

Exploring critical organisational change phenomena as barriers,  
enablers and opportunities for successful digital transformation in the  
South African mining industry.

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## **I. Abstract**

This study explored the critical organisational change phenomena influencing the success of digital transformation in the South African mining industry amid the challenges of modernisation. Recognising the inadequacies of a narrow technology-centric approach, the research adopted an exploratory qualitative design, emphasising the interplay between organisational change phenomena and organisational elements. Findings underscored the significance of organisational digital maturity in determining digital transformation readiness, success, and scope, with identified barriers and enablers emphasising the need for a holistic integration of OCP with organisational change and organisational design elements. The study provided actionable recommendations for organisations, emphasising the leverage of digital transformation for improved decision-making and operational efficiency, mitigating resistance through comprehensive organisational change phenomena and organisational digital maturity implementation, and positioning DT as a key driver for business improvement in the South African mining sector.

This study contributed valuable insights to the evolving landscape of digital transformation within organisational change, specifically tailored to the unique challenges of the South African mining industry. By highlighting the importance of a holistic and integrated approach, the study offered practical guidance for organisations aiming to enhance their DT strategies, potentially revitalising the mining industry and fostering improved business outcomes in terms of safety, production, and sustainability.

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## V. Table of abbreviations and acronyms

Abbreviation	Description
<b>DT</b>	Digital Transformation
<b>OC</b>	Organisational Change
<b>OD</b>	Organisational Design
<b>OCP</b>	Organisational Change Phenomena
<b>CM</b>	Change Management
<b>DC</b>	Dynamic Capability
<b>OCC</b>	Organisational Change Capability
<b>ODM</b>	Organisational Digital Maturity
<b>BIO</b>	Business Improvement Outcomes
<b>BD</b>	Big Data
<b>IoT</b>	Internet of Things
<b>AI</b>	Artificial Intelligence
<b>BC</b>	Blockchain
<b>M&amp;A's</b>	Mergers and Acquisitions
<b>Au</b>	Gold

Table 1: Abbreviations

## **1 Chapter 1: Need for the study**

Chapter 1 introduces the study by providing context and background to the research. The problem, need and purpose of the study is unpacked.

### **1.1 Introduction**

Business environments around the world have become more turbulent, complex and dynamic as we navigate wars, pandemics, rising energy costs, rising inflation and, frequent eruptions of novel disruptive technologies (Hvidsten et al., 2023; Paine & Delmhorst, 2020; Peng et al., 2021; Van de Ven, 2021; Warner & Wäger, 2019). Therefore, organisations must find ways to adapt to these changes and, innovate with new technologies in order to stay relevant, competitive and sustainable (Alkhamery et al., 2020; Hanelt et al., 2021; Peng et al., 2021; Vial, 2019; Warner & Wäger, 2019).

Digital transformation (DT) emerges as an organisational change (OC) mechanism, process or journey organisations embark on, to modernise and adapt to change. It is generally understood as the adoption and integration of modern digital technologies into the business to stay competitive, remain relevant and innovate to generate new value (Alkhamery et al., 2020; Hanelt et al., 2021). Verhoef et al. (2021) views digital transformation (DT) as a change in how an organisation employs digital technologies which drives business model innovation for increased value creation. DT is inherently coupled to the topic of organisational change (OC) and, is viewed as OC that is set in motion and formed by the diffusion of digital technologies (Hanelt et al., 2021).

The above discussion has relevance, as South African mines are modernising, and with this is the need for DT. It is suggested that in this drive toward modernisation, DT is inevitable for improved health, safety, productivity and sustainability (MineralsCouncilofSouthAfrica, 2023; Pelders et al., 2019). Further that DT efforts often fail, as many organisational factors must be considered and addressed for the transformation to be successful (Vial, 2019). Insights from this study could assist leaders and managers in organisations with the development of DT strategies and ultimately, influence the strategic implementation and business outcomes of DT.

Two basic phenomena, 'how organisations adapt to and, how leadership implement change in order to deliver the organisational strategy', is considered by OC literature. We know that most companies are adapting to change, more so in terms of embarking on DT endeavours. So how the change is included within the company strategy and executed is important.



DT is often referred to as the adoption of digital technologies by an organisation in order to digitise non-digital products, services or operations. A key aspect of this study is to understand how OC phenomena interact with DT efforts within mining organisations, as barriers and enablers and, to identify opportunities for DT, could unlock potential and improved business outcomes.

## **1.2 Background**

Due to the eruption of novel digital technologies and industry 4.0, organisations across the globe embark on various forms of DT in order to achieve improved business performance (Alkhamery et al., 2020; Bansal et al., 2023; Hanelt et al., 2021; Vial, 2019). DT is primarily technology driven (Leão & da Silva, 2021; Prokopenko et al., 2020). DT is affecting and perplexing most organisations across various industries and organisational contexts which was further exacerbated by the COVID 19 pandemic (Hanelt et al., 2021). Verhoef et al. (2021) argues that big data (BD), the internet of things (IoT), artificial intelligence (AI), blockchain (BC) and robotics promises to orchestrate significant shifts in how organisations function. The broad and rapid emergence of these digital technologies propel organisations to digitally transform their businesses.

This narrow technology-oriented view often blurs the more fundamental role of DT's processual characteristics and its multi-dimensional nature with intricate and complex interdependencies. therefore, a plethora of elements such as a company's strategy, structure, culture, human resource capabilities, business model design as well as the competitive environment must be considered in a greater transformational effort (Leão & da Silva, 2021; Verhoef et al., 2021).

Due to the disruptive nature of DT and its impact on competitiveness, smaller and more agile players continue to challenge incumbent firms in multiple industries. Large organisations tend to be threatened by smaller players as they possess high levels of inertia in responding to changes in processes, competencies and cultures. Furthermore, on the humanistic side of organisations, they are forced to rethink and redefine the capabilities and skills of human capital as novel technologies like AI are starting to overtake human capabilities which pose a significant social challenge in adapting and growing human capital to the new digital context. Failing to adapt workforces to this digital context will have adverse impacts on unemployment, further propelled by labour-saving process innovations (Leão & da Silva, 2021; Verhoef et al., 2021).

The mining sector has faced a number of challenges including increasing depth and distance from the shaft, increasing health and safety concerns for workers and contraction in the actual drill time at the workplace; all contributing to burgeoning costs (Minerals Council South Africa, 2018). The economic performance of the mining industry has been volatile as the costs increased while productivity stagnated. Modernisation of mines has been proposed as a solution to address health, safety and productivity concerns in the industry, and has the potential to enhance skills development, employment, exports and revenue, while also adding cumulative benefits to local communities. This process allows mines to transition and transform to extend the life of mine, retain jobs, enhance safety and health of workers and improve access to minerals (Minerals Council South Africa, 2018). In the mining industry, modernisation includes the need and drive for DT.

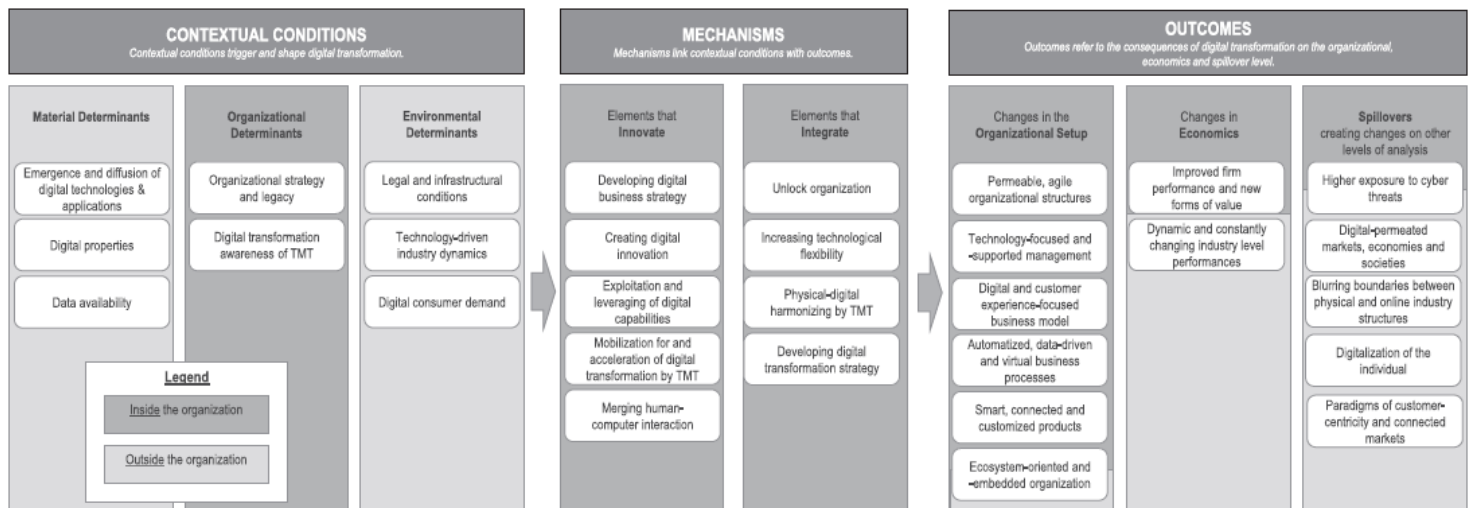
### **1.3 Problem definition**

The general consensus regarding successful DT is that it should improve business performance and yield a higher competitive advantage (Alkhamery et al., 2020; Leão & da Silva, 2021; Prokopenko et al., 2020). In spite of the imminence and importance of OC and DT, approximately 70% of OC efforts fail (Bojesson & Fundin, 2021; Supriharyanti & Sukoco, 2023; Zhang et al., 2020). Organisations tend to rush into DT without considering various organisational and technological change phenomena resulting in expensive DT failures (AlNuaimi et al., 2022). This is further exacerbated by the growing disconnect between rhetoric and reality and, an ongoing strategy-execution gap. Furthermore, many organisations fail in DT efforts as a result of introducing new technologies without taking a complete systems view and developing holistic integrated plans and adequate digital strategies (AlNuaimi et al., 2022).

Despite the high priority of DT, and the increasing interest in its benefits, there is still limited understanding of not only the phenomenon itself, but also the interdependencies of various OCP which may influence the process and ultimately the outcome of DT. Literature provides limited alignment on a framework and approach to DT in order to prepare for and, successfully deliver on DT outcomes (Alkhamery et al., 2020; Prokopenko et al., 2020).

However, Hanelt et al. (2021), developed a multi-dimensional framework for DT based on an extensive systematic review illustrated in figure 1 below, which indicates both internal and external OC elements during the process of DT. The framework thus becomes very relevant for this study as it represents a holistic systemic view of DT, and is used as a foundation for this study, as it takes into consideration the challenges as expressed in the discussions above.

Figure 1: Multi-dimensional framework for digital transformation



(Hanelt et al., 2021)

This framework illustrates OCP to be considered for healthy DT. However, key to this study is how OC phenomena interact with DT efforts of mining organisations, as enablers, barriers, or opportunities; and in doing so may influence the DT strategy and, ultimately the business outcomes of organisations. This is the focus of this study.

#### 1.4 Theoretical need

The theoretical need for the study is to further develop the existing body of knowledge by exploring the phenomenon of DT from an OC perspective. Due to the complexity and multi-dimensional nature of the organisational phenomenon, no single theory or framework fully explains this phenomenon. Furthermore, little research on DT has been conducted in the mining industry which creates an opportunity to build onto theoretical models as related to the mining context, where there is an apparent need due to the drive toward the modernisation of mines.

#### 1.5 Business need

The business need for the study, as mentioned earlier, is to improve the success rate of DT efforts. Organisations are drawn into the possible benefits of successfully transforming their organisation such as improved safety, health, productivity and cost among other. As mentioned, these transformational efforts often fail due to various internal and external as well as macro and micro level organisational change phenomena (OCP) that influences the DT process and therefore, the outcomes. Furthermore, due to the complexity and limited understanding of these phenomena, organisations grapple with how DT efforts should be led and managed. Specifically, in the mining industry, organisations are seeking to understand the interplay of these phenomena in order to develop adequate DT strategies, initiate business

model innovation and, to build dynamic capabilities (DC's) for sudden, and often continuous, OC due to novel and disruptive digital technologies.

### **1.6 Purpose of the study**

To better understand the OCP which may influence the success of DT, critical OCP will be probed into. OC refers to the activities and actions, in which an organisation modifies a major component of its organisation, such as its organisational culture, organisational structure, leadership strategies, operating technologies or infrastructure it uses to operate, and its internal systems and processes. Further to note, OC is viewed as; “a difference in form, quality or state over time in an organisational entity” (Hanelt et al., 2021).

This study places a focus on DT, which becomes more relevant in the context of mining modernisation. Exploring critical OCP at various levels as barriers, enablers and opportunities for successful DT in the South African mining industry is paramount for this study.

Therefore, this study will gain insights and deeper understanding of OCP as inputs into DT strategies and organisational readiness frameworks for higher success rates of DT and improved business outcomes. Moreover, in the mining context, such outcomes may allow for improved safety, production and sustainability.

Finally, this study intends to extend the existing body of knowledge as current theories only partially covers OCP as it relates to DT in organisations and, more specifically, mining organisations in South Africa. Furthermore, from a business perspective, by gaining further knowledge on the barriers, enablers and opportunities of DT, develop improved DT strategic frameworks and business models that may, as a result of successful DT efforts, improve critical business drivers, such as productivity, health, safety and cost, for mining organisations in South Africa.

### **1.7 Study outline**

Chapter 1 focuses on the research problem and need for the study.

Chapter 2 will provide for a literature review for key concepts relevant to the study.

Chapter 3 highlights the objective for this study and the key research questions.

Chapter 4 considers the research methodology.

Chapter 5 will discuss analysis and findings.

Chapter 6 will include a discussion on the findings.

Chapter 7 will provide conclusions and recommendations.

## **1.8 Summary**

Chapter 1 introduced and provided an overview of the study. Furthermore, the problem need and purpose was discussed and, finally, an outline of the study was provided. To, follow Chapter 2 will probe into key concepts for the study through a literature review.

## **2 Chapter 2: Literature review**

Chapter 1 introduced the study with the relevant overview, justification and intent of the study. Chapter 2 discusses key concepts, models and theories considered as a base for the study. This section will also look into critical OC phenomena as barriers, enablers and opportunities for successful DT.

### **2.1 Introduction**

With the focus on OCP and DT, literature on these phenomena as well as other fields, concepts and frameworks relevant to the study was reviewed.

### **2.2 Digital Transformation**

One of the challenges in both literature and practice is the multiple different definitions, interpretations and applications of DT (Ben Slimane et al., 2022; Hanelt et al., 2021; Leão & da Silva, 2021; Prokopenko et al., 2020). Furthermore, many studies used the terms digitisation, digitalisation and DT indifferently without distinctively highlighting their boundaries (Ben Slimane et al., 2022). Verhoef et al. (2021) suggest that digitisation, digitalisation and DT represent distinct stages of DT. DT represents the most pervasive phase as it describes an organisation-wide change, leading to business model innovation and development which might be novel to the organisation or industry (Verhoef et al., 2021). DT is different from traditional forms of strategic change due to the nature and rate of change which is further accelerated by emergent and disruptive digital technologies (Warner & Wäger, 2019).

DT has a myriad of implications and consequences for organisations from external stakeholder engagement to internal processes and individual products. Most of these implications and consequences relate to the gestalt of the organisation where organisational setups emerge as an area of focus. Outcomes in this area refer to the constituents of the organisation and how organisations change during DT.

We accept the definition of DT used by Hanelt et al. (2021), as; “OC that is triggered by the widespread diffusion of digital technologies”. This allows us to potentially explain the phenomenon of DT and its management in business practice from a wide knowledge base as it relates to, in particular, OC (Hanelt et al., 2021).

Leadership strategies, skills and capabilities emerge as one of the key areas that might be impacted by, as well as influence, the adoption of technology and DT outcomes (Alkhamery et al., 2020; AlNuaimi et al., 2022; Feliciano-Cestero et al., 2023; Hanelt et al., 2021; Verhoef et al., 2021). Organisational culture emerges as an important player, especially in larger

traditional organisations, as it may be greatly impacted by DT as well as serving as a possible catalyst and a bonding agent towards successful transformation (Alkhamery et al., 2020; AlNuaimi et al., 2022; Feliciano-Cestero et al., 2023). Permeable and agile organisational and management structures seem to provide an advantage in dealing with and managing disruptive changes through the rapid adoption of digital technologies brought about by DT (AlNuaimi et al., 2022; Hanelt et al., 2021; Verhoef et al., 2021). Furthermore, the literature reveals the pertinent role of DC's as it links to the pace and agility to adjust to DT and technological disruptions in an organisation (Alkhamery et al., 2020; AlNuaimi et al., 2022; Feliciano-Cestero et al., 2023; Hanelt et al., 2021).

DT has received much research attention in the new digital age and thus has produced theories attempting to explain the phenomenon, however, due to its multi-dimensional aspects and complexity there is ample room to validate and build theory by further exploring this phenomenon. Furthermore, much explorative scope remains on OC characteristics pertaining to DT as conventional frameworks only cover it partially. Therefore, literature regarding this phenomenon motivates further exploratory research on the topic (Hanelt et al., 2021; Leão & da Silva, 2021; Verhoef et al., 2021).

Vial (2019) developed a process model which illustrates the building blocks of DT included in figure 2 below. This model has similarities to the model of Hanelt et al. (2021) however, attempts to also describe the relationship between organisational elements during the process of DT.

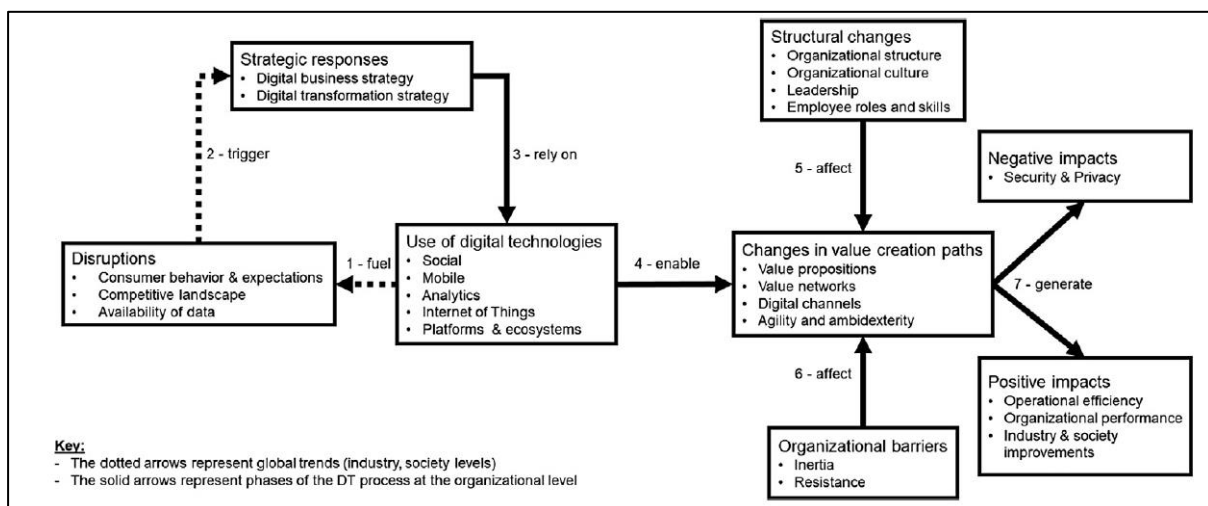


Figure 2: Building blocks of the digital transformation process

(Vial, 2019)

### 2.3 Organisational Change and organisational design elements relevant to digital transformation

Models, such as the McKinsey 7S model, are used as a tool in practice to analyse and ultimately illustrate how organisations can achieve organisational or operational excellence by focussing on the interactions of key OD elements such as strategy, structure, systems, style, staff, skills and shared value. These models are useful in DT as it illuminates interdependencies throughout the organisation impacted and influenced by transformation or business improvement efforts (CFI, 2023).

These OC and OD elements or objects experience changes through the change elements within the change system. It is important to take cognisance of how DT relates to various OC objects on various levels and dimensions. Furthermore, the change elements are subject to the perspective of the relevant discourse previously discussed. Throughput is the process where the actual change is realised. Each discourse has a different view on change and consequently different change processes. Various effects such as individual, group, organisational and social are generated from the system model for change. The organisational context influences the system which then in turn influences the environment. Table 3 below, summarises the relevant process elements pertaining to specific discourses. Figure 3 below, illustrates the generic systems model for OC (Maes & Van Hootegem, 2019).

*Table 2: Process elements of different discourses*

Discourse	Process elements
Normative	Exploration, planning, action, integration
Interpretive	Scanning, interpretation, learning, incorporation
Critical	Having a voice, critical reflection and self-criticism, emancipation, democratic decision-making
Dialogic	Discursive activity, performativity, connectivity



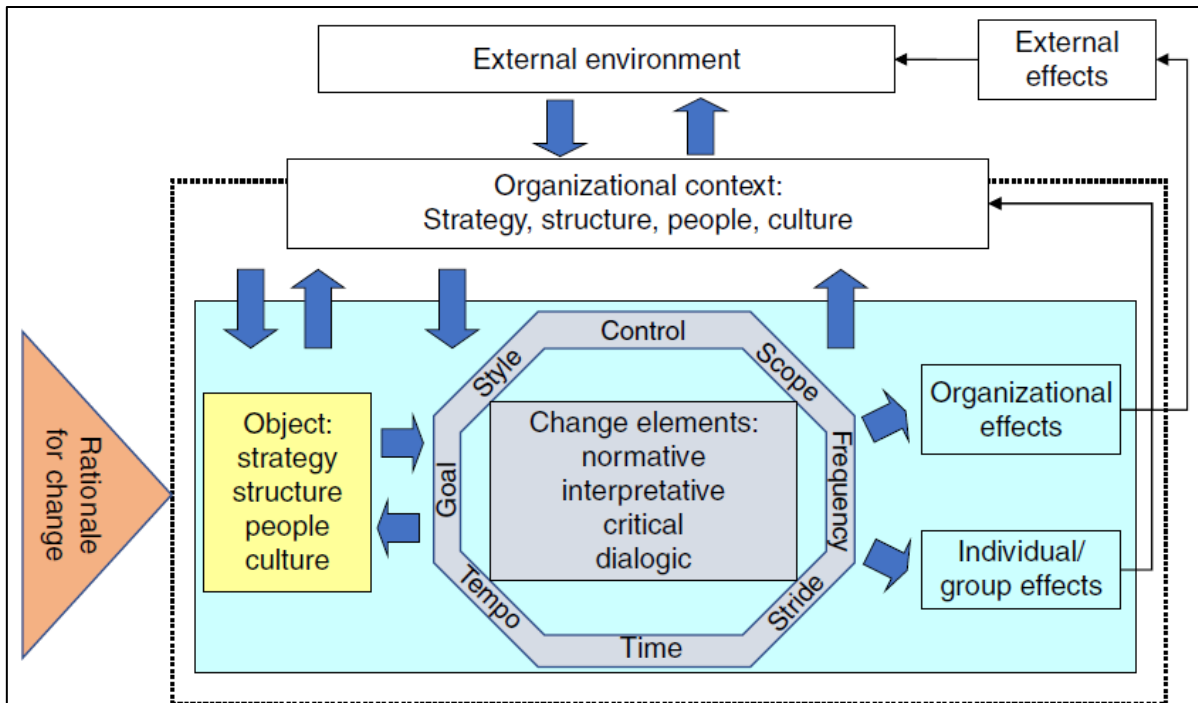


Figure 3: Process model for organisational change

### 2.3.1 Strategy

Strategy refers to the decisions leaders, including managers, take to ultimately increase business outcomes of the organisation, determine the future strategic direction and to enhance their competitive edge. Alieva and Powell (2023); Hanelt et al. (2021) emphasises the importance of digital strategy development for DT. For organisations to stay relevant in markets incumbents will have to consider a DT strategy (Alkhamery et al., 2020). Alkhamery et al. (2020) also states that DC's can assist the organisation to prepare for the DT strategy. By integrating DT with existing knowledge on OC would enable us to provide organisations with guidance on how to manage DT better, particularly regarding strategy and OC. The shifts toward malleable organisations and digital business eco-systems can support OC and strategy practices. Developing a digital business strategy has been identified as a means to help unfreeze the organisation for effective transformation. A further strategic imperative is for managers to develop DT awareness as the contextual conditions continuously changes (Hanelt et al., 2021).

### 2.3.2 Structure (Organisational structure, technology, infrastructure and resources)

Structure here in its most basic sense refers to the organisational structure for processes and systems and, includes organisational design. This also includes assets, technology, infrastructure and resources which might be impacted by or influence DT. Feliciano-Cestero et al. (2023) argues that limited technical resources poor infrastructure are among the main

factors that threatens DT. In the context of DT various OC objects, in addition to digital technologies, are crucial to take into account as they have an impact on the entire organisational and operational structure (Alkhamery et al., 2020). Alieva and Powell (2023) argued that a lack of resources is among the main reasons for not adopting new technologies.

### **2.3.3 People (Individual skills, behaviour and leadership)**

People talks to the individual actors within the organisation. It includes their abilities, weaknesses and behaviours where behaviour have specifically been identified as a critical component of organisation change. The people object includes aspects of individual competencies, behaviour as well as managerial or leadership skills among other which are impacted by or required for successful DT. Alkhamery et al. (2020) highlights one of the essential success factors of DT to be people. Alieva and Powell (2023) states that employees' soft factors and behaviours are essential for adapting to changes in an organisation and, represent a core part in value creation and continuous improvement. Organisational readiness is defined as the people preparedness level within an organisation to implement organisational development practices (Alkhamery et al., 2020). Furthermore, Alkhamery et al. (2020) states that DT is more than just adopting new digital technologies but also, by conducting changes in people shared values to be in support of DT efforts. Organisation need to develop employees' digital literacies in accordance with workplace digitalisation as well as to grow an innovative culture which will in turn enhance employee commitment (Alieva & Powell, 2023). From a leadership point of view, Khaw et al. (2022) argues that organisations should grow their leadership talents and skills to ensure that their digital strategy is in alignment with its corporate strategy and highlights that leaders struggle to lead digitalisation due to gaps in leadership competencies, especially digital leadership capability.

### **2.3.4 Culture**

Finally, culture is identified as another fundamental element of OC and generally defined as the values, norms and actions that characterise the social relationships in a formal structure. Within the culture object, we consider organisational culture both as an outcome of and, as an input toward successful DT. Alkhamery et al. (2020) argues for organisations to successfully execute a DT strategy and to meet business improvements, firms need to transform their entire business operations including its organisational culture. Culture is viewed as a strategic asset which, if conducive, can enable business transformation and the adoption of digital technologies. Many DT efforts fail as a result of a non-digital culture therefore, organisations need to change their organisational culture values to promote internal readiness for change. One of the most prominent organisational culture values to support DT emerged as being

open to change (Alkhamery et al., 2020). Alieva and Powell (2023) argues that a lack of internal digital culture is among other barriers to adopt and implement industry 4.0 technologies.

## 2.4 Organisational Change phenomena

As stated previously, OC is viewed as; “a difference in form, quality or state over time in an organisational entity”. DT is viewed as; “OC that is triggered by the widespread diffusion of digital technologies” (Hanelt et al., 2021). According to Van de Ven (2021), “the process of OC is an observed and/or experienced difference over time in some organisational characteristic, activity or idea”. Therefore OCP related to DT includes shifts in various aspects of organisations, pertaining to OC and organisational design (OD) elements, as they traverse DT towards modernised organisations.

## 2.5 Barriers, enablers and opportunities of digital transformation

The barriers, enablers and opportunities for successful DT is summarised in table 3 below and grouped according to the relevant OC and OD elements.

Table 3: Barriers, enablers and opportunities of digital transformation

	<b>Barriers</b>	<b>Enablers</b>	<b>Opportunities</b>
<b>Strategy</b>	Rigid strategic planning (Warner & Wäger, 2019) Organisational values (Alkhamery et al., 2020)	Digital resources (Verhoef et al., 2021) Digital growth strategies (Verhoef et al., 2021) Dynamic capabilities (Alkhamery et al., 2020)	Phases or stages of digital transformation (Verhoef et al., 2021) Generate new business models (Verhoef et al., 2021) Industry and societal improvements (Vial, 2019) Operational efficiency (Vial, 2019) Organisational performance (Vial, 2019) New business opportunities (Verhoef et al., 2021) Enable opportunities to innovate (Verhoef et al., 2021) New environmental opportunities (Hanelt et al., 2021)
<b>Structure</b>	High level of hierarchy (Warner & Wäger, 2019) Lack of resources (Alieva & Powell, 2023)	Implementation and adoption of information technologies (IT), digital technologies and digital assets (Alkhamery et al., 2020; Verhoef et al., 2021) Flexible organisational structure (Verhoef et al., 2021) Malleable organisational designs and digital eco-dynamics (Hanelt et al., 2021) Digital business eco-systems (Hanelt et al., 2021) Cross functional teams (Warner & Wäger, 2019)	

		Dynamic capabilities (Alkhamery et al., 2020)	
<b>People</b>	Resistance to change (Vial, 2019; Warner & Wäger, 2019) Employees' soft factors and behaviours (Alieva & Powell, 2023)	Digital capabilities and agility (Khaw et al., 2022; Verhoef et al., 2021) Fast decision-making (Warner & Wäger, 2019) Executive support (Warner & Wäger, 2019) Dynamic capabilities (Alkhamery et al., 2020) Digital transformation awareness (Hanelt et al., 2021) Employee commitment (Alieva & Powell, 2023)	Generate new knowledge (Verhoef et al., 2021)
<b>Culture</b>	Legacy – old vs new ways of doing (Verhoef et al., 2021) Inertia (Vial, 2019) Culture values (Alkhamery et al., 2020)	Dynamic capabilities (Alkhamery et al., 2020)	
<b>Other</b>		Metrics and goals (Verhoef et al., 2021)	Digitalisation of the individual (Hanelt et al., 2021)

## 2.6 Change management and the nature of change

Change management (CM) aims to deal with shifts or transformations of organisational processes, technologies or goals in a systemic way. The intent of CM, is to deploy strategies to positively influence and facilitate employee buy-in and improve adaptability to change (CFI, 2023).

Various CM models have been developed over the year ranging from Kotter's eight steps to Lewin's three stage model. Planned change models have many similarities with slight variations which includes steps focussing on urgency, coalition, vision, communication, change plans, implementation, consolidation and institutionalisation, as in Kotter's eight step model (CFI, 2023; Stouten et al., 2018; Van de Ven, 2021). Lewin's three stage model which includes the "un-freeze", "Change" and "Re-freeze" stages. Common steps in such models include creating a need and vision for the OC, communicating and promoting it to the participants and, supporting with training and incentives to assist with the implementation of the changes (Van de Ven, 2021).

The biggest common challenge with similar approaches have been overcoming resistance to change. Going beyond traditional planned change models, recent studies are taking a more dynamic view where unplanned changes occur in organisations all the time. This position reflects drastic permutations in information technologies, social media platforms, flatter organisational structures, generational shifts and organisations contributing to societal welfare (Van de Ven, 2021).

Historically OC have focussed on planned-episodic change which is more strategic, rational and top-down. Future scholarship is more interested in unplanned-continuous OC which is more experiential, emergent and bottom-up. Interestingly, as planned-episodic and unplanned-continuous change seem to be two opposing views, they are actually connected and intertwined into one another (Van de Ven, 2021).

The nature of change in organisations are complex as they change all the time in many different ways which vary in frequency, scope, uniqueness and duration. Van de Ven (2021) argues there are three different types of change. First and most abundant are well known, recurrent changes that mostly follow routine standard operating procedures (i.e. budget cycles, maintenance). Secondly, some relate to more sizable planned initiatives such as mergers and acquisitions (M&A's). Lastly, some changes are entirely new which requires unique developments by the people involved such as technological and process innovations (Van de Ven, 2021).

As summarised in table 4 below, this developing view suggests that OC is a dynamic, unpredictable and evolving process. It assumes a socially constructed reality, involves various conflicts with numerous change advocates of differentiated power who gets rationally and emotionally drawn into dialectical change and social movements. The traditional change maker evolves into a meaning or, sense-maker. Finally, bringing the two poles together as they often play out in practice, both continuous and episodic or radical changes represent different micro and macro levels of evaluating a change process. From a managerial perspective when rolling out planned change initiatives an episodic view might be useful however, for maintaining and repairing organisation stability a continuous view is required (Van de Ven, 2021).

Table 4: Traditional versus emerging view of organisational change

Dimension	Traditional view of organizational change	Emerging view of organizational change
Frequency	Episodic, infrequent, discontinuous change.	Continuous, constantly ongoing, evolving change.
Change	Planned change, driven by human choice, goal-directed typically top-down, controlled intervention	Unplanned, purpose emerges in the process, bottom-up, adaptive, pluralistic, social movements
Process	Goal-directed stages and prescribed steps requiring outside intervention	Sensemaking, improvisation & in-process learning from shared experiences in social networks
Assumptions	Rational, logical analysis with valid data on objective reality and consensus support of participants	Reality is socially constructed, negotiated, involves conflicts, contradictions, power, political processes & emotions
Models	Teleology, planned change Life cycle, regulated change	Evolutionary, competitive change Dialectical, conflict change
Change Agent/ Leader Role	Change maker: Prime mover who creates, directs change goals, process & outcomes	Meaning maker: Sense maker who reframes how people think of changing
Governance	Top-down hierarchical fiat	Formal & informal contracts on decision rights & roles of stakeholders

(Van de Ven, 2021)

## 2.7 Systems and systems thinking for digital transformation

OC phenomena is often viewed through a systems theory lens. In doing so an organisation can be viewed as a system containing sub-systems and, aspect systems. Sub systems includes production, accounting, human resources and administrative systems. Aspect systems represents hierarchic relations, data flows and the like. With such a view management of change is viewed as a sub-system. A systems model for change is a more effective way to capture the complexity of change than linear change models. Literature often reveals that change cannot be captured in a single theory. Maes and Van Hoote gem (2019) developed four discourses across two dimensions to deal with the plurality and conflicting theoretical views of OC. These discourses are normative, interpretive, critical and dialogic.

When digital technologies are absorbed or adopted into organisations, they interact with organisational antecedents such as organisational and managerial characteristics. Organisational characteristics include organisational strategy and legacy. This includes the organisational history, resources, processes, values and culture. Managerial characteristics includes managements attitude towards change and new technology (Hanelt et al., 2021).

A systems model in its most basic form consists of an input, process and output. This process does not exist in a vacuum and operates within a certain context including reasons for

triggering the system. Different internal (Within the system) and external (Environment) factors activate the change system. For the most part four different types of change objects emerge from literature which are Strategy, structure, people and culture.

Furthermore, to understand the mining environment, it is important to understand how a mine operates which can be described through their value chain, that is, exploration, plan, develop, mine, process, transport and market, and the end of life plan. This fundamental value chain describes the process of a mining operation to sell mineral resources to the market. Each step can be considered a system, which is made up of other systems (Arnold & Wade, 2015). The mining process can be broken down into drilling, blasting, loading and hauling, and hauling can be further broken down into smaller systems. This gives a basic understanding that the entire mining value chain is interrelated, interdependent and interacting elements that form collective entities to the system it operates in (Arnold & Wade, 2015). Further, a systems thinking approach may not only integrate the complete mining value chain, from exploration through to mining and processing execution activities, but also allows for incorporating work management and integrated operational planning processes, along with the organisational structure, roles, behaviours and data management routines required to significantly improve effective tactical and strategic decision-making.

## **2.8 Organisational digital maturity, capacity and readiness for change (Digital transformation)**

Digital maturity is a relative new concept in DT literature defined as “the capacity to respond to change in an appropriate manner” (Vial, 2019). Organisational readiness for change primarily considers attitudes of individuals toward change. Organisational change capacity is inclusive of organisational readiness and, infrastructure, culture and leadership capacities. (Bojesson & Fundin, 2021).

## **2.9 Dynamic capabilities for digital transformation**

The proposed dynamic capability of organisational change capacity (Heckmann et al., 2016) is described as a multidimensional phenomenon (Judge and Douglas, 2009) concerning the individuals, processes and interactions, and organisational structure. This is manifested in, for example, employee attitudes (Andreeva and Ritala, 2016), leadership capabilities (Judge and Douglas, 2009; Heckmann et al., 2016), organisational systems and processes (Heckmann et al., 2016) and organisational culture (Judge and Douglas, 2009; Heckmann et al., 2016).

As discussed in the previous sections, the nature of OC, especially change triggered by novel disruptive digital technologies, occurs more frequent and even continuous as opposed to infrequent and episodic. Therefore, DC's is often highlighted in literature as a useful lens to observe the phenomenon of DT. Adaptations to variations in technology has commonly been studied through a strategic management theoretical lens (Ellström et al., 2021; Warner & Wäger, 2019). To create an organisation that is able to manage DT due to various digital disruptions, organisations need to focus on their capability to change (Ellström et al., 2021).

Building on its initial intent to explain how organisations develop or maintain a competitive advantage, DC's focus on how firms change their resource base to continuously adapt to and build a competitive advantage in a volatile and dynamic environment. Innovation forms the base of DC's and provides the organisation with the means to intentionally, construct, adjust and extend its resource base (Ellström et al., 2021; Warner & Wäger, 2019). In order to successfully navigate continuous change, in this case DT, firms need to develop capabilities to facilitate and enable changes to their business models. These DC's are; sensing opportunities and threats, seizing these opportunities and, reconfiguring or transforming the underlying resources or assets for a competitive advantage (Ellström et al., 2021; Warner & Wäger, 2019).

According to Warner and Wäger (2019), organisations need to develop strong DC's for rapid business model innovation in order to remain relevant in the emergent digital economy. Warner and Wäger (2019) further argues that strategic renewal of organisational business models, a collaborative approach and the organisational culture influences the extent of DT.

Digital sensing as well as shaping capabilities include activities such as scanning, creating, learning and interpreting. Warner and Wäger (2019) argues there are sub-capabilities under digital sensing such as digital scouting, digital scenario planning and digital mind-set crafting. To successfully carry out sensing and shaping of opportunities, a need arises for entrenched organisational routines, eco-system awareness which includes threats from new entrants and, the ability to predict and take advantage of new technologies. For DT, organisations need to develop and grow their digital sensing capabilities (Ellström et al., 2021).

Digital seizing is where the opportunities or possibilities identified under sensing is actioned through combinations of products, processes and services. Warner and Wäger (2019) argues that digital seizing is constructed from sub-capabilities in the form of strategic agility, rapid prototyping and digital portfolio balancing acts. This capacity to seize the sensed opportunities is what an organisation requires to generate value from new business initiatives as well as the



required changes needed throughout the organisation. Low commitment, risk aversion or budget constraints are common reasons organisations do not seize new opportunities. Leadership and strategy is among the elements organisations can leverage to overcome such inhibitors of seizing (Ellström et al., 2021). In order to sense and seize various market opportunities through digital technologies, organisations need to develop their digital agility (Verhoef et al., 2021).

Digital reconfiguring or transforming, is where organisational routines are frequently, even continuously, renewed. Warner and Wäger (2019) identifies micro-foundations of this DC as navigating innovation eco-systems, re-designing internal structures and improving digital maturity of the organisation and its workforce. This capability of reconfiguring or transforming, is required to change organisational structures in a changing environment is necessary for sustainable profitable growth. Especially when new strategies requires transformation of existing resources, new resources and to supplement other areas of the resource base of an organisation. Due to the pace and novelty of DT in organisations, certain digital expertise might be lacking. Therefore, developing reconfiguring capabilities are essential for organisations to create or access new resources (Ellström et al., 2021).

Organisations require more flexibility and adaptability to navigate successfully through DT efforts. Ellström et al. (2021) identifies failure to capture potential and, difficulties regarding human factors as three generic challenges of DT. The first highlights organisations' failure to make adequate organisational changes in habits and ways of working in order to realise the maximum benefit of the transformation. Secondly, the risk of inertia and employees exhibiting resistance to change and, finally, data security issues emerged as a common issue.

Finally, Warner and Wäger (2019) produced a process model to build DC's for DT included as figure 3 below. This model conceptualises DT as a process of building DC's (Warner & Wäger, 2019).

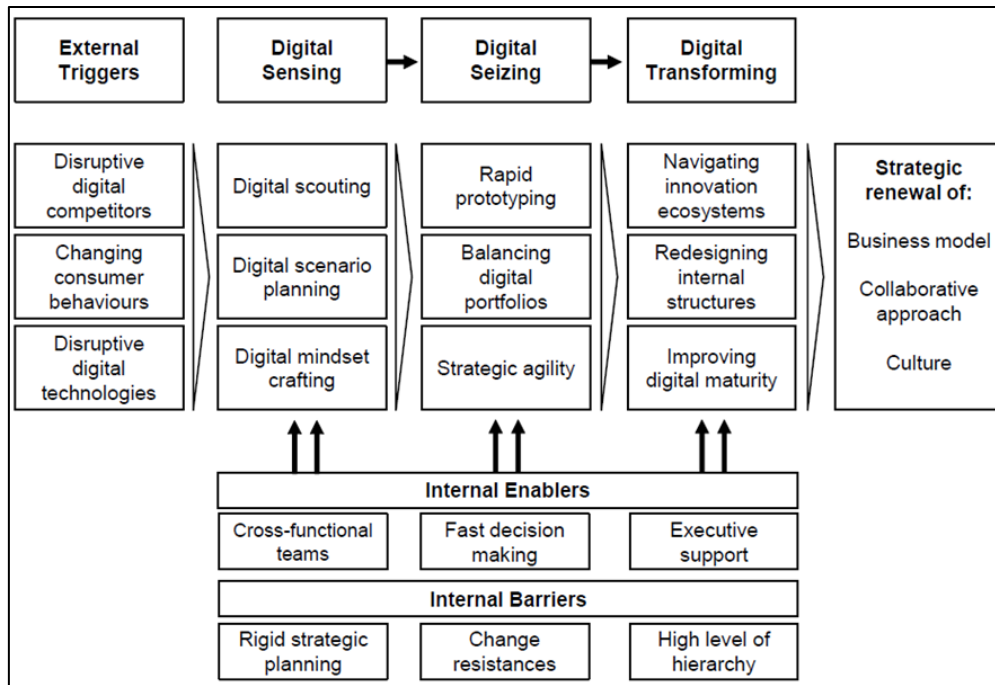


Figure 4: Building dynamic capabilities for digital transformation: A process model

(Warner & Wäger, 2019)

## 2.10 Improved business outcomes from digital transformation

As most mining organisations are more strategically focussed on internal product and process innovations due to limited impact or influence on the external market and commodity prices, safety and health, productivity and sustainability business improvement outcomes are pivotal in mining. Literature suggest that DT could have a positive impact on safety, production and support sustainability (Feliciano-Cestero et al., 2023).

### 2.10.1 Safety and health

DT has been yielding various safety and health benefits to the mining industry. From a study on the value on DT initiatives in the mining and metals industry, improved safety performance emerged as one of the key findings highlighting a 10 percent reduction in fatalities and 20 percent reduction in total injuries (World Economic Forum, 2017).

### 2.10.2 Productivity

Bruyns (2022) argues that more efficient processes and workflows are generated from DT initiatives. Creating digitised and automated workflows, designed to optimally manage information and data, gives employees more time to focus on value-adding business activities improve integrated planning and enables dynamic management of planned tasks and develop assigned projects and tasks faster.

### **2.10.3 Sustainability**

Bruyns (2022) indicated that the focus of new technology initiatives on pollution prevention, cleaner production processes and waste management to enhance sustainability of a mining organisation. Bruyns (2022) attested that digital solutions deliver optimally when integrated into the existing systems adopted at the mine to obtain high safety and productivity performance and, long term sustainability.

### **2.11 Summary**

Chapter 2 provided a literature review where relevant theory was presented for the study. To follow, Chapter 3 will set out the objectives and research questions for the study.

### **3 Chapter 3: Objectives and key research questions of the study**

Chapter 2 unpacked the relevant theory pertaining to the study through a literature review. Chapter 3, will outline the objectives, scope, and research questions for the study.

#### **3.1 Problem statement and research objective**

The objective of the study is to consider critical OCP as barriers, enablers and opportunities for successful DT. This study will gain insights and deeper understanding of the OCP as inputs into DT strategies and organisational readiness frameworks for improved business outcomes within the South African mining context. The improved business outcomes may include improved safety and health, productivity and sustainability. Furthermore, insights gained from the study can assist DT strategy development and digital business model innovation. Finally, the study anticipates providing a model to support DT towards improved business outcomes in mining.

#### **3.2 Scope of study**

This study will be focused on the gold and coal mining sectors. These sectors remain relevant to this study as these sectors might be in a different phases of mining modernisation and their DT journey, with rich insights to be obtained per commodity.

#### **3.3 Research questions**

##### **3.3.1 Main research question:**

What are the critical OC phenomena that could support DT towards improved business outcomes in the South African mining industry?

##### **3.3.2 Sub-questions:**

1. What are the barriers of DT?
2. What are the enablers of DT?
3. What are the opportunities of DT to enable improved business outcomes?
4. How can organisational change phenomena (i.e. culture, organisational structure, leadership, strategies, operating technologies, infrastructure, systems, processes and people) support digital transformation towards improved business outcomes?
5. Why is DT key for improved business outcomes?

##### **3.3.3 Clarification of research questions:**

To clarify the intent of the main research question, bolstered by sub-questions 1 to 5, it seeks to understand:

- The critical OCP, mining organisations in South Africa, should consider in preparation of, and during, DT to increase the probability of successful DT endeavours
- It further seeks to understand which OCP acts as prominent barriers and enablers of DT, in South African mining organisations
- Finally, the research questions seek to understand what opportunities DT can unlock to achieve improved business outcomes in the South African mining industry

### **3.4 Summary**

Chapter 3 provided the objectives and key research question for the study. Clarification of the research questions' intent was also given. To follow, Chapter 4 will discuss the proposed research design and methodology.

## **4 Chapter 4: Proposed research design and methodology**

Chapter 3 provided clarity on the objectives of the study and, discussed the research questions and their intent by providing further clarification. Chapter 4, unpacks the proposed research design and methodology selected for the study in order to crystallise the approach for the study.

### **4.1 Introduction**

This study was explorative in nature as it aimed to gain insights into OCP for successful DT. It intended to gain a deeper understanding of the barriers, enablers and opportunities for successful DT and, looked into how organisations and leaders can better prepare for and devise DT strategies to generate improved business outcomes, in the South African mining industry. Exploratory studies seek to discern general information about a topic that the researcher does not adequately, or clearly, understand (Saunders & Lewis, 2017). Therefore, due to the nature of the research problem and purpose statement, this study followed an exploratory qualitative research design.

### **4.2 Philosophy**

In the realm of research philosophy positivism, realism, interpretivism and pragmatism were considered. Even though there are no right or wrong philosophies it carries important assumptions about how we view or approach a problem. The researcher sought for better understanding of various OCP by taking an empathetic stance and considering the socially constructed reality and experiences of the participants. Therefore, to best achieve the purpose of this exploratory research, an interpretivism research philosophy was followed (Saunders & Lewis, 2017).

### **4.3 Approach**

As the researcher intends to build theory from data and observations, Saunders and Lewis (2017) suggest, when seeking for understanding of the meaning humans attach to events, an inductive approach is motivated. Furthermore, this study will seek to extract themes from the collected data to improve our understanding, to further enhance theory (Saunders & Lewis, 2017). Therefore, this study followed an inductive approach.

### **4.4 Strategy**

The research strategy had to be suited for the particular type of research question and sub-questions. Furthermore, the strategy implied certain traditions of sampling, data collection and analysis (Saunders & Lewis, 2017). The specific research question and sub-questions thus

demanded a phenomenological strategy as it would best achieve the purpose of the research by seeking for deeper insights and understanding of various OCP during DT.

#### **4.5 Methodological choice**

Saunders and Lewis (2017) suggested that the methodological choice had to be informed by the research purpose, philosophy and approach. Therefore, a qualitative mono-method methodological choice was selected for this study. This was supported by the exploratory nature of the study as it intended to gain insights into various OCP as it relates to OC and OD elements during DT. A qualitative method was also proposed due to immature literature surrounding the topic due to the multi-dimensionality, complexity and sensitivity to specific industries. Finally, since text data was going to be collected, grouped, themed and analysed, a qualitative method was justified.

#### **4.6 Time horizon**

As a result of the time limitations to conducting this study, a cross-sectional research design is selected, as the research will be conducted on a specific topic at a specific time (Saunders & Lewis, 2017). The researcher finds it ideal to follow a cross-sectional research study in which interviews will be conducted over a single short period in time (Saunders & Lewis, 2017).

#### **4.7 Population**

Saunders and Lewis (2017) described the population as the complete set of group members however, it could also be organisations and places in addition to people or employees. The population for the study were public mining companies in South Africa. Turnover, multi-nationality, mining methods (i.e. conventional, mechanised etc.), number of employees, geographical layout (i.e. open pit, underground etc.) and commodity diversity was to be used as markers to classify companies into different categories.

The study was focused on the gold and coal mining sectors. These sectors remain relevant to the study as they are in a different phases of mining modernisation and DT journey, with rich insights to be obtained per commodity.

#### **4.8 Sampling method and size**

The sample of a study was a subgroup of the complete population (Saunders & Lewis, 2017). As this was a qualitative study where a small sample of the population was to be selected a non-probability purposeful sampling technique was to be utilised. In this case, the sample was made up of a subset of organisations which formed part of the whole population. The researcher used their judgement, according to a set criterion, and actively chose the sample that will best be able to answer the research question at hand as further justification (Saunders

& Lewis, 2017). Therefore, a non-probability, purposive, criteria sampling technique was used to select the sample.

A minimum sample size of between 12 and 18 interviews was suggested to stand the best chance of reaching data code saturation. The sample was to be further segmented in order to reach different leadership levels and positions with rich information on the topic within the organisations. Therefore, 2 organisations were to be selected, 9 interviews were to be conducted per organisation. Specified criteria for sampling was included to ensure that only organisations that completed, or were in the process of, DT, publicly traded mining organisations (Listed on the JSE), actively conducting mining operations and, were accessible (consent obtained).

The study intended to reach saturation of new themes from the participants therefore, 18 participants was going to be included from two separate companies, each operating in a different commodity sector. Gold (Au) and Coal sectors were to be considered.

The targeted sample, inclusive of the participant role profile, quantity and company, was included in table 5 below.

*Table 5: Participant role profile and company distribution*

<b>Profession</b>	<b>Company A (Gold)</b>	<b>Company B (Coal)</b>
<b>Senior Technology/ Innovation Managers</b>	2	2
<b>IT Managers</b>	2	2
<b>HR Managers</b>	1	1
<b>Senior Operations Managers</b>	2	2
<b>Operations Lower Management</b>	2	2

#### **4.9 Unit of analysis**

The unit of analysis for the study intended to be the individual mining organisations selected in the sample. The unit of observation intended to be middle to top leadership or management positions and, selected DT leaders with rich, experience and insights on the topic within in these organisations. Mining companies included in this study intended be those who have already embarked on DT to some extent.

#### **4.10 Measurement instrument**

The literature surrounding the topic was reasonably well established and the researcher was interested in understanding and gaining deeper insights into the phenomena. The subject matter was expected to be highly sensitive and confidential. Therefore, a semi-structured interview guide was suggested as a measuring instrument. The questions would



predominantly be open-ended, supplemented by probing techniques. This intended to allow the participants to unpack their views and understanding of the questions.

#### **4.11 Data gathering process**

Primary data would be collected through semi-structured interviews through a combination of face-to-face and online (i.e. Microsoft Teams, Zoom) interviews with each participant within the selected sample of the population. Informed consent would be obtained from all the participants as well as approval to conduct the research, needed to be obtained from the Gordon Institute of Business Science (GIBS) before conducting any interviews. All interviews were going to be audio recorded and transcribed using Atlas.ti. The data collected had to be strictly be kept confidential, anonymised and securely stored on a password-protected and access-controlled secure google drive platform administered by GIBS.

Appendix A provided for the data gathering tool. Appendix B indicated that a company consent letter for each mining company, had to be obtained with permission to participate in the study. Appendix C provided for the participant consent letter, for their permission to participate in the study. Participant consent had to be obtained prior to conducting the interviews.

#### **4.12 Analysis approach**

The transcribed data would be analysed using a thematic analysis technique. To conduct this analysis the transcribed data had to be coded, grouped and categorised to extract key themes from the data gathered.

The use of a Five-Phase cycle was selected to be utilised in order to analyse the data set and support the thematic analysis (Yin, 2011). Phase one, is compiling, where the researcher will organise all data that has been collected (Yin, 2011). Phase two, is disassembling the data or coding the data into smaller pieces and categories (Yin, 2011). Phase three, is reassembling the data and representing them in a tabular form (Yin, 2011). Phase four, is interpreting the data that have been reassembled. Phase five, is concluding where the researcher draws a conclusion from the entire study (Yin, 2011). The Five-Phase Cycle is an iterative process which requires the researcher to review and adjust between each phase until a conclusion can be determined (Yin, 2011).

#### **4.13 Quality controls**

This study intended to explore multi-dimensional aspects of the topic, using companies as the unit of analysis and include classification markers. To enrich the understanding of the phenomena as well as to enhance the quality of data a tri-angulation mechanism was proposed as a quality control measure.

The researcher had to verify the data by finding at least three ways to corroborate the study. Firstly, the researcher would make use of the literature review from multiple sources to validate and provide evidence to themes (Saunders & Lewis, 2018). The interviews with mining experts would allow the researcher to validate the facts that would emerge from the study (Saunders & Lewis, 2018). This further addressed concerns regarding validity and reliability to ensure there would be no bias in the researcher's interpretation of the findings. Lastly, the researcher would gather information from different organisations as opposed to using only a single organisation as a reference. This would allow the researcher to answer the question if the research was generalisable and could be applicable to other organisations (Saunders & Lewis, 2018).

#### **4.14 Ethical considerations**

Prior to any interviews with respondents, the researcher would be required to obtain ethical clearance from the Research Ethics Committee of the Gordon Institute of Business Science (GIBS). Once the ethical clearance application was approved from the committee, the researcher would be allowed to collect data. The objective of the ethical clearance was to ensure that the research was conducted in the appropriate manner and that both parties' rights were preserved throughout the process. Every respondent would be asked to participate in an interview and, a signed consent form (Appendix C) had to be received as proof of consent before any interview would commence. All respondents would be assured of confidentiality and that all data collected during the interview would be kept anonymous. English as the business language would be used.

#### **4.15 Limitations**

Limitations of the study included:

- Limited time constraints influenced the time horizon of the study. Hence, the cross-sectional study could limit the study and probe for future longitudinal studies.
- Relative small sample size as only limited organisations in the population would participate
- DT is a global phenomenon that stretches across multiple industries and continents thus only focussing on the mining industry within South Africa would limit the study

#### **4.16 Summary**

Chapter 4 unpacked the proposed research design and methodology.

## 5 Chapter 5: Analysis and findings

Chapter 5 included the analysis and findings from the interviews conducted in an attempt to answer the research questions formulated and stipulated in Chapter 3.

### 5.1 Introduction

The findings and analysis was based on the data collected during the semi-structured interviews. Data was collected according to the methodology and design developed in Chapter 4. All but one interview was conducted virtually via the Microsoft Teams digital platform (One face-to-face). The interviews were recorded and transcribed using the Microsoft Teams digital platform.

17 participants were interviewed from two underground mining companies in South Africa, each mining a different commodity. The interviews were spread between different functions, levels and departments to obtain a broader organisational view and, for tri-angulation purposes. The data collected from the interviews were coded, grouped and analysed to extract themes using Atlas.ti software. The key themes, and sub-themes, which emerged from the thematic analysis that answered the research questions in Chapter 3 were discussed and summarised in this chapter.

### 5.2 Description of sample

In total, 9 interviews were conducted from Company A (Gold commodity) and 8 from Company B (Coal commodity). The role categories interviewed, included 4 senior technology or innovation managers (2 per company), 4 information technology or information systems managers (2 per company), two human resources managers (1 per company), 3 senior operations managers (2 from Company A and 1 from Company B) and, 4 lower management roles in operations (2 per company). 1 interview in the senior operations manager role category could not be obtained from Company B according to the design and methodology stipulated in Chapter 4. The sample role category distribution was summarised in table 6 below.

Table 6: Sample role category distribution

Role category	Role category code	Company A Gold (Au) sector	Company B Coal sector
Senior Technology/ Innovation Managers	A	2	2
IT/IS Managers	B	2	2
HR Managers	C	1	1
Senior Operations Managers	D	2	1
Operations Lower Management	E	2	2

All the participants were either directly or indirectly responsible for, or involved with, DT efforts in their respective roles, business units (Central or operational) and areas of responsibility. DT responsibilities varied from strategic to execution level based on the role categories interviewed. The sample interview information, which included the participant number, role category code, company, commodity, demographics, interview method and duration are detailed in table 7 below.

*Table 7: Interview sample detail*

Participant	Role category code	Company	Commodity	Gender	Age category	Experience	Method	Duration
1	A	B	Coal	Male	31-40	16 years	Virtual	1h 20min
2	C	A	Gold	Male	41-60	25 years	Virtual	0h 55min
3	A	A	Gold	Male	41-60	36 years	Virtual	1h 1min
4	B	B	Coal	Male	31-40	15 years	Virtual	1h 23min
5	B	A	Gold	Male	41-60	28 years	Virtual	1h 9min
6	D	A	Gold	Male	31-40	15 years	Virtual	1h 39min
7	A	A	Gold	Male	-	-	In person	1h 13min
8	B	B	Coal	Male	41-60	10 years	Virtual	1h 3min
9	E	B	Coal	Female	20-30	6 years	Virtual	1h 34min
10	C	B	Coal	Female	41-60	15 years	Virtual	1h 8min
11	E	B	Coal	Male	-	-	Virtual	1h 6min
12	B	A	Gold	Male	-	-	Virtual	0h 57min
13	E	A	Gold	Male	41-60	22 years	Virtual	1h 11min
14	A	B	Coal	Male	41-60	20 years	Virtual	1h 19min
15	E	A	Gold	Male	41-60	35 years	Virtual	1h 9min
16	D	B	Coal	Male	31-40	9 years	Virtual	1h 39min
17	D	A	Gold	Male	41-60	27 years	Virtual	1h 17min

To further describe the sample, the total number and duration of interviews were summarised in table 8 below.

*Table 8: Interview quantity and duration*

Description	Quantity
Number of interviews	17
Total duration of interviews (Minutes)	1263
Maximum duration (Minutes)	74
Minimum duration (Minutes)	55
Average duration (Minutes)	99

Raw coding revealed, relative saturation after ten interviews and complete saturation with the final interview. This was justified by the absence of new codes generated from the final transcript codification due to the diffusion of additional insights illustrated in figure 5 below.

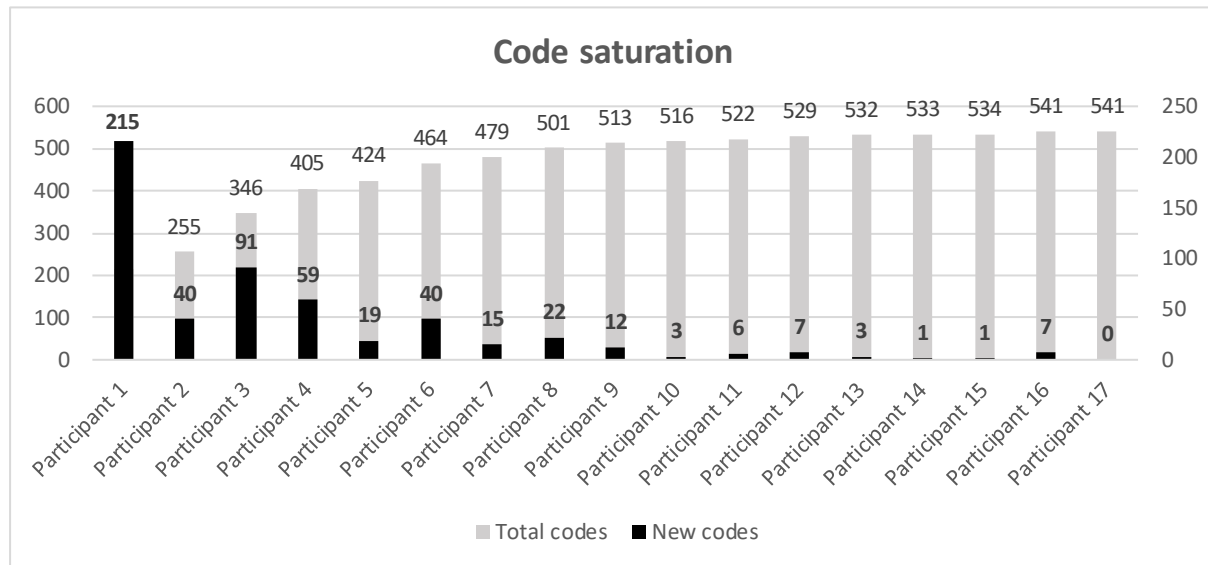


Figure 5: Saturation curve

### 5.3 Presentation of general findings

#### 5.3.1 Digital transformation and organisational change phenomena

The general findings from the research interviews were extracted and discussed below.

- The general view from the interviewed participants was that DT is a multi-dimensional, long term and continuous journey. 11
- Furthermore, a consensus was reached by the participants that DT is largely triggered by external changes such as 4IR, geo-political uncertainty and the development of new digital technologies. 4

Table 9: General findings codes detail and quotations

Participant	Company	Role code	Quote or comment
1	B	A	"And you need to then understand that this whole journey is gonna be a journey, a long one, and it needs to be agile... "
6	A	D	"I think in in idea that transformation is not not just mimic mimicking what used to be a manual process and now making it just faster and just digital version of it. I think the transformation also tries to go beyond that and say, well, now we've got the data and the business intelligence where is more synergies, can we bring in AI. Can we cross reference to other processes and create new value? So that's actually the transformation ends when you get to to more value."

9	B	E	<i>"It's moving with the 4IR trying to make sure that we are moving with the times and making sure that we are on par with the digital world, you know, not to, be left behind."</i>
8	B	B	<i>"you won't get the benefits if you don't at least call it at the transformation component and you'll get some benefit. You may have some real time data, but you will I think you'll miss the Leapfrog component of it? The UM. Yeah, obviously the transformation. But so you'll get the get. I think the transformation but is exponential where Just digitize is linear."</i>
12	A	B	<i>"I mean, if you look at, since just after COVID and even during the Covid pandemic, your organization quickly realized that technology can be an enabler."</i>
1	B	A	<i>"It's not an easy game"</i>
17	A	D	<i>"So if you wanna do these things when you implement, you need to make sure that whatever piece of equipment that you implement is actually working. Don't implement throughout the whole mine, but then when you start pulling the figures, people tell you up, but you can't trust this."</i>

### 5.3.1.1 Summary of general findings on digital transformation

In essence, the findings portrays DT as an imminent, complex, and ongoing process with multiple dimensions, requiring a substantial and sustained effort. Participants discerned digitisation, digitalisation, and DT as distinct yet interconnected stages within the broader DT framework. Recognising the intricate interdependencies and organisational impacts, they emphasised the need for a significant transformational commitment to successfully achieve and extract value from DT.

The consensus emerged that DT is instigated by a combination of external factors like the 4IR and emerging digital technologies, as well as internal factors driven by business improvement needs. Ultimately, participants collectively asserted that DT is imperative for enhancing competitiveness, fostering growth, and ensuring the long-term survival and relevance of organisations.

## 5.4 Presentation of findings by theme

The research questions were consolidated into three main themes, with related sub-themes. The findings were represented through the themes and sub-themes, as per the discussions below.

### 5.4.1 Theme 1

#### 1) Harmonisation of organisational change phenomena with organisational change and design elements will influence digital transformation implementation and outcomes

Through theme 1, the following in terms of research questions were addressed.

- **Main research question:**

What are the critical OC phenomena that could support DT towards improved business outcomes in the South African mining industry?

- **Relevant sub-research questions:**

- Sub-research question 1: What are the barriers of DT?
- Sub-research question 2: What are the enablers of DT?
- Sub-research question 4: How can organisational change phenomena (i.e. culture, organisational structure, leadership strategies, operating technologies, infrastructure, systems, processes and people) support DT towards improved business outcomes?

As per theme 1 the following findings were considered:

- 7 participants conceded that in fact all OCP, with reference to culture, structure, leadership, strategy, technology, infrastructure, systems processes and people, can support or impede DT for improved business outcomes.
- Moreover, 11 Participants highlighted that aligned and integrated OCP, with reference to culture, structure, leadership, strategy, technology, infrastructure, systems processes and people, following a holistic organisational approach will create synergies and propel DT toward achieving improved business outcomes.
- 9 participants supported the notion that following an atomistic approach or only focussing on one OCP and lack of organisational readiness will impede DT and yield delayed business improvement outcomes.
- Moreover, 4 of the interviewed participants supported that organisational and departmental interdependencies impacts and influences DT success and progression.

The relevant participant code detail and quotations are captured in table 10 below:

*Table 10: Theme 1 code detail and quotations*

Participant	Company	Role code	Description of quote
2	A	C	<i>"So all of these things are interrelated. I actually you can't split any of this. You're not, and vice versa. Umm, you cannot split any of this, so it's some it's it's super vital and it's got a direct impact. All those elements that you've listed there on how it or cannot support digital transformation."</i>
5	A	B	<i>"Because I mean, typically all of them has an impact on improved business outcomes"</i>
9	B	E	<i>"I think for me, I'm looking at them from. I think this is certain hierarchy to them, right? Umm. So if the one is not in place, the other one can't be in place, so that's why I'm saying you can't just focus on the one without. Focusing on all of them"</i>

3	A	A	<i>"So according to my perspective, these elements when effectively harnessed and aligned, they will actually create a synergy or synergistic impact and propelling organizations towards the improved business outcomes and increase competitiveness and sustained growth in the digital age"</i>
4	B	B	<i>"All of all of the ones listed here, there is an interdependency. If you've got everything right but you don't bring your people along, then it will not. You will not get going"</i>
6	A	D	<i>"I think it's critical that. You have a integrated. Approach. Uh, you can't have one silo doing something on its own. You need involvement of IS, engineering. Who? Whoever the customer is, because to get these systems to give us Business intelligence and then interact with other systems."</i>
14	B	A	<i>"No, you'll have to sort of integrate all of them. Not, really just focusing on one cause, I mean you can you can focus on infrastructure if your people are not then with you if they are no sort of proper systems and you know you need to integrate all of them."</i>
16	B	D	<i>"I think they are definitely interdependent. I mean, again, I don't even see systems, processes and people as separate."</i>
1	B	A	<i>"If we're talking organization in this case, there is lots of integration that is required."</i>
4	B	B	<i>"Well, I'm saying that is if we've experienced that to have a successful digital transformation and to exponentially extract value out on that they some basic things that need to be in place so that that enables your if your if you've got a very high level of integration in your business digital the value of digital transformation exponentially increases."</i>

#### 5.4.2 Sub-themes of theme 1

In order to further substantiate the intricacies and interdependencies of various OCP and OD elements the following sub-themes was identified. Sub-themes focussed on OCP influences and interdependencies within specific OC and OD elements.

##### 5.4.2.1 Sub-theme 1.1: Strategic organisational change phenomena

This sub-theme considered strategic elements inclusive of organisational strategy and resource allocation involved in DT.

##### a) Strategy

- 16 participants strongly supported that aligning the digital strategy with all stakeholders and, effectively communicating the shared vision can foster support for DT efforts, whether from top-down directives or bottom-up initiatives.
- 14 participants agree that the integration of DT into organisational strategies, emphasising its role in safety, operational excellence, and cost reduction is important.
- Organisations are actively undergoing agile DT, iteratively adjusting their business model, aligning with digital strategies, and emphasising collaboration within the industry for successful adaptation. This view was constructed from 10 participants.



## b) Resources

- Successful DT in mining necessitates committed financial investment, collaborative co-development, and a shift in conservative mind-sets towards capital expenditure. This opinion was constructed from 14 participants.

The relevant participant code detail and quotations are captured in table 11 below:

Table 11: Sub-theme 1.1 code details and quotations

Participant	Company	Role code	Description of quote
1	B	A	"Yeah, it's everything was spoke about, but preparation starts at the strategic level. Everyone needs to align. Everyone needs to see the vision first. From there you need a proper digital road map, well thought of. Carefully thought of bought into by almost most players at the strategic level"
2	A	C	"Well, I think the first thing for me is one needs to be quite clear on where this digital transformation fits into your business strategy."
9	B	E	"So once you once you start the engagements a bit earlier, you get to redefine your plan or your strategy in order for it to be more attractive to the to the end users"
1	B	A	"You need to agile approach to deal with it. You cannot do it otherwise. The reason for that is because we are not matured in this digital era. Nobody fully understand what is happening."
5	A	B	"So really, but it must be part of your strategy. Uh, so that you can allocate resources to so you say plan prepared."

### 5.4.2.2 Sub-theme 1.2: Software and hardware organisational change phenomena

This sub-theme considered software and hardware elements inclusive of technology and infrastructure involved in DT.

#### a) Technology

- 7 participants were of the opinion that DT success hinges on integrated systems, reliable data, and accurate technology implementation to build trust and user confidence.
- A view that suggest, the integration of technology in business processes extends beyond its technical aspects, encompassing a comprehensive transformation that involves upskilling, cultural change, and the implementation of digital tools to enhance operational efficiency was supported by 3 participants.

#### b) Infrastructure

- 8 participants converged on the opinion that successful DT hinges on a well-integrated infrastructure, including adaptable communication networks, with the true value emerging from informed decision-making and proactive strategies.
- 6 participants further aligned that DT hinges on establishing a robust infrastructure, including fiber technologies and network systems, as the foundational prerequisite for successful implementation and value extraction.

- Finally, 3 of the interviewed participants suggested that DT in mining focuses on prioritising infrastructure, like integrated networks, to shift from reactive to proactive approaches, ensuring real-time information capture and tangible operational benefits.

The relevant participant code detail and quotations are captured in table 12 below:

Table 12: Sub-theme 1.2 code details and quotations

Participant	Company	Role code	Description of quote
16	B	D	"because there's looseness. You open it up. There isn't looseness, and now you lose faith in the technology. And that has led to condition monitoring being a contentious point within the engineering space."
4	B	B	"So there is definitely a skills transformation needed. So implementing technology in transitioning skills but also transitioning the culture"
4	B	B	"If you want to digitalize a business process, do you need a? You need a way to 1st capture the information you need to. Uh get hardware implies you need to get away to let that that information flow. Communication happen and example is a Wi-Fi network."
1	B	A	"We spoke of the infrastructure to say you need to lay down the infrastructure first. Fiber Technologies, network switches and all that..."
8	B	B	"to able to have operations centers and advance analytics, we need connectivity."

#### 5.4.2.3 Sub-theme 1.3: Soft and humanistic organisational change phenomena

This sub-theme considered soft and humanistic elements inclusive of people, organisational culture and leadership involved in DT.

##### a) People

- All participants aligned that effective change management, clear communication, and stakeholder engagement are vital for successful DT in the mining industry.
- Addressing the varied digital competency levels and resistance among mining industry workers is essential for successful implementation of digital technologies according to 16 of the participants.
- Furthermore, 6 participants were of the opinion that embracing DT in industries like mining requires training and involvement of passionate individuals, especially from the younger generation, to bridge the generational gap in technology acceptance and drive successful innovations.

##### b) Culture

- 15 participants converged to the view that organisations are fostering a digital culture by embracing data-driven decision-making, transparency, and innovation through technologies ensuring proactive engagement and enhancing workplace safety and efficiency.
- Again, 15 participants converged to the understanding that successful DT in mining relies on a positive culture of openness, trust, and adaptability, enabling innovation

and embracing new technologies, while resistance and lack of accountability impede progress and hinder improved outcomes.

- Organisations are actively pursuing a DT, integrating technologies and fostering a shift in culture to improve operational efficiency and safety. This opinion was supported by 10 of the participants.

### c) Leadership

- Effective leadership strategies are crucial for successful DT in the mining industry, shaping a culture of openness and engagement that facilitates the integration of technology and enhances overall operational efficiency, was the combined view of 14 participants.
- Effective DT in the mining industry demands visionary and digitally competent leadership at the strategic level, fostering a culture of innovation and encouraging active employee engagement, enabling the organisation to overcome traditional barriers and drive technological advancements according to 14 participants.
- 6 participants observed that leadership faces challenges in embracing DT due to the lack of short-term business case justification, organisational short-termism, and resistance across the organisational spectrum, as well as the mining industry's expectation of immediate results.

The relevant participant code detail and quotations are captured in table 13 below:

*Table 13: Sub-theme 1.3 code details and quotations*

Participant	Company	Role code	Description of quote
2	A	C	"if we don't do change management, well, people don't get it and then they don't use it as they should."
12	A	B	"the one more important, the one is obviously competency of using the system. That's one of the barriers that people are we don't know how to use something you don't want to use it."
4	B	B	"so you need to make sure that they there's a training and you take people along with you whilst they're doing this."
1	B	A	"it will be difficult for somebody to come from outside who cannot really digest and understand data, to easily fit into this culture of data driven, data is there for everyone to see to a certain extent"
4	B	B	"So if you don't have that culture innovation, openness, then a it's impacting it in a very negative way."
7	A	A	"process of integrating the digital technology into the various aspects of the organization and in this scenario, the organization that I'm referring to its XXX and those aspects of XXX that includes our culture, the strategy as well as in terms of how we, how we do business"
2	A	C	"Yeah, well, leadership is right at the top most critical. Because they set the tone, I mean they set the tone of how they use it and the examples they set."
4	B	B	"So you know, if your leadership don't have the vision, you are actually dead in the water"
1	B	A	"Imagine leadership that is driven by short-termism. To say I understand the must do it, but I'm driven by a contract here. I must be done in five years or seven years and I need to shine in them. That leadership will not entertain this discussion."

#### 5.4.2.4 Sub-theme 1.4: Systemic and processual organisational change phenomena

This sub-theme considered systemic and processual elements inclusive of systems and processes involved in DT.

##### a) Systems

- 10 of the participants suggested that DT has streamlined operations by replacing paper-based processes with digital systems, enabling real-time data capture, proactive management, and quicker responses to issues.
- 12 participants had the opinion that Integrated digital operations, including systems, processes and data, must be simple, efficient, effective, reliable, integrated, relevant and accurate to form the base/foundation for successful DT

##### b) Processes

- 10 of the participants suggested that DT in mining entails replacing manual, paper-based processes with digital systems, enabling real-time data analysis, efficient decision-making, and improved productivity and safety. Furthermore, 7 participants was of the combined opinion that DT goes beyond digitising manual processes, encompassing the integration of data from diverse systems, the application of AI, and organisational changes to create new value, challenging traditional ways of engagement and decision-making in businesses.
- 5 participants suggested that efficiently integrated business processes and effective procurement practices are essential for a successful DT, enabling seamless implementation and coordination across different areas.
- 5 participants constructed a view that DT is digitalising business processes using technology to improve business outcomes.

The relevant participant code detail and quotations are captured in table 14 below:

Table 14: Sub-theme 1.4 code details and quotations

Participant	Company	Role code	Description of quote
6	A	D	"For example, planned maintenance is going away from a paper system to a uh, handheld digital interface."
4	B	B	"big a big part of Ohh digital transformation is implementing systems and integrating different systems and businesses and processes and people."
5	A	B	"So we're using tablets from safety officer point of view, inputting data underground on digital, uh. What is it digital, Equipment and where we still have to do paper based because of peoples ability, then we have OCR scanning and it becomes digital for us."
6	A	D	"transformation is not not just mimic mimicking what used to be a manual prices and now making it just faster and just digital version of it. I think the transformation also tries to go beyond that and say, well, now we've got the data and the business intelligence where is more synergies, can we bring in AI. Can we cross reference to other processes and create new value?"
3	A	A	"you've got inefficient business processes with different maturity levels and this guy doesn't. The right hand doesn't know what the left hand is doing. It makes digital transformation difficult, but if you've got a high a high level of integration"

### 5.4.2.5 Sub-theme 1.5: Structural organisational change phenomena

This sub-theme considered structural elements inclusive of organisational structure involved in DT.

#### a) Structure

- 12 participants constructed the opinion that restructuring organisational roles, upskilling the workforce, and embracing agile practices are crucial for effective implementation of DT initiatives.
- Establishing cross-functional DT teams and integrating digital initiatives across the organisation, supported by thorough research and stakeholder engagement, aligns the company's strategy with its digital goals. This view was extracted from 9 participants.

The relevant participant code detail and quotations are captured in table 15 below:

Table 15: Sub-theme 1.5 code details and quotations

Participant	Company	Role code	Description of quote
9	B	E	"organizational structure, if you don't staff your organization correctly with the proper support and if you don't have the correct Technical Support systems in place and you also don't stuff, let's say your mine correctly then certain things won't happen because you have not"
1	A	A	"Your structure needs to support this digital strategy. Remember, other than the team that sits there, we had to bring you a. This call it bodies appointment into our structure we've got the whole department called Digital Digital Team, this digital technicians, this digital, it's chief digital technician and whatnot going right across the organization"

### 5.4.3 Theme 2

#### Organisational digital maturity influences digital transformation implementation and outcomes

Through theme 2, the following in terms of research questions were addressed:

- **Main research question:**

What are the critical OC phenomena that could support DT towards improved business outcomes in the South African mining industry?

- **Relevant sub-research questions:**

d) Sub-research question 1: What are the barriers of DT?

e) Sub-research question 2: What are the enablers of DT?

- f) Sub-research question 4: How can organisational change phenomena (i.e. culture, organisational structure, leadership strategies, operating technologies, infrastructure, systems, processes and people) support DT towards improved business outcomes?

As per theme 2 the following findings were considered:

- 10 of the interviewed participants suggested that establishing a strong foundation through phased alignment, governance, and a focus on fundamental elements is essential for successful DT in mining.
- Continuous DT is essential, with a focus on informed leadership, strategic integration, and proactive alignment of technology with organisational needs. This was the combined view of 13 participants.
- Successful DT requires addressing data integrity challenges, maintaining context in digitised processes, and ensuring the functionality of technology before widespread implementation was insinuated by 5 of the participants.
- Furthermore, 3 participants claimed digitising without solid basics intensifies problems and strategic guidelines are essential for effective and innovative development.

The relevant participant code detail and quotations are captured in table 16 below:

Table 16: Theme 2 code details and quotations

Participant	Company	Role code	Description of quote
6	A	D	"Because it's probably more of a case of what is your. Company ready for so you should almost more read what is the capabilities the needs, the ones the burning platforms where you are looking for a better solution and then try and match technologies out there to do that need so the need will drive the technology more than the technology will drive the need."
16	B	D	"I think there is an element of understanding where the world is going and the value that digital processes can provide."
1	B	A	"you need to have a solid platform foundation and basics must be right before you can digitize"
16	B	D	"I think most that the quality foundation for me there would be a well defined operational process. That comes back to, you know, understanding your organisational, operational, design, understanding how processes flow into systems, understanding how information flows through the organization and if that is well understood"
8	B	B	"So uh poor data quality. Umm. And where the poorly defined business processes"
15	A	E	"But the integrity of that or the integrity of the data that you that you utilize or that you want to utilize to analyze something, he's totally dependent on the integrity of the information that was submitted into the database."
1	B	A	"basics and the standards are not right, digitizing only magnifies your issues and complicates your life"
8	B	B	"So we chose to the second where we said that there are some inefficiencies in the business. We first need to clarify. Let's say the work management process or the planning process and then we will apply digital. Umm. Otherwise you will just digitize inefficient practices"
6	A	D	"digital transformation is something. Organic. Often where it builds on itself, I mentioned that with the with the systems. Umm. So if the organization in any of these aspects are creating a barrier for a certain development, then you kill a whole chain of developments. So I think the the art is to assess the organization to see where you can start building and then probably to work on those aspects which are not conducive enough or not at the place where you want it to be to accelerate"

#### 5.4.4 Sub-themes of theme 2

In order to further substantiate the influence of ODM on DT the following sub-themes was identified. Sub-themes focussed on ODM influences on DT within specific OC and OD elements.

##### 5.4.4.1 Sub-theme 2.1: Strategic organisational digital maturity

This sub-theme considered strategic ODM inclusive of organisational strategy and resource allocation involved in DT.

###### a) Strategy

- 9 participants suggested that the organisational strategy evolves through waves, with a gradual integration of DT, emphasising strategic leadership and intentional sequencing for effective implementation.
- Successfully digitising traditional businesses involves strategic alignment, meticulous planning, and initial infrastructure establishment, with challenges in precisely measuring the impact of digital initiatives. This was the opinion of 4 participants.
- Furthermore, 2 participants conceded that balancing profit-driven improvements with risk mitigation is key for adaptability, highlighting the essential role of technology as a strategic enabler in organisational decision-making.

###### b) Resources

- 11 participants identified barriers to DT include funding challenges, resistance to prioritising digital initiatives, and the perception of high costs, with ongoing efforts to shift mind-sets and allocate funds strategically.

The relevant participant code detail and quotations are captured in table 17 below:

Table 17: Sub-theme 2.1 code details and quotations

Participant	Company	Role code	Description of quote
8	B	B	"I think need to have clarity on terms of your, on how agile, you wanna progress the specific strategy. So in other words, do you wanna do a proof of concept or do you wanna give go all in with specific initiatives or drives"
1	B	A	"if you go for traditional business, case NPV and in isolated stages, because that's where the trick is. If you wanna digitize, you would have to put the infrastructure first, be it underground. So if you go underground, you gonna have to put a fiber. You're gonna have to put the networks and that time. There's nothing to it. There is no results, is not delivering any tonnage of whatever ore body. There's nothing. That's the digital it's infrastructure first and then later on plenty things can be done with this infrastructure where you get into the space of data analytics"
12	A	B	"technology has never been seen as a true strategic enabler to the organization. And I mean with that view, it doesn't get the required air time it deserves and with that unfortunately it's not always top of mind when MNA's are considered or when opportunities are considered. So if that's not well positioned with the organization, it can be a barrier ultimately because you need to, you need to have the one the appetite for it"

7	A	A	"I mean look, it's basically the budget and resources, I mean look we are company and the main aim of a company is to make your shareholders happy. So in terms of budget as well, we are doing the necessary RND, but it is still limited when it comes the technology portion."
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#### 5.4.4.2 Sub-theme 2.2: Software and hardware organisational digital maturity

This sub-theme considered software and hardware ODM inclusive of technology and infrastructure involved in DT.

##### a) Infrastructure

- Aging infrastructure and outdated systems present challenges to DT, necessitating financial allocations and emphasising the need for foresight in the process. 4 participants constructed this view.
- 12 participants conceded that a robust and up-to-date infrastructure, complemented by leadership commitment and employee engagement, forms the essential foundation for successful DT, enabling organisations to implement and optimise advanced technologies effectively.

##### b) Technology

- 14 participants converged to inadequate digital technologies hinder DT by frustrating users, causing resistance, and impeding progress due to their poor reliability, applicability, and user-friendliness, thereby preventing intended outcomes.
- Reliable digital technologies and user-friendly applications can support DT and gain buy-in from employees and stakeholders was relevant to 11 participants.
- 3 participants revealed that a customer-centric approach, advanced technology, and mature operating technologies with high integration are crucial for organisations to develop responsive solutions, but in challenging environments like underground operations, enabling fundamental technologies become essential for meaningful advancements and revenue growth.

The relevant participant code detail and quotations are captured in table 18 below:

Table 18: Sub-theme 2.2 code details and quotations

Participant	Company	Role code	Description of quote
1	B	A	"The Ferrari can take you from here, from point A to point B very quickly and it will definitely help you if all you're looking for is to get from point A to point B very fast. However, you must have the infrastructure for it, the tar road, must be sound. Then you get there quick. If you bring a Ferrari, your entire road is full of pothole, the Ferrari will never get you there."
5	B	B	"ensure our infrastructure underground, our network, our Wi-Fi network infrastructure, not Wi-Fi, our network infrastructure underground was put by our engineering discipline and what we call it is to enable us to locate people when they for whatever reason, is missing"
16	A	D	"Uhm, definitely. If we we're seeing that as well. Very simple example is the more you digitalize the more traffic you have on your system and so if you want chaos, then digitalized before you're sure that your fiber network and handle it,"



6	A	D	"Infrastructure, I mean, you've got to make those base layers, I don't know this is more brick and mortar, but I mean systems and infrastructure in terms in my mind I'm thinking of networks and server rooms and all sorts of sensors as giving you the data at the bottom."
13	A	E	"outdated and put it that way. We've got system whereby. When we introduce all this, the technology, technological transformation we, we, we are the risk that the system maybe might crash because I mean for example we've got a backbone network that everybody everything runs through there and previously you will you will maybe you have about 10% usage of it."
17	A	D	"let's call it. In shallower mines or in open cast mines? But it's not, so it's not so viable at depth, but you can adapt some of these technologies or you can alter some of these technologies to actually provide for your needs."
17	A	D	"And operating technology, I think that's the same point where I mentioned if the technology you wanna use is not accurate then rather not bring it, you'll just create negative vibes and you will not see the intended outcome,"
12	A	B	"I mean, that's critical. Uh for operating technologies and the infrastructure for that matter, talking about IT infrastructure. Umm to support the DT and to improve the business continuously"
4	B	B	"if you've got it, operating technologies standard. Really in place, if it's level of integration or openness from that technology, it's a lot easier to implement it. You can extract the value a lot easier, so if you've got that and that talks a lot back to maturity. So maturity look like you said previously, it's got the people components, skill level understanding all of that, but also the technical footprint see if you any environment where there is upper writing technologies is low maturity level to transition that and extract the value it becomes much more difficult."

#### 5.4.4.3 Sub-theme 2.3: Soft and humanistic organisational digital maturity

This sub-theme considered soft and humanistic ODM inclusive of people, organisational culture and leadership involved in DT.

##### a) People

- Implementing DT in the mining industry is hindered by widespread resistance to change, fuelled by a lack of education, job security concerns, and a slow shift away from traditional workflows. 15 participants constructed this view.
- 5 participants highlighted resistance to DT in the mining industry stems from a lack of perceived need, inadequate explanation of system benefits, and challenges in adopting new technologies, highlighting the importance of clear communication and mind-set shifts.
- Furthermore, 3 participants suggested that successfully embracing DT in the organisation involves prioritising a culture that values digital technologies, retraining the workforce, particularly addressing resistance, with leadership acceptance as a key enabler.

##### b) Culture

- 7 of the interviewed participants conceded to successfully navigate DT in the mining industry, requires building genuine relationships with employees, addressing union concerns, and fostering open communication to overcome resistance and ensure collaborative engagement.

- 2 participants held the view that an organisational data-driven approach, reflects a transformative shift toward fostering accountability and cultural change through digital systems.

**c) Leadership**

- All of the participants strongly suggested that collaborative industry efforts, strategic planning, regulatory alignment, leadership, cultural shifts, and a pragmatic approach are highlighted as key factors for the successful DT of the South African mining sector.
- Moreover, 10 participants agreed that effective leadership is pivotal in navigating resistance, building trust, and fostering a collective mind-set shift for successful DT in the mining industry.
- Finally, in the evolving technological landscape, it's crucial to empower individuals to effortlessly shift manual processes to digital solutions, emphasising cultural alignment and skill development. 2 participants constructed this opinion.

The relevant participant code detail and quotations are captured in table 19 below:

*Table 19: Sub-theme 2.3 code details and quotations*

Participant	Company	Role code	Description of quote
3	A	A	"The problem with the mine is because people are not educated."
7	A	A	resistance to change and those are the things that we currently encounter them on some of our operations."
9	B	E	"Resistance like why are we doing this? I don't even know why this is here. Then you start hearing, then that's where the rumors actually also come in, whereby no, this actually going to take our jobs. Now these people want to spy on us now this."
12	A	B	"they think they might be out of a job, or it's just a matter of that, they just not at that skilled level where they can actually see what technology can do."
12	A	B	"that brings unionized labor and that also is a huge barrier to what we and can achieve when we talk about digital."
1	B	A	"are already data driven because of this digital sort of transformation and I'm saying the way we do things"
7	A	A	"So hence I say it starts with the leadership support because of now if XXX as a CEO of the company keeps on opening up is hand for continuous RND on digital transformation then it becomes much easier for us to roll out a lot of innovation when it comes to getting to transformation."
4	B	B	"The collaboration with other mining houses that's I think that's that's key because I collaboration drives. Economies of scale. It drives advances in technology, those kind of transitioning, which then becomes relevant to digital transformation."
1	B	A	"At the same time, we've got the regulator we need to take the regulator off because we live in the regulator behind and as we go with this digitization, they do not understand the benefit of it."
6	A	D	"making sure that we enable people to easily convert manual processes to integrate the digital solution"

**5.4.4.4 Sub-theme 2.4: Systemic and processual organisational digital maturity**

This sub-theme considered systemic and processual ODM inclusive of systems and processes involved in DT.

**a) Systems**

- Successful DT relies on integrated systems, sound processes, and proven technology to overcome barriers and ensure accuracy in implementation was the combined view of 15 of the interviewed participants.

**b) Processes**

- 13 participants conceded that DT uses technology to streamline operations, enhance decision-making, and improve overall business performance by converting data into actionable insights.

The relevant participant code detail and quotations are captured in table 20 below:

*Table 20: Sub-theme 2.4 code details and quotations*

Participant	Company	Role code	Description of quote
3	A	A	"I think here we are people centric we depend on people. So with the cultural resistance and the legacy systems being particularly challenging"
11	B	E	"right equipment, making it more easier for people to understand simple technology, even ours system that we're using for, for feedback"
16	B	D	"And I also think that there are fundamental limitations to a digital platform that sometimes are a barrier and you need to design a digital environment very well in order for it to replace a non digital system."
6	A	D	"digitization where there's enough equipment and most equipment is now giving you data and it is now sort of incompatible with the manual person paperwork process running that. So it is a natural conclusion or progression that our business processes start building on top of the base layer data and give you the manager, the supervisor, the executives, all of them a digital view and a digital process to just continue with this this data."

**5.4.4.5 Sub-theme 2.5: Structural organisational digital maturity**

This sub-theme considered structural ODM inclusive of organisational structure involved in DT.

**a) Structure**

- 7 of the participants converged on the notion that transitioning to an agile organisational structure is vital for successful DT, enabling efficient communication and streamlined processes.

The relevant participant code detail and quotations are captured in table 21 below:

*Table 21: Sub-theme 2.5 code details and quotations*

Participant	Company	Role code	Description of quote
4	B	B	"agile organization structure and I'm not. And that's also applicable to the. Mine structure. But in practice, it's still a very, very hierarchical structure which makes red typea issue."
1	B	A	"We converted some traditional artisans and we look for new skills. I'm now talking at the operational level. We should talk about technicians that did certain things at varsity so they structure also needs to be put in place, because if you do this thing and you don't have the structure to implement it, it's not going to work."

### 5.4.5 Theme 3

#### Digital transformation is key for business improvement outcomes

Through theme 3, the following in terms of research questions were addressed:

- **Main research question:**

What are the critical OC phenomena that could support DT towards improved business outcomes in the South African mining industry?

- **Relevant sub-research questions:**

- a) Sub-research question 3: What are the opportunities of DT to enable improved business outcomes?
- b) Sub-research question 5: Why is DT key for improved business outcomes?

As per theme 3 the following findings were considered:

- 15 participants stressed the pivotal role of DT in revolutionising business outcomes, emphasising its importance for operational efficiency, error reduction, resource optimisation, and meeting customer expectations.
- 16 participants suggested that DT also fosters a cultural shift, influencing safety practices, HR strategies, and organisational structures, driving a data-driven ecosystem.
- 16 participants yielded that through DT, organisations leverage data for improved decision-making, safety, and efficiency, despite technical challenges. Integration of technology and data analytics highlights transformative impacts and opportunities for continuous improvement.
- Organisations are actively developing engineering-focused mobile applications to improve maintenance processes, emphasising talent retention, relevance, and a strong technology foundation for sustained growth in a dynamic market. This view was constructed from 6 participants.
- 3 participants had the combined view that DT enhances business outcomes by enabling remote operations, reducing human-machine interface, and optimising performance, with a focus on quality, cost, safety, delivery and morale, resulting in informed decision-making, high employee morale, and increased efficiency and competitiveness through timely decision-making from any location.

- Finally, 3 of the interviewed participants conceded that digital integration harnesses data to facilitate cohesive master schedules, flattening information hierarchies, and ensuring comprehensive and efficient operations through consolidated workplace information.

The relevant participant code detail and quotations are captured in table 22 below:

Table 22: Theme 3 code details and quotations

Participant	Company	Role code	Description of quote
2	A	C	"So you've got this plethora of information that gets summarized into a 1 pager for a mine overseer and it can make informed decisions."
1	B	A	"Real time decision making that's that's what you get. And quicker in terms of response, which is under a convenience, you respond quicker to certain things in real time. You easily affect the results now."
10	B	C	"So the efficiency comes in the sense that if everything is digital and it's systematic you, you don't really have to be frustrated by not finding information correctly, not knowing where to get it, not knowing who to consult because everything is just in a click of a button and everything is already packaged for you to be able to work."
3	A	A	"digital transformation can significantly improve operational efficiency by optimizing the workflow and reducing manual error."
4	B	B	"yes. Uh, it's because of the potential of technology. That's it's there, but it's also not just improved business outcomes, but it's still to sustain improved business outcomes for you, you, you lift the level that you're operating on through digital transformation."
15	A	B	"But if you drive digital transformation, it will certainly improve your outcomes."
17	A	D	"The first thing I think I want to say is that if you don't, adapt with the times, you gonna fall behind. I mean, competitors will have an advantage"
3	A	A	"And digital transformation can significantly improve operational efficiency by optimizing the workflow and reducing manual error. Because you know, if it depend on people manually, there will be errors definitely where you have people, there will definitely be errors and thus leading to a better utilization of resources and enhanced profitability."
1	B	A	"It's purely because of digital. So you can operate remotely because of this and the fact that you can operate remotely, it means you reduce human machine interface, you improve your safety, you improve performance, you can improve the extraction of your ore body because you leave some of the ore body underground because you want to make sure there is a safety aspect."
14	B	A	"I will say you know it digitally transformed you know organization you know you will then definitely be able to have a high. A morale in that in that in that organization, high morale, which will definitely give you positive results, you know cause you know you will have your staff well informed to then be able to take a decision and that decision can be taken wherever the person is"

#### 5.4.5.1 Sub-theme 3.1: Improved productivity

- 12 participants suggested that organisations are embracing DT to enhance productivity through automation, optimisation, and real-time monitoring.

#### 5.4.5.2 Sub-theme 3.2: Improved safety

- DT in mining enhances safety, optimises efficiency, and boosts productivity through remote operations and real-time data utilisation. This was the combined view of 12 participants.

#### 5.4.5.3 Sub-theme 3.3: Improve quality

- 5 participants yielded that organisations' commitment to DT is clearly reflected in its data-driven approach, enabling real-time monitoring and immediate course correction

for quality improvement, further leading to enhanced efficiency and productivity across operations.

#### 5.4.5.4 Sub-theme 3.4: Reduce costs

- DT and real-time monitoring, leveraging equipment tags for immediate failure detection and informed decision-making, significantly cut costs and, delivers substantial savings amidst energy crises. This view was constructed by 5 participants.

#### 5.4.5.5 Sub-theme 3.5: Improved sustainability

- 7 participants had the combined view that DT is essential for advancing sustainability in mining, fostering safety, efficiency, and community involvement through advanced monitoring, safety standards adherence, and sustainability prioritisation, ultimately enhancing brand image, market value, and proactive decision-making based on real-time information.

The relevant participant code detail and quotations are captured in table 23 below:

Table 23: Sub-theme 3.1-5 code details and quotations

Participant	Company	Role code	Description of quote
9	B	E	"And and so and the obvious one would be uh tons, right. So which is productivity? So because you are transforming towards the digital world where everything is more efficient and you can see, let's say you see, see breakdowns"
10	B	A	"So there is no doubt that we benefit from the results were trying to measure, it's improved productivity, improved everything"
3	A	A	"It is very, very, very fundamental and we actually saw some sort of a shift in our safety performance where we are now doing much"
6	A	D	"So for my safety point of view, I think it's quite obvious then. Now you can have, uh, a quick turn around time for your interventions. Uh, and that should translate to improved safety."
16	B	D	"Umm, but what we are realizing now is that at for us to meet our essentially production carbon level demands in combination with the quality, we have a information processing need that is above what you can expect from people. And therefore there is no doubt that we need to go to a digital platform where in real time we can analyze information"
1	B	A	"the quality of ore body in relation to how we make the end product. Uh, so the customer requires quality coal in order to make their own product and there infrastructure or their equipment is very sensitive to what we provide."
17	A	E	"this technology is actually helped us to reduce our costs and significantly. I mean, I think that's way wire the mine and getting information in real time has played a big role"
1	B	A	"from asset perspective. We are now able to access the tags on equipment. A critical equipment I'm talking to monitor the condition of the machine in real time. You're able to understand what is the current in that machine doing what is the vibration in that machine doing, and then you react quicker and you are able to and you know prevent components from failing. And that's the cost aspect of it."
3	A	A	"It's an encompassing the enhancement of safety measures and adherence to regulations, as well as prioritization and sustainability throughout the implementation of improved environmental management. And in addition, our efforts in transformation and compass, the enhancement of risk management capabilities, uh and the reinforcement of in actually in transformation and compass it encompass the enhancement of the risk of management"
3	A	A	"the integration of advanced monitoring became essential to uphold the safety standards and employee well being, you know aligning this with an overarching lead to enhance the sustainability and mitigate the environmental impact."

## 5.5 Summary of findings

A high level view of the findings in theme 1 suggests that, DT impacts, influences and depends on an aligned and integrated approach, spanning the entire organisation, as clear interdependencies exist between OCP and OC/OD elements for successful DT. Furthermore, from the theme 2 findings, ODM emerges as a crucial player and determinant in DT as it spans across all the OC/OD elements and, determines not only the readiness for DT, which impacts adoption and success rate, specific to different levels or stages of DT, but also the extent and scope of DT. In both themes 1 and 2, critical OCP barriers and enablers emerge that directly impacts the DT journey, value realisation and ultimately the success of DT. Finally, it is clear from the findings in theme 3, that DT is key for improved business outcomes, highlighting improved efficiency and decision-making. These findings are summarised in tables 27, 28, 29 and 30 below.

### 5.5.1 Summary findings on barriers and enablers

Opportunities was omitted from the summary as they were included and part of the theme 3 which focussed on improved business outcomes.

Barriers and enablers extracted from themes 1 and 2 are summarised in table 24 below:

Table 24: Summary of barriers and enablers

Barriers	Comment	Enablers	Comment
<b>Inadequate digital strategy and approach</b>	Atomistic, isolated, rigid and over-optimistic (Rushed) approach, not part of core strategy, low priority	<b>Adequate digital organisational strategy and approach</b>	Agile, long-term view, measured, inclusive, aligned, integrated, resourced
<b>Low digital competencies</b>	Lack of digital skills, knowledge, education, aptitude, literacy, understanding	<b>High digital competencies</b>	Adequate digital skills, knowledge, education, aptitude, literacy, understanding
<b>Immature digital organisation</b>	Digitally disabled, isolated, unstable, unstandardised (Processes, systems, data), no digital foundation/base with manual, limited and inaccurate data	<b>Mature digital organisation</b>	Digitally enabled, integrated, agile (Processes, systems, data) with rich, accurate and relevant real-time data
<b>Inadequate digital capability</b>	Outdated, incompatible, incapable digital infrastructure	<b>Adequate digital capability</b>	Modern, intelligent, capable, reliable, stable digital infrastructure and technology
<b>Immature digital organisational culture</b>	Closed, traditional, rigid, complacent, resistant, untrusting, fearful and un-innovative organisational culture	<b>Mature digital organisational culture</b>	Conducive, resilient, innovative, progressive, open, adaptive and transparent digital organisational culture
<b>Inadequate digital resources</b>	Conservative and risk averse investment, funding, capital, and low affordability	<b>Adequate digital resources</b>	Un-conservative and available investment, funding, capital
<b>Poor change management</b>	Digital overload, change fatigue, poor communication, exclusive, rushed approach	<b>Good change management</b>	Aligned, integrated, inclusive, realistic, measured, collaborative, agile, customer-centric
<b>Low collaboration</b>	Lack of collaboration and alignment with unions, regulator, suppliers, developers, companies and,	<b>High Collaboration</b>	Active R&D, consult, share, learn, partner and work with (Internal and external) teams, departments, business units, companies, institutions,

	unreliable external dependencies		regulator, councils and universities
<b>High organisational resistance to change</b>	Un-willingness or restrictive to change, transition and transform, maintain the status quo, perception of employment uncertainty (Retrenchment), lack of understanding (Benefits/value/intent)	<b>Mature digital leadership</b>	Transformational, visionary, influential, digital, engaged, open, agile, innovative
<b>Organisational short-termism</b>	Short-term incentives, metrics, contracts, accountability, lack of vision and long-term thinking, short-term return on investment (ROI) expectations, instant result driven industry	<b>High dynamic capabilities</b>	Sense (Internal and external trends and opportunities), seize (Develop and implement solutions), transform (Extract/realise value and reconfigure resource base)
<b>Lack of digital need or benefit</b>	Lack of organisational need, inability to identify potential, opportunities and trends	<b>Adequate digital structure</b>	Strategic digital department to identify opportunity and drive innovation throughout the organisation, transition/introduce digital workforce skills (labour/leadership)

## 5.5.2 Summary

Chapter 5 presented the findings per themes and sub-themes.



## **6 Chapter 6: Discussion of findings**

In this Chapter, the findings presented in Chapter 5 were be discussed in relation to the literature review in Chapter 2 and the research questions in Chapter 3. The discussions were grouped per theme as per Chapter 5. A discussion on the general findings was also included in this Chapter. Finally, a summary of the discussions is included at the end of the Chapter.

### **6.1 Discussion on general findings**

The general findings regarding the view that DT is a multi-dimensional, long term and continuous journey which strategically revolutionises the organisational agrees with the views of Leão and da Silva (2021), Verhoef et al. (2021) and Van de Ven (2021). Findings suggesting that a continuous and frequently changing global environment, largely due to 4IR, geo-political events and new digital technologies, triggers DT to enhance competitiveness, customer satisfaction opportunities and, to survive and remain relevant in a digital era, supports the views of Alkhamery et al. (2020), Hanelt et al. (2021), Hvidsten et al. (2023) Paine and Delmhorst (2020), Peng et al. (2021), Van de Ven (2021), Vial (2019) and Warner and Wäger (2019).

Furthermore, the findings on the view that DT requires a greater transformational effort throughout the entire organisation as it disrupts, depends, affects and is effected by multiple aspects of the organisation (Hereafter referred to as OC and OD elements), agrees with Leão and da Silva (2021) and Verhoef et al. (2021). Moreover, due to many unknowns, uncertainty and digital immaturity surrounding the phenomenon, organisations should be more agile and adaptive to navigate complexities and continuously innovate as DT evolves throughout the organisation. This opinion agrees with Alkhamery et al. (2020), Hanelt et al. (2021), Peng et al. (2021), Vial (2019) and Warner and Wäger (2019).

Findings suggest confusion with the terms digitisation, digitalisation and DT supporting positions held by Ben Slimane et al. (2022), Hanelt et al. (2021), Leão and da Silva (2021) and Prokopenko et al. (2020). However, deeper probing for expansive understanding, revealed that digitisation and digitalisation forms part of the greater DT journey. Digitisation represents the first, and most basic, stage of DT where data is generated through digital technologies and devices still mimicking the traditional processes. Digitalisation is dependent on digitisation and represents the second, more advanced stage, of utilising data and digital capabilities to modify business models, processes and systems slightly within organisational boundaries for incremental value enhancement. Findings further suggest that DT is dependent on, and inclusive of both digitisation and digitalisation, which represents the third, and most

advanced stage, where digital capabilities are integrated and leveraged throughout the entire organisation to completely revolutionise and modernise the business by embracing digital for long term success, creating new value and growth paths. This deduction aligns with Verhoef et al. (2021) in terms of stages of DT.

Finally, most participants viewed DT as a long and difficult journey as it requires large upfront financial investment, dependant on multiple organisational change phenomenon and only yields significant return on investment in the long run, which can substantiate the argument of Alieva and Powell (2023) that lack of resources are among the main reasons for not adopting new technologies.

## **6.2 Discussion of findings for theme 1**

The discussions below unpacks and relates theme 1 findings to the literature reviewed in Chapter 2. The key findings of theme 1 is discussed, followed by discussions on sub-themes of theme 1.

### **6.2.1 Discussion of key findings for theme 1**

It is clear from Chapter 5, that theme 1 focusses on the relationships, interdependencies and influences of various OCP, not only between different OCP, but also between OCP and OD elements within the organisation. The balance, alignment and integration of these OCP and OD elements with the organisational approach to DT greatly influences not only the DT process but ultimately, the value generated from DT efforts over time. The findings further emphasises the essential interconnectedness of organisational elements in facilitating DT for enhanced business outcomes. It asserts that various aspects, including organisational change phenomena, are intricately linked. These findings supports the view by Hanelt et al. (2021) on organisational absorption of digital technologies interacts with organisational antecedents such as organisational and managerial characteristics. It further supports the argument of Alkhamery et al. (2020) that various OC objects are crucial to take into account as they have an impact on the entire organisational and operational structure.

Furthermore, a hierarchical relationship is suggested among factors such as organisational culture, structure, and people, highlighting their interdependence. Despite recognising the unpredictability of human behaviour, the findings affirms that, with the right organisational culture and structure, people will align with the direction of DT. This finding supports the arguments of Alkhamery et al. (2020) on organisational transformation, specific to business operations and culture, as a necessity for successful DT. It further supports the argument of Warner and Wäger (2019) that strategic renewals of organisational business models, a

collaborative approach and the organisational culture determines the extent of DT. In terms of organisational structure, findings agrees with Alkhamery et al. (2020) that various OC objects, in addition to digital technologies, are crucial to take into account as they have an impact on the entire organisational and operational structure. In terms of people, findings supports views from Alkhamery et al. (2020), and Alieva and Powell (2023), that human factors are essential to the success of OC.

A phased approach to digitisation is advocated, aligned with business model maturity. The interconnectedness of strategy, business model adjustments, and full-scale digital implementation is stressed. The significance of an integrated approach was underscored, taking into account long-term goals, data-driven decision-making, and the breakdown of siloed operations. Inclusive of OC and OD elements and, a sequential strategy-focused approach was recommended for optimal DT results. These findings supports views from Arnold & Wade (2015) and AlNuaimi et al. (2022) regarding a holistic, integrated and systematic approach to DT.

The critical role of integrated systems and processes in successful digitalisation is highlighted. DT is deemed valuable when built upon a foundation of sound, simplified, and integrated systems. This finding supports the view of Bruyns (2022), where it is attested that digital solutions deliver optimally when integrated into the existing systems adopted at the mine to obtain high safety and productivity performance and, long term sustainability.

Relying solely on advanced technologies like AI or digital tools is cautioned against, with an emphasis on comprehensive, people-centric approaches. Again supporting the views of Alkhamery et al. (2020), and Alieva and Powell (2023), that human factors are essential to the success of OC.

Barriers to DT, includes challenges in co-developing technologies, employee frustration or resistance, and cultural miss-alignment, are discussed. The finding on resistance supports the views from Vial (2019), Warner and Wäger (2019) and Alieva and Powell (2023). Findings on cultural barriers supports views from Verhoef et al. (2021), Vial (2019) and Alkhamery et al. (2020). Operational and compatibility challenges arising from integrating modern technology with outdated systems are acknowledged, necessitating phased implementation aligned with business processes.

The importance of robust change management, including the removal of legacy systems, is stressed to ensure a homogeneous environment. Findings supported views from Stouten et al. (2018) and CFI (2023). Furthermore, addressing data quality, well-defined business processes, and proper procurement processes is highlighted for successful digitalisation. This finding supports Hanelt et al. (2021), by including processes into organisational characteristics impacted by the absorption of new technologies. Challenges in adopting technology into manual, labour-intensive industries, such as mining, are acknowledged, emphasising the need for gradual training and technology simplicity. This finding points to Ellström et al. (2021) by identifying the risk of inertia, which is common in labour intensive mining organisations.

Overall, the answer to whether OCP can support DT is a resounding “yes”, contingent on the holistic integration of various organisational elements.

### **6.3 Discussion of findings for theme 2**

The discussions below unpacks and relates theme 2 findings to the literature reviewed in Chapter 2. The key findings of theme 2 is discussed, followed by discussions on sub-themes of theme 2.

#### **6.3.1 Discussion of key findings for theme 2**

It is clear from Chapter 5, that theme 2 focusses on the role of organisational digital maturity as both an influencer and an outcome of DT. It further identifies that organisational digital maturity is broader than only considering human factors but also includes other OC elements such as technology, infrastructure, leadership, culture and data. This finding partially disagrees with the definition of Alkhamery et al. (2020) that defines organisational readiness as the people preparedness level within an organisation to implement organisational development practices. The findings suggest that in the context of successful DT in the mining industry, achieving digital maturity and readiness is foundational. This involves aligning DT phases into the operating model of the organisation, emphasising enhancement over replacing weak foundations. This finding partially agrees with the view of Alkhamery et al. (2020) that many DT efforts fail as a result of a non-digital culture, which necessitates the need to promote internal readiness for change.

The findings emphasises the crucial need for continuous DT within the organisation, with a specific focus on leadership, strategic alignment and DC's. The findings further underscores the importance of leaders staying informed about market trends and technological advancements, indicating a commitment to a comprehensive organisational mind-set shift. The establishment of a dedicated digital team or department with cross functional

responsibilities throughout the organisation reflects a strategic approach rather than relegating digital initiatives to an isolated group. This view coincides with Alkhamery et al. (2020) that DC's can assist the organisation to prepare for the DT strategy.

The findings also highlights the necessity of continual change, aligning technology with organisational needs, and understanding the practicality of digital solutions in real-world scenarios. The importance of external stakeholder perspectives, small-scale process improvements, collaboration with external institutions, and the integration of digitalisation into the business model are also emphasised. Overall, a proactive stance towards DT involves systematic research, engagement, and a commitment to staying informed about global technological advancements and finding internal opportunities to exploit. These findings supports the view of Ellström et al. (2021) of creating an organisation that is able to manage DT due to various digital disruptions, organisations need to focus on their capability to change (Ellström et al., 2021). Furthermore, it strengthens the argument of Alkhamery et al. (2020), AlNuaimi et al. (2022), Feliciano-Cestero et al. (2023) and Hanelt et al. (2021) that DC's plays a pertinent role in DT as it links to the pace and agility to adjust to DT and technological disruptions in organisations.

A strategic DT approach is suggested to be broken down in tiers, or phases, focussed on integrated operations, revision of the operating model and, full scale digitalisation, which encapsulates the greater DT effort. This touches on the view put forward by Verhoef et al. (2021) which suggest that digitisation, digitalisation and DT represent distinct stages of DT, where DT is seen as the most advanced stage inclusive and dependent on digitisation and digitalisation. This finding further aligns with Warner and Wäger (2019) where micro-foundations of DC's are identified as navigating innovation eco-systems, re-designing internal structures and improving digital maturity of the organisation and its workforce. The emphasis is on establishing a quality foundation through well-defined operational processes and understanding key drivers to achieve a level of maturity or readiness adequate for the imminent digital initiatives. This underscores the importance of digital maturity and the interconnectedness of strategy, resources, technology, structure, infrastructure, systems, processes, culture, leadership and people in achieving accurate results.

Furthermore, findings suggest that accurate data is critical, and addressing poor data quality is a key challenge. The integrity of digital systems relies heavily on the accuracy of input information. Implementing a comprehensive and mutually exclusive system is essential, although it's important to balance this with the potential loss of context and hindered communication when personal engagement is removed from digitised processes. This

emphasises the critical role of data maturity in DT which is a function of technology, infrastructure, systems, processes and people. Supported views from Vial (2019) and Bojesson and Fundin (2021).

#### **6.4 Discussion of findings for theme 3**

The discussions below unpacks and relates theme 3 findings to the literature reviewed in Chapter 2. The key findings of theme 1 is discussed, followed by discussions on sub-themes of theme 3.

##### **6.4.1 Discussion of key findings for theme 3**

In essence, the findings underscore the pivotal role of DT in revolutionising business outcomes. Defined as a substantial leap in the digital realm, the process is deemed crucial for enhancing operational efficiency, minimising errors, and optimising resources. DT has significantly enhanced operational efficiency, offering opportunities for improvement across various aspects. From optimising personnel efficiency to streamlining operations through predictive capabilities, the impact extends to safety, remote functionality, and quality-centric perspectives. In the mining industry, ongoing initiatives like mobile applications exemplify efficiency gains through the elimination of manual processes. It enables the strategic reassignment of human resources, improving decision-making and overall productivity. This finding agrees with Bruyns (2022) on DT improving efficiency, productivity, sustainability.

Furthermore, DT is seen as more than a strategic imperative, evolving into a comprehensive and holistic enhancement for businesses to meet customer expectations in the digital age. The benefits span improved decision-making, faster response times, and enhanced safety measures contributing to increased production. Which again agrees with Bruyns (2022). Embracing DT is portrayed as essential for managing the complexity of large organisations and ensuring continued competitiveness in an evolving digital landscape. This supports the view of Feliciano-Cestero et al. (2023) that DT could have a positive impact on safety, production and support sustainability.

Organisations are leveraging data and DT in the mining industry for enhanced decision-making. Real-time data accessibility, proactive safety measures, and streamlined operations are emphasised. The integration of technology, data analytics, and human elements is crucial. Challenges include technical complexities, but the benefits include improved efficiency, safety, and overall business performance. This supports the finding of Vial (2019) that improved organisational performance is an opportunity of DT.

Organisations are actively developing digital solutions, particularly in engineering, to enhance maintenance processes and stay competitive in the evolving market. The key elements for maintaining competitiveness are highlighted as talent retention and staying relevant. The conversation recognises the perpetual need for improvement in the capitalist world, using the mining industry as an example where technological adaptation is essential for operational efficiency and long-term viability. This finding agrees with the combined view of Alkhamery et al. (2020), Hanelt et al. (2021); Peng et al. (2021), Vial (2019), and Warner and Wäger (2019) suggesting that organisations must find ways to adapt to these changes and, innovate with new technologies in order to stay relevant, competitive and sustainable.

#### **6.4.2 Discussion of key findings for sub-themes of theme 3**

The sub-themes of theme 3 are further discussed to substantiate and justify the overarching theme 3 findings by unpacking the specific findings as it relates improved business outcomes of DT.

##### **6.4.2.1 Discussion of key findings for sub-theme 3.1: Productivity**

The findings of sub-theme 3.1, suggest that DT drives improved productivity in the mining industry. The focus is on achieving significant improvement in productivity. Real-time monitoring facilitates quick responses to issues, minimising downtime and optimising production. Digital solutions also play a crucial role in ensuring safety, preventing accidents, and enabling rapid emergency response which all directly impacts production. Overall, organisations deem DT as a fundamental strategy for achieving safety, efficiency, and profitability goals in the mining sector. This finding agrees with Bruyns (2022) on DT improving efficiency, productivity, sustainability. Moreover, it also supports the view of Feliciano-Cestero et al. (2023) that DT could have a positive impact on safety, production and support sustainability.

##### **6.4.2.2 Discussion of key findings for sub-theme 3.2: Safety**

DT in mining has significantly enhanced safety outcomes by reducing human-machine interface and fostering a proactive safety culture. Real-time monitoring, data collection, and hazard identification systems have contributed to a notable decrease in injury frequency. The integration of digital solutions has streamlined safety processes, emphasising quick interventions and improving decision-making. Automation and digital technologies, such as collision avoidance systems, enhance safety performance, while thermal cameras and data analysis contribute to fire prevention. Overall, DT not only improves safety but also optimises efficiency, reducing human exposure to high-risk areas and positively impacting productivity.

This finding agrees with Bruyns (2022) on DT improving efficiency, productivity, sustainability. Moreover, it also supports the view of Feliciano-Cestero et al. (2023) that DT could have a positive impact on safety, production and support sustainability.

#### **6.4.2.3 Discussion of key findings for sub-theme 3.3: Quality**

The emphasis on quality improvement through DT is evident in the organisation's data-driven approach, allowing for real-time monitoring and immediate course correction to avert potential disasters. The integration of digital solutions, particularly in engineering and maintenance, has streamlined operations, enhancing overall efficiency and productivity from a quality perspective. The organisation recognises the pivotal role of digital solutions in improving both employee and customer experiences, aiming for a modernised and value-added service. The need for a digital platform to support decision-making is acknowledged, given the surpassing information processing needs for production and quality control. This supported the view of Bruyns (2022).

#### **6.4.2.4 Discussion of key findings for sub-theme 3.4: Sustainability**

DT is crucial for sustainability in the mining industry, enhancing safety, efficiency, and community engagement. The integration of advanced monitoring, adherence to safety standards, and prioritisation of sustainability contribute to a positive brand image and market value. The focus on proactive decision-making, particularly in responding to emergencies, highlights the value of real-time information. The ongoing journey of DT aims to upgrade systems, address communication gaps, and optimise energy consumption, promising improved cost management. Overall, the multifaceted impact of DT extends to safety, efficiency, and community relations within the mining sector. This finding agrees with Bruyns (2022) on DT improving efficiency, productivity, sustainability. Moreover, it also supports the view of Feliciano-Cestero et al. (2023) that DT could have a positive impact on safety, production and support sustainability.

#### **6.4.2.5 Discussion of key findings for sub-theme 3.5: Cost**

The findings underscore the cost benefits of real-time monitoring through DT. Accessing equipment tags allows for immediate detection of critical machinery issues, preventing failures and reducing costs. Communication is pivotal for analysing machine performance, enabling informed decisions to cut costs. In the South African mining industry, technology has played a crucial role in achieving significant cost savings amid energy crises. This supported the view of Bruyns (2022).



## 6.5 Summary of discussions

It is clear from the discussions on the findings through themes 1 to 3, as it relates and compares to literature in Chapter 2, in most cases agrees with existing literature and in some cases builds on existing literature of DT and OC. In particular, as it relates to the research questions in Chapter 3, the findings, anchored in literature, answers the questions put forward.

As clarified in Chapter 3, the main research question, bolstered by sub-questions 1 to 5, seeks to understand:

- The critical OCP, mining organisations in South Africa, should consider in preparation of, and during, DT to increase the probability of successful DT endeavours
- It further seeks to understand which OCP acts as prominent barriers and enablers of DT, in South African mining organisations
- Finally, the research questions seek to understand what opportunities DT can unlock to achieve improved business outcomes in the South African mining industry

From the discussions on theme 1 findings, it is evident that the integration and alignment of OCP with OC and OD elements throughout the organisation is critical for organisations to consider in their DT endeavours. More specifically, OCP pertaining to strategic, software and hardware, soft and humanistic, systemic and processual and, structural elements of the organisation (Hereafter referred to as the 5S's) must be considered. The 5S's include, organisational strategy, resources, technology, infrastructure, people, organisational culture, leadership, systems, processes and organisational structure. Moreover, apart from the fact that all OCP pertaining to the 5S's significantly influences and affects DT outcomes, the key take away from theme 1, is that they are interdependent and reliant on each other which necessitates a holistic, integrated and aligned approach to unlock synergies during DT for favourable outcomes. Finally, if the 5S OCP are not holistically and systemically addressed, DT efforts will be greatly impeded and restricted resulting in high organisational resistance to DT and OC efforts and, even lead to worse or negative business outcomes.

From the discussions on theme 2, it is evident that the ODM is critical for organisations to consider in their DT endeavours, as it significantly influences DT not only by indicating organisational readiness for DT, but also determines the scope and extent of DT efforts. Again, ODM touches all aspects of the organisation, referred to as the 5S's, in further support of the findings in theme 1. Therefore, organisations in the South African mining industry, should focus on the 5S's in terms of OCP and ODM to support DT for improved business outcomes.

Finally, from the discussions on theme 3, it is evident that DT is key for mining organisations in South Africa to achieve improved business outcomes. The discussions particularly indicated that a marked improvement on decision-making, as a result of broadly accessible relevant, in-time, or, real-time data throughout the organisation. In labour intensive organisations like mining, even the smallest improvement in decision-making directly impacts the bottom line. DT further yields significant improvements in operational efficiencies, also driving productivity improvement. DT was identified as a substantial advancement in the digital realm, enhancing operational efficiency, minimising errors, and optimising resources. Efficiency gains include personnel optimisation, streamlined operations through predictive capabilities, and improvements in safety. Improved safety, quality and cost, among other, further emphasises DT as a key business improvement driver. The findings underscored DT's importance in managing the complexity of large organisations and ensuring competitiveness in a changing digital landscape.

After the findings were deliberated and discussed the following condensed summary of barriers and enablers were constructed in table 25.

*Table 25: Summary of critical OCP as barriers or enablers*

<b>Critical OCP as barriers or enablers</b>
Internal and external collaboration
Organisational digital maturity and readiness
Alignment/ Integration of OCP with 5S's
Adaptability/ Resistance to change
Dynamic capability
Change management

## **6.6 Summary**

Chapter 6 deliberated and discussed the findings extracted from Chapter 5 with literature in Chapter 2. In Chapter 7, will focus on recommendations, learnings and limitations and, finally, close out and conclude the study.

## **7 Chapter 7: Recommendations and conclusion**

In this chapter, recommendations and conclusions based on the discussions in Chapter 6, as the themes generated from the findings in Chapter 5 relate to literature in Chapter 2, are put forward. Chapter 7 encapsulates the preceding chapters by providing implications, recommendations, learnings and limitations. Finally, a conclusion to the study is provided.

### **7.1 Introduction**

The rapidly changing external environment, primarily due to 4IR, geo-political uncertainty, novel digital technologies and a declining South African mining industry, as well as internal business improvement goals, largely due to operational inefficiencies, inadequate safety and productivity performance, reactive organisational cultures and sustainability challenges, served as the catalyst for the study. Several studies have examined DT in a global context, however limited studies on DT have been conducted in traditionally non-digital industries such as in South African mining, with its unique contexts.

Therefore, this study aimed to gain insights and deeper understanding of OCP as inputs into DT strategies and organisational readiness frameworks for higher success rates of DT and, improved business outcomes. Moreover, in the mining context, such outcomes may allow for improved safety, production and sustainability.

From the discussions of findings in Chapter 6, key elements were identified as important for organisations to consider in preparation of and execution of DT.

The key points to be elaborated on under recommendations and take-aways were:

- Holistic Integration of OCP with OC and OD Elements
- Focus on the 5S's in OCP and ODM for DT Success
- Leverage DT for Improved Decision-Making and Operational Efficiency
- Mitigate Resistance through Comprehensive OCP and ODM Implementation
- Embrace DT as a Key Driver for Business Improvement

### **7.2 Implications of the findings**

Findings of this study proved to have both theoretical and business implications.

### **7.2.1 Theoretical**

This study has confirmed the existing body of knowledge and has obtained insights through this study to enhance the literature and thinking on this topic.

### **7.2.2 Business**

South African mines are modernising. In this drive toward modernisation, DT is inevitable for improved health, safety, productivity and sustainability (MineralsCouncilofSouthAfrica, 2023; Pelders et al., 2019). DT efforts often fail, as many organisational factors must be considered and addressed for the transformation to be successful (Vial, 2019). In spite of the imminence and importance of OC and DT, approximately 70% of OC efforts fail (Bojesson & Fundin, 2021; Supriharyanti & Sukoco, 2023; Zhang et al., 2020). Organisations tend to rush into DT without considering various organisational and technological change phenomena resulting in expensive DT failures (AlNuaimi et al., 2022).

Therefore, findings from the study became relevant for South African mining organisations. Recommendations provided in this chapter may be considered by mining companies for effective DT.

## **7.3 Recommendations and strategic take-aways for business**

It is evident that DT impacts, influences and depend on various aspects throughout the entire organisation, which emphasises that all stakeholders in mining organisations need to understand the greater transformational effort DT requires, beyond a narrow, and isolated, technology adoption focus. Therefore, mining organisations need to understand their needs and opportunities regarding DT in order to scope, prioritise and measure their DT efforts. Furthermore, deliberate and swift action from organisations are recommended to develop and institutionalise enablers of DT in order to counter-act the barriers to not only streamline DT efforts but also to bolster the probability of success and value creation.

Based on the study's findings, several recommendations can be derived for organisations in the mining industry looking to enhance their digital transformation efforts.

### **7.3.1 Recommendations:**

Organisations are encouraged to adopt a holistic approach to integrate and align OCP with OC and OD elements. In addition, organisations should prioritise the 5S's (strategic, software and hardware, soft and humanistic, systemic and processual and, structural elements of the organisation) in both OCP and ODM to support DT efforts.

Furthermore, organisations should actively invest in DT initiatives to enhance decision-making capabilities by providing broadly accessible relevant, in-time, or real-time data throughout the organisation. A further recommendation was that organisations need to recognise that resistance to DT and OC efforts can arise if the 5S OCP and ODM are not holistically addressed.

Finally, organisations were encouraged to embrace DT as a key driver for business improvement, emphasising its role in managing the complexity of large organisations and ensuring competitiveness in a changing digital landscape.

### **7.3.2 Strategic take-aways:**

A key takeaway from this study was the interdependence and interconnectedness of the 5S's during DT. Further in support of the above, DT requires strategic intent and development of digital strategies which are core to the business focussed on an agile, dynamic and continuous approach that holistically treat these elements as interconnected components to unlock synergies for favourable DT outcomes.

Furthermore, the study revealed the critical role of ODM in indicating organisational readiness for DT and, in many ways, determine the scope of DT efforts. In support of this the alignment of ODM with OCP, focusing on the 5S's, can provide valuable inputs to design a strategy and approach to DT.

Another key takeaway was the significant impact DT has on decision-making throughout the organisation, especially in labour-intensive industries like mining. The improved decision-making capacities produced by successful DT further bolsters organisational excellence improvements through other significant efficiency gains that could be obtained from DT.

Similarly, focussing on ODM and OCP related barriers and enablers would address and systemically help mitigate resistance throughout the organisation and facilitate smoother DT implementation, and prevent negative business outcomes.

A final key takeaway was, if DT is leveraged to drive business improvements, it could unlock efficiency gains, personnel optimisation, predictive capabilities, safety enhancements, and overall operational excellence. DT's potential was recognised to deliver tangible benefits in safety, quality, and cost.

### 7.3.3 Integrated and adapted DT framework

Chapters 1 and 2 have provided frameworks relevant to this study, and it was indicated that the frameworks provided will be adapted further based on the study findings. The discussion from 7.3, as per the key elements and recommendations made, have been considered and incorporated in the recommended framework below. The framework may be applied as a multi-dimensional systems framework for DT.

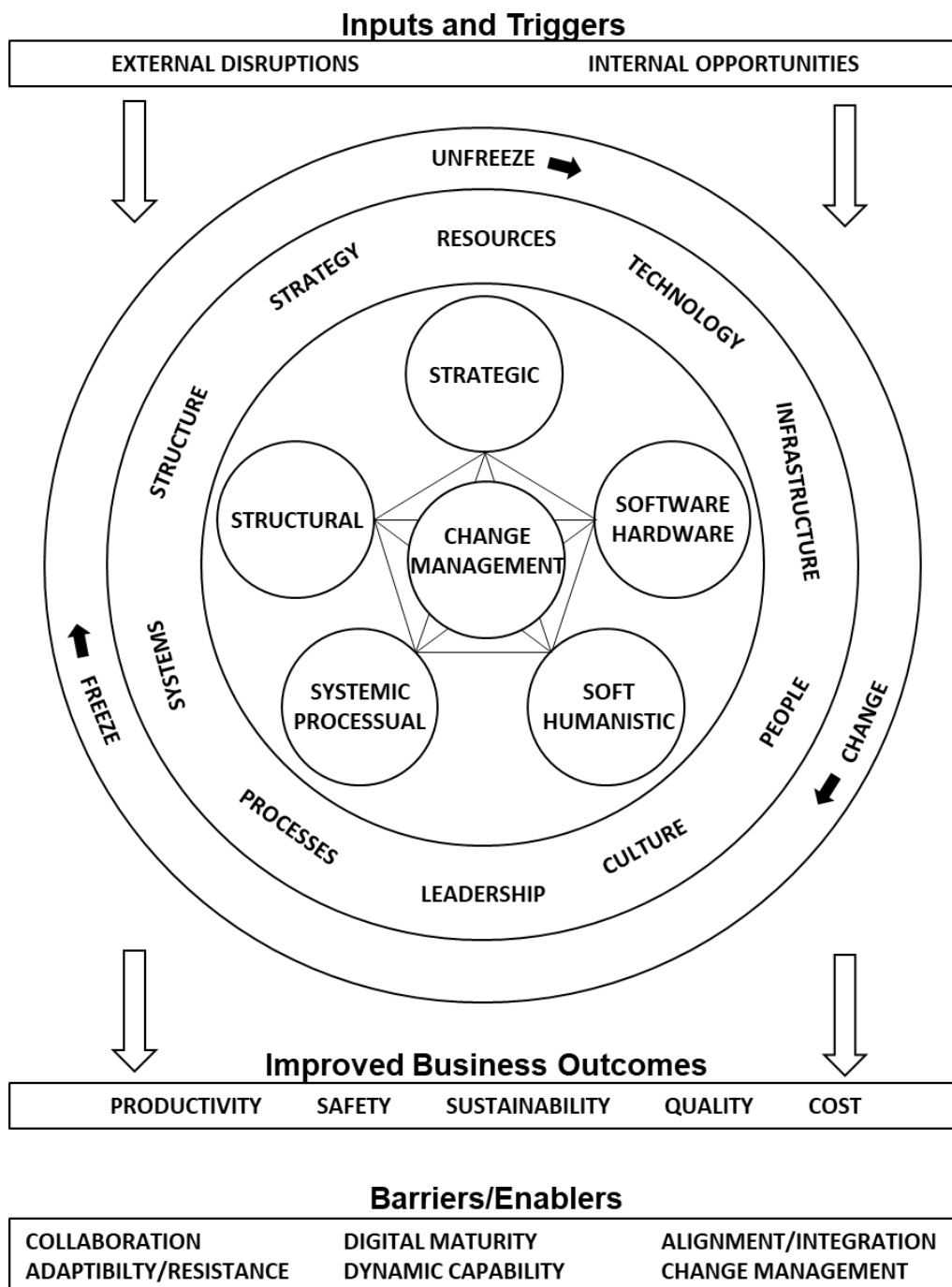


Figure 6: 5S Integrated DT model (Author source)

#### **7.4 Key take-aways for industry**

The South African mining industry could enhance DT success by adopting a holistic approach that integrates OCP with OC and OD. The 5S's if systematically addressed during DT could unlock synergies. Integration of these elements were crucial for overcoming potential organisational resistance and avoiding negative business outcomes.

Additionally, an industry focus on ODM was essential, as it influences the readiness and scope of DT efforts throughout an organisation. Industry should note of the positive opportunities DT provides on decision-making, operational efficiency, safety, quality, and competitiveness which underscores its importance for achieving improved business outcomes in the dynamic digital landscape of the South African mining sector.

Furthermore, industry could learn from this study by acknowledging the greater effort DT requires and progresses through different stages of digital maturity. On a national level, lack of understanding and resistance to change as a result of poor education and low digital literacy could be addressed and uplifted centrally to further support industry efforts.

Finally, collaboration was highlighted as a key take-away for industry which could not only act as an enabler from an alignment point of view between the regulator, institutions, unions, councils, suppliers and developers, but also from a technological development and testing point of view.

#### **7.5 Limitations of study**

This study was conducted within two underground South African mining organisations each operating in different commodity sectors. The two commodities focussed on in the study was Gold and Coal. Furthermore, 17 interviews were conducted across 5 different role categories balanced between the two companies. Finally, senior to lower management levels within the organisations were focussed on for this study.

Therefore, the following limitations to this study was highlighted:

- Limited commodity scope as more mining commodity sectors are active in South Africa
- Limited scope pertaining to the type of mining operations as opencast mining operations might have different views and experiences of DT
- Limited reach in terms of participants and role categories as only certain role categories were included and, frontline workers on execution level was excluded

## 7.6 Conclusion

The world around us is continuously changing, faster than most organisations can adapt. These dynamic shifts in digital technologies, geo-politics and pandemics, creates opportunities for, and in many ways necessitates, organisations to deploy DT strategies to survive, thrive and grow in a volatile, digital world. However, the success rates of DT and OC efforts seem dismal, partly due to the typical narrow and atomistic, technology-oriented approach to DT. Such approaches to DT greatly underestimates the broader organisation effort it deserves and requires to realise intended outcomes.

Mining organisations in South African are modernising, digitally transforming, in a response to external shifts, mostly in digital technologies, and internal challenges, largely due to marginal profits and operational inefficiencies, which relegates traditional practices and the “old way of doing things”. Limited understanding of DT and, shortage of literature specific to DT in mining drove the need to explore these phenomena for this study.

The study set out to explore and gain insights on critical OCP that could support DT towards improved business outcomes in the South African mining industry. The importance of this was emphasised by the need of mining organisations to better understand how to prepare, plan for and, implement DT efforts for improved business outcomes. Furthermore, the need to better understand which OCP acts as prominent barriers and enablers of DT for consideration into organisational strategy and business model development as well as, resource allocation and requirements for successful DT. The need to understand what opportunities DT could unlock in mining organisations for improved business outcomes was prominent.

The outcomes of the study satisfied the intent and purpose, initially put forward, to explore and gain insights on OCP and DT within South African mining organisations for improved business outcomes. It is evident that DT in mining organisations, due to high OC and OD (5S's) interdependencies, requires a wide contextual scope and high intra-organisational focus which suggests a holistic co-evolution approach to DT. In further support to this approach, the critical role of OCP integration and alignment with OC and OD elements (5S's) was emphasised throughout the study. Furthermore, the study revealed the vital role of ODM in DT, as it not only determines the scope but also influence the DT process and therefore the outcomes. The study further identified and confirmed critical OCP as barriers, enablers and opportunities of DT. Moreover, the study revealed, based on the opportunities, that DT is indeed key for improved business outcomes as it creates improved decision-making and operational efficiencies throughout the organisation, especially realised improvement in productivity, safety and sustainability.



Finally, the study provided recommendations and insights to business, leaders and scholars which enhances the understanding of the topic, explained critical aspects for organisations to consider for organisational strategy development and implementation tactics, provided a useful model to support and guide organisations, and shared relevant industry learnings to further support DT endeavours.

If executed successfully, DT has the potential to not only realise organisational excellence, but possibly save the dying mining industry of South Africa.

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## 9 Appendix A: Data gathering tool

### Interview Questions

1. What is your understanding of digital transformation and how is it playing out in your organisation?
2. Was there a need, or gap, identified for digital transformation in your organisation, if so how?
3. Was the identified opportunity for digital transformation incorporated into your organisational strategy and business model, if so how?
4. What are the barriers of digital transformation?
5. What are the enablers of digital transformation?
6. What are the opportunities of digital transformation to enable improved business outcomes?
7. Can organisational change phenomena (i.e. culture, organisational structure, leadership strategies, operating technologies, infrastructure, systems, processes and people) support digital transformation towards improved business outcomes, if so how?
8. Is digital transformation key for improved business outcomes and is it measured, if so how?
9. What are the critical organisational change phenomena that could support or impede digital transformation towards improved business outcomes in the South African mining industry?
10. In general how can organisations prepare and plan for digital transformation?

## 10 Annexure B: Company Consent form



July 2023

To whom it may concern,

\_\_\_\_\_ Mining Company

South Africa

I am currently a student at the University of Pretoria's Gordon Institute of Business Science and completing my research in partial fulfilment of an MBA.

I am conducting research on exploring critical organisational change phenomena as barriers, enablers and opportunities for successful digital transformation in the South African mining industry. I will be interviewing 6 employees, from your company, which will include senior to low level management in central as well as operational departments or business units.

Our interview is expected to last about an hour, at maximum. There are 10 questions. Participation is **voluntary, and participants withdraw at any time without penalty**. All data will be reported without identifiers. Company anonymity will be maintained at all times.

I will make direct contact with participants and schedule interviews as their schedules permit. I however do need your permission for your company's permission in this study. Please sign the consent form below, on behalf of your mining company.

If you have any concerns, please contact my supervisor or me. Our details are provided below.

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Phone	0649080043

Name and Signature of  
Executive - on behalf \_\_\_\_\_  
\_\_\_\_\_ Mining Company

Date \_\_\_\_\_

Signature of researcher \_\_\_\_\_

Date \_\_\_\_\_

## 11 Annexure C: Participant consent form

Dear \_\_\_\_\_

I am currently a student at the University of Pretoria's Gordon Institute of Business Science and completing my research in partial fulfilment of an MBA.

I am conducting research on exploring critical organisational change phenomena as barriers, enablers and opportunities for successful digital transformation in the South African mining industry.

Our interview is expected to last about an hour, at maximum. There are 10 questions.

**Your participation is voluntary, and you can withdraw at any time without penalty.** All data will be reported without identifiers. Anonymity will be maintained at all times.

If you have any concerns, please contact my supervisor or me. Our details are provided below.

Researcher name                      Jacques Fourie  
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Phone                                      0649080043

Signature of participant              \_\_\_\_\_

Date    \_\_\_\_\_

Signature of researcher              \_\_\_\_\_

Date    \_\_\_\_\_