategy.

The Firm, a South African mining organisation that is governed by the MHSA and King IV Act as part of the industry and listing on the Johannesburg Stock Exchange (JSE), embarked on a journey of DT. This journey was positioned with the strategic intent of optimising the business as well as obtaining a competitive advantage. The leadership embarked on a journey of exploring the macro-environment which resulted in several enactments of the dynamic capabilities operational actions. These actions impacted the micro-environment of The Firm. This interaction of the macro- and micro-environments is noticeable in The Firm's response to learning and implementing new technologies as well as its response to the Covid-19 pandemic.

The Firm followed a process of exploring, building, and extending, which incrementally built on the DT journey from initiation to establishing structures that integrated digital as part of the daily activity of The Firm, including dynamic processes at levels outside the strategic level. These processes embedded multiple dynamic capabilities operation actions which included:

- Scanning
- Learning
- Calibrating
- Designing
- Selecting

- Committing
- Leveraging
- Accessing
- Creating
- Releasing

These operational actions can be categorised into dynamic capacities: sensing, seizing, and transforming. It was established that components of DT were enabled through these actions which were pervasive throughout the processes of dynamic capabilities. The concatenation of the deductive and inductive components/themes that enabled the DT journey were found to be:

- Development and Changes Amongst Leaders
- Change Management
- Changes in Organisation Structure
- Skills Development of Employees
- Agile and Start-up Methodology
- Changes in Organisational Culture

To reiterate, all of these were found to be enabled through dynamic capabilities operational actions.

Therefore, the first sub-research question can be answered as follows: dynamic capabilities can enable DT in the South African mining industry, through a process of dynamic operationalisation actions which is overarched by exploration, building, and extending dynamic processes. These actions and processes are directed to achieve subcategories of DT which enable the DT journey. These findings support the initial research proposition and incorporate both macro and micro environments.

Research sub-question 2

How could digital transformation enable and sustain value realisation in the South African mining industry?

Proposition 2: It is proposed (based on the literature) that DT can create new or enhance existing value realisations avenues which affect people, process, and technology. Additionally, research highlights that improvement in data and connectivity leads to better decision making which enhance new or existing value. The DT components either impact value directly or result in solutions or further developments that enable and sustain value. This enablement and sustainability are further affected by change in processes, methodologies and frameworks that ultimately impact tangible and intangible components of value.

The concatenation of deductive and inductive components/themes would have also been pivotal in enabling and sustaining either value or components of value. The major findings which enable the second sub-research question that were evident from a value perspective which were identified through the firm are:

- Value was deemed to be both tangible and intangible.
- The mining industry requires significant capital deployment in enabling digital infrastructure as compared to other industries such as banking.
- There is an opportunity to evaluate technology deployment methodologies which can further enable, test and sustain value, such as agile and start-up methodologies.
- A VRF is essential to sustain value.

These themes ultimately relate to changes that affect people and processes which result in technology solutions that enhance the way people do work or the business executes tasks in line with the second research proposition. Hence, people, process and technology is pivotal in a DT journey. These findings were applicable and conducted by a firm in the South African mining industry, which embedded solutions that are unique to the country and industry as previously highlighted. The theme of innovation, transparency and inclusivity is also underpinned in this research providing areas for potential future research. In addition, macro-level factors were seen to influence The Firm's dynamic capabilities which translated to changes in the micro-level environment.

Therefore, it was established that The Firm, as a mining organisation that experiences the nuances of the South African environment, enabled its DT journey through sub components of DT by enacting processes of dynamic capabilities which further resulted in the enablement of

components of value. These components of value resulted in the enablement and sustainability of value in the organisation.

During this case study the DCF was applied as a process to evaluate the enablement of DT; and further evaluate the enablement and sustainability of value as a result of DT. It is important to note that the themes, both inductive and deductive themes may also have a converse effect on the desired propositions. For example, if change management was not conducted sufficiently then it could have resulted in poor implementation/usage of technology and therefore loss in organisational value. Therefore, the inductive and deductive themes may be an area of future work for their effects on both the positive and negative outcomes of the research questions. Additionally, in this research the propositions held true but future studies that possibly include multiple case studies may serve as a basis for comparison on what is necessary and sufficient for the DCF to enable DT as well as the possible converse factors which hinder or inhibit the successful DT transition even when DCF is utilised.

6.3. Overall Relevance

It may be argued that multiple industries have adopted a DT approach, however the mining industry have been slow to adopt or lagging other industries, because of current infrastructure, non-diverse work force and issues with digital literacy. This lack of adoption is further emphasised in South Africa, where the mining industry significantly contribute to the GDP and impacts many direct and indirect stakeholders. Therefore, this research is relevant to mining organisations that want to optimise their business and to South Africa, where there is significant opportunity but not limited to:

- Create a digital diverse work force.
- Upskill employees and South Africans.
- Develop value through infrastructure development.
- Create leaders that embed transparent and value driven change management.
- Enable digital strategy through dynamic capabilities.

Therefore, this research is not only relevant to managers, leaders, and employees at the firm level but also at the macro-level for policy makers who could improve the facilitation of digital technologies in the mining industry which may empower South Africans.

6.4. Recommendations

Based on the findings from The Firm's DT journey, it is recommended that similar organisations that choose to embark on a transformation process through digitalisation to purposefully optimise their business, focuses on the following:

- A process of dynamic capabilities processes, which includes *exploring* the macro-environment; *building* on their current capabilities and micro-environment; and *extending* their capabilities to facilitate the changes, improvements, and misalignments because of the building process.
- Embedding dynamic capabilities operational actions as part of these processes whereby these actions may be utilised across the three processes. The operational actions enable components of DT, of which several components/themes were highlighted.
- The DT components are directed towards enabling and sustaining quantitative and qualitative value. Themes which enhance the enablement and sustainability of value as part of this research as formed part of the components of DT.
- Embedding innovation and transparency as part of the dynamic capabilities process and operationalisation actions.

Therefore, it is recommended that dynamic capabilities can enable DT which further enables and sustains quantitative and qualitative value in the South African mining industry.

6.5. Limitations

This research is limited as follows:

- Due to access and the author's time constraints the embedded single-case study may have limited the potential of the generalisability of the research. However, components of this research may be applicable in other asset intensive industries in South Africa, Africa

and beyond. This is due to the involvement of the participants mainly from partner firms and their wider network and experience.

- The research was limited to the mining industry and may have application in other industries which has not been confirmed in this research.
- The research was limited to qualitative methodology and a quantitative analysis may have provided additional insight.
- The findings were limited to the participants of this research, additional participants may have resulted in additional insights.

6.6. Suggestions for Future Research

The following areas are suggested for future research is recommended:

- The effects of digital technology types and their specific impact on value such as the exact value that was realised through the service management system.
- The majority of themes in this report may be further analysed to understand their individual impact on DT and value, including but are not limited to:
    - The individual dynamic capabilities processes and/or operational actions
    - Development and changes amongst leaders
    - Organisational change
        - Change management
        - Changes in organisational structure
        - Changes in organisational culture
    - Skills development of employees
    - Different project and technology deployment methodologies
    - The capital intensity of infrastructure
    - A VRF
- The effects of various types of innovation (such as open innovation, secondary innovation, incremental, adjacent, radical innovation, etc.) with respect to DT and/or value realisation.
- The impact on transparency and inclusivity when embarking on a DT journey.
- Further evaluation of the major findings of this research through the utilisation of quantitative analysis and potentially actual results from individual initiatives that were deployed.

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Appendix 1: Interview Protocol for semi-structured interviews

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Dynamic Capabilities and Digital Transformation for Innovation in the South African Mining Industry

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Details of the respondent

Name:

Title:

Organization:

Contact details:

Email Address:

Opening Statement to Respondent

The Presidential Commission on the Fourth Industrial Revolution's Summary Report and Recommendations, as presented in January 2020, noted that the mining sector traditionally lies at the heart of South Africa's industrial complex (Presidential Commission on the 4IR, 2020). Although the extractive industry is no longer at the forefront of economic activity in South Africa, it remains an essential sector as it contributes 18 percent, directly and indirectly, to South Africa's GDP.

The mining sector has traditionally favoured strategies of incremental, piecemeal innovation over radical, disruptive innovation due to its asset intensive business models. However, there is a notable shift within the mining industry in South Africa, as well as globally, towards digital transformation to enable and sustain value realisation through ensuring competitive advantage. The sector is already benefiting from several 4IR technologies including autonomous operations, mobility, analytics, digital workers, drones, and intelligent sensors amongst others.

Several academic studies have indicated that capabilities[25] enable the successful deployment of a digital transformation strategy. This research intends to determine how these capabilities enable and sustain digital transformation in South Africa's mining industry to ensure value realisation.

Interview questions

Questions	Potential Focus Areas
1 What was the strategic intent that initiated the digital transformation drive?	• Strategic overview. • Impact categorisation • Dynamic process
2 How did the organisation go about embarking on this Digital Transformation journey?	• Dynamic capacities/processes • Strategic overview

[25] The concept of dynamic and ordinary capabilities will be explained to the participant as follows: Dynamic capabilities are the inimitable signature practices and differentiated business models used by competitive firms, and are rooted within a firm's heritage, culture, values, collective abilities and context specific knowledge acquisition and learnings (Shuen et al., 2014). Dynamic capabilities are distinguished from a firm's ordinary capabilities, which inform best practices and can be found within the marketplace and therefore can be bought (Teece et al, 1997).

3 How would you define value realisation within the organisation?	• Value realisation and categorisation of value
4 What capabilities do you deem essential to the successful implementation of a digital transformation strategy in pursuit of value realisation?	• Current capabilities • Dynamic capabilities/processes • Enabling and sustaining value
5 Can these capabilities be bought from outside the organisation or do they need to be internally developed through the organisations' heritage, culture, values, collective abilities and context specific knowledge acquisition and learnings?	• Dynamic capacities/processes
6 How did the organisation transition to these skills?	• Dynamic processes/capacities
7 In your opinion has digital transformation improved value realisation in the organisation. If yes, how? If no, why not?	• Digital transformation and value realisation • Value realisation framework
8 What structural changes were necessary to maintain digital transformation or the emergent strategy?	• Dynamic processes/capacities • Organisational structure

9 What capabilities/attributes have become redundant if any? (this doesn't necessarily mean the removal of personnel/skills but potential the repurposing of skills.)	• Dynamic capacities
10 How does digital transformation affect people, processes, and technology in the organisation?	• Digital transformation definition and organisational respond to change.
11 How important is connectivity and the integration of data in decision making?	• Digital transformation and value impact

Appendix 2: Summary of Digital Transformation and Dynamic Capabilities Theory Definitions (From Literature Review)

Theory	Definition
Digital Transformation (adaptation of inputs from Young & Rogers (2019) and Vial (2019)	DT is a process wherein organisations' people, process and technology "respond to changes taking place in their environment by using digital technologies to alter their value creation process".
Value Categorisation (Vial, 2019)	
New Propositions of Value	Such as augmenting or transitioning the sales of physical products to the sale of services
Value Networks	Such as involving the seamless integration of multiple stakeholders
Digital Channels	Such as new digital solutions to improve the brand of the organisation
Ambidexterity and Agility Enablements	These technologies may allow firms to adapt quicker to environment changes as well as opportunities to scale

Organisational Structure	DT brings significant change to an organisation and may include this.
Organisational Culture	DT brings significant change to an organisation and may include this.
Development and Changes Amongst Leaders	DT brings significant change to an organisation and may include this.
New Employees and Changes in Employees' Roles and Skills	DT brings significant change to an organisation and may include this.
Impact Categorisation (Vial, 2019)	
Organisational Level Impacts	Such as impact to organisational efficiency and the changes in business processes
Organisational Performance	Such as firm growth, financial performance, competitive advantage, and reputation
Higher- level Impacts	Such as impact to industry and societal levels
Undesirable Outcomes	Not part of the above impact levels however mainly in the security and privacy domain

Technology Integration (Young & Rogers, 2019)	
Data	The importance of the integration of operation technologies such as sensors on pumps with information such as servers and networks. This allows for the flow of information at different layers through your technology stack
Connectivity	The structured movement of data is important and how it gets to its destination. For example, the movement of data from a truck to a server on premises or to the cloud servers in another country
Decision	The ability to turn this data into insights for people to make decision. Therefore, driving an integration between analytics and people which ultimately converts these decisions into value drivers for the business. The more advanced these technologies and processes, the more autonomous they may become ultimately removing the human from certain activities

Theory	Definition
Dynamic Capabilities Framework (Barreto, 2010)	"A dynamic capability is the firm's potential to systematically solve problems, formed by its propensity to sense opportunities and threats, to make timely and market-oriented decisions, and to change its resource base."
Dynamic Processes (Yeow et al., 2018)	
Exploration	It is the process phase in which the organisation explores, scopes or searches for opportunities. Opportunities are identified and strategic commitment is made.
Building	The organisation focuses on designing and changing its processes and resource base to support its committed strategy
Extending	As capabilities develop new alignment issues arise or additional effort is required. This requires further development on building phase, focusing on improving the new capabilities and processes developed within the organisation
Dynamic Capacities (Yeow et al., 2018)	

Sensing	This is the process of identification, assessment, co-development and development of environmental opportunities inclusive of technology
Seizing	The firm's efforts to capture value from the opportunities identified through the sensing capacity
Transforming	Are the efforts of the firm to change its resources to align with the emergent strategy
Operationalisation Actions (Yeow et al., 2018)	
Scanning	Is the firm's attempt to acquire information to explore and understand opportunities in the market, including new markets or new business models
Learning	Is the firm's efforts to acquire additional insight and to monitor and assess potential opportunities
Calibrating	Are the efforts of the firm, to further review make sense and to refine previous efforts which were made with regards to the chosen opportunities
Designing	Are the firm's efforts which focus on the creation and planning of new firm structure

Selecting	Are efforts of the firm to choose between the different design options and additional potential opportunities
Committing	Are the firm's efforts to make decisions on the execution of the chosen design as well as decision with respect to the choices of services, business model, partner and/or process
Leveraging	Are the actions which aligns current resources with building new capabilities in support of the new strategy
Creating	Refers to the formation of new resource, structures and processes which complement each other to create new products/services or capabilities
Accessing	Is making use of external capabilities to achieve internal requirements
Releasing	Is cutting back on the current resources which do not support the current strategy