Assessing Digital Transformation within a South African Mining Firm

Mahene Patrice Benzane

A research report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Management in the field of Digital Business

Johannesburg, 2019

KEY WORDS

- Mining Industry
- Digital Mining
- Digital Transformation in Mining
- Mining Technology
- Digital Maturity in Mining
- Digital Transformation
- Digital Transformation in Mining
- Change Management
- Digital Leadership in Mining
- Digital Leadership
- Sustainable development
- 4IR (The Fourth Industrial Revolution)
- Digitisation
- Digitalisation
- Digital Business Transformation

ABSTRACT

South Africa is still one of the top global producers of various mineral commodities, including gold, coal, platinum, palladium, manganese, titanium, and uranium. The mining industry contributes about 8% to the GDP of South Africa, and it used to be a dominant sector in the past. This industry is known to be a labour-intensive sector with little application of the digital technologies which many industries that were born after the boom of mining in South Africa are currently using. The recent example is the increasing depth of gold which tends to require technology interventions to access these resources where it is not feasible for physical humankind intervention, and this shows the need to transform the mines digitally.

The effects of various digital technologies in the mining industry due to the Fourth Industrial Revolution (4IR) phenomenon means that mining organisations can mine smarter, improve safety, reduce cost, develop new insights from their current operation, and contribute towards the sustainable economic and social development of the country. However, the required level of digital maturity, the applicable digital transformation model in terms of what to digitally transform within the mining value chain, as well as understanding the mechanism required to drive maximum adoption and successful implementation of these digital technologies across all levels of the organisation remains unclear and challenging.

In a quest to address these, a qualitative research strategy was selected as a means of getting to understand what needs to be digitally transformed in the mining value chain, this would then help identify an applicable Digital Transformation Framework for a mining firm willing to embark on this transformation journey. This qualitative approach is further used in the research to unpack the effective ways to engage various stakeholders within the organisation to help enable successful implementation and adoption of these digital technology initiatives. To do this, a single case study method was utilised and Company X was identified as an ideal mining company in which to conduct the study. Company X has embarked on a digital transformation journey which they run through an internal initiative called Digital@Comapany X, and they have been making a buzz across the

South African mining industry as the pioneers in adopting and embracing digitisation in mining, hence they were selected for this study.

Based on the reviewed literature, the research made several propositions. One of the propositions indicated that the digital transformation of the internal processes within the mining value chain is the key area of focus for a South African mining firm. The key findings from this case showed that 100% of the interviewed executives, junior managers, middle managers, and senior managers believe that the introduction of the digital technologies within Company X will lead to worker enablement through digitised processes that will eventually improve decision making by using the power of visualised data.

Therefore, according to the first proposition made, it is evident from the research that digitalisation of the internal process within the mining value chain is an important area of focus. In summary, the findings showed the following areas as what the digital transformation initiative aims to transform: Digital Capability, Human Resources, Worker Enablement, Culture, Customer Experience, Process Digitisation, Unified Data, and Performance Management. 50% of the executives indicated the importance of customer experience in their digital transformation journey. 65 % of the respondents indicated the importance of unified data by having integrated operations centres, whereas 36% mentioned performance management as the key area of focus, and only 14% of the respondents mentioned IT infrastructure to enhance digital capability as another focus area for the internal digital transformation journey.

According to the reviewed literature, it was further proposed that the Digital Piano framework is the most appropriate or relevant transformation model to be used by Company X, and can be further tested by mining firms intending to embark on a digital transformation journey. The aim was to test this proposition by comparing what to transform in practice according to Digital@Company X roadmap to what other various theoretical and conceptual frameworks focus on in terms of the digital transformation process. The findings were not entirely in agreement with the proposition made. Based on what is currently done at Company X, the combination of these following frameworks

in the context of the mining firm proves to be more appropriate than using a specific model: Digital Piano framework, Digital Orchestra Framework, Six Keys to Success Framework, Digital Enterprise Integrative Management Framework, Digital Transformation Framework, by Corver and Elkhuizen, The Digital Reinvention Framework, and the Digital Innovation Strategy Framework.

Therefore, choosing a single framework from the literature to apply to the mine as a relevant digital transformation strategy may have a dire digital transformation process or journey that leads to poor implementation, lack of adoption and wastage of resources with no realisation of intended digital benefits if it does not holistically cover various aspects of the mine or organisation as a whole. The researcher named the combination of these frameworks an Integrated Digital Transformation Framework for Mining (IDTFM).

The last proposition made in this research was that to embark on the digital transformation journey in the mining sector in the 4IR era requires the co-operation and participation of all stakeholders to ensure the successful implementation and adoption of digital technology initiatives. According to the findings, the following themes in terms of what may or may not lead to success emerged: Poor Change Management, Unclear Vision, Value Realisation, Stakeholder Involvement, and Ease of Use and Adoption.

According to the findings gathered from the 14 respondents, it is evident that there is a clear understanding of what could lead to the failure of digital technology interventions within Company X. Respondents further echoed the importance of change management, vision, stakeholder engagement, the value brought by these technologies as well as the importance of Ease of use to drive adoption. The managers have a strong interest in the practicality of any IT system implemented to drive productivity and efficiency, and the ease of use of the system is an important factor for them as key stakeholders that need to drive these initiatives at the operations. 80% of all the respondents emphasised on the ease of use. 57% indicated the importance of stakeholder involvement, and further findings showed the significance of good change management is one of the driving factors for successful implementation and adoption. In addition to these findings, one of

the two executives interviewed highlighted the importance of everyone understanding the vision of the company.

Therefore, the third proposition is validated through the research findings and literature that any lack of effective stakeholder engagement when pursuing a digital transformation roadmap or efforts within a mining firm will lead to a lack of adoption and ineffective implementation.

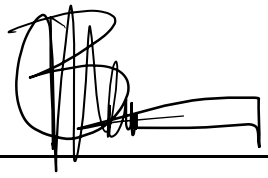
To link some of the findings to the literature, the Diffusion of Innovations Theory developed by E.M. Rogers in 1962, states that Innovation, communication channels, time, and social system are the four key components of the diffusion of innovations, and when promoting innovation to a target population, it is important to understand the characteristics of the target population that will help or hinder the adoption of the innovation. The Technology Acceptance Model (TAM) theoretical framework helps explain the usage of technology within a specific context, and the usage could either be the ease of use or the usefulness of that specific technology as perceived by the users (Venkatesh and Bala, 2008). Therefore, based on the 80% of the respondents believing that the ease of use of these technologies and the perceived usefulness in terms of practical application will lead to easier adoption indicates that TAM is accurate in the case of Company X. Therefore, the research further recommends the use and applications of these theories when embarking on the digital transformation journey of a mine.

Further to these findings, the Diffusion of Innovations Theory has been used successfully in many industries including communication, agriculture, public health, criminal justice, social work, and marketing, therefore it can also be applied in a case of a mining firm to ensure adoption of innovations brought in the form of digital technology implementations. TAM is also applicable in the context of a mining firm and must be utilised.

With the support of literature and the findings of the research, It is further recommended that the leadership team in a mining firm must create and follow an integrated digital transformation compass (Westerman, Bonnet & McAfee, 2014).

DECLARATION

I, _____Mahene Patrice Benzane__, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Management in the field of Digital Business at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Name: Mahene Patrice Benzane Signature: 

Signed at ……Centurion, Gauteng……

On the …10 th…. day of ……April…… 2020

DEDICATION

I would like to dedicate this to the Benzane Family, more especially my parents (Mario Benzane and Flora Benzane). You have raised an ambitious your man that got to understand the power and value of education at a young age. Despite you not having the privilege of formal education, I must say that growing up seeing how you advocated for education is impressive. Without that, I would probably not tasted schooling.

Thank you for believing in me and my ambitious plans. I believe Nyiko, my son and other family members will follow these footsteps and strive to set the bar even higher. Nomsa Benzane did us proud by bringing the first International Masters in our family, I hereby present you with another master's degree. This goes out to Nomsa too for motivating me.

ACKNOWLEDGEMENTS

In the beginning, it looks tough, until it is done. In every journey that we walk there are people that either make it difficult or easy for us to reach the end. This has been an interesting yet challenging journey for me. I would like to extend my sincere gratitude to the following individuals or group of individuals:

- To my Supervisor, Mr. Ashraf Patel, thank you very much for being there for me throughout this journey, from the beginning until the end. Without your commitment and being there to push and encourage me, I do not think I would have managed to complete it on time. Thank you for being a point of my accountability. Thank you for continuously sharing academic information that was relevant to my study. Words cannot explain how I appreciate your efforts and every step of the way you have taken with me.
- To my family and those closely related to me, thank you for believing in me and your continuous support, I can write a book about all of you. To KI Wa Minato, without you, I could have not coped with many aspects of this journey, I appreciate you Skeem Sam.
- To Company X, you are indeed powering possibilities. I could have not done this if you did not open your doors for me to use your company to contribute to the body of academic knowledge in the field of digitalisation in the context of mining. Thank you so much.
- To Ayanda Magida, thank you for supporting most of us throughout this research process.
- To Professor Brian Armstrong, your lectures helped me quite a lot too. Thank you for the contribution you made indirectly to my research through the content you taught.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1. INTRODUCTION

1.1 Purpose of the study

This qualitative study will explore the concept of **digital transformation** for embedding digital technologies and their applications within a South African mining firm. Company X Mining Resource company is a case study for this research. The focus of this research is on what to digitally transform through the Digital@Company X program/roadmap. The study will look at the broader application of these digital technology initiatives, and the organisational approach required to enable sustainable implementation and adoption that will embed these technologies in how Company X runs a mine.

1.2 Context of the study

The Mining industry contributed R351 billion to the South African gross domestic product (GDP) in 2018, and the sector alone employed a total of 453,543 people in the same year (Mineralscouncil.org.za, 2019). The mining sector continues to play a key role in the economy of South Africa.

South Africa is still one of the top global producers of various mineral commodities, including gold, coal, platinum, palladium, manganese, titanium, and uranium. It currently contributes 8% to the GDP, and it used to be a dominant sector in South Africa (Projectsiq.co.za, 2019).

This industry is known to be a labour-intensive sector with little application of the digital technologies which many industries that were born after the boom of mining in South Africa are currently using. The recent example is the increasing depth of gold which tends to require technology interventions to access these resources where it is not feasible for physical humankind intervention, and this shows the need to transform mines digitally (James,2019)

The study is relevant in the context of South Africa's corporate transformation in a digital world, and the sectoral analysis in the mining industry as it provides unique challenges given the sheer distance between mining operations, extraction, logistics, transport, beneficiation, and the financial markets. This long winding value chain is unique and provides a data scientist with unique perspectives that may apply to various other mining companies – in a fiercely competitive but declining industry when it comes to considering when to embark on a digital transformation journey.

Digital technologies continue to change how people live and interact across the world. Technology is changing traditional industry structures and reinterpreting what it means to be a customer and a citizen (Berman, Korsten and Marshall, 2016). The terms digitisation and digitalisation are often used interchangeably in business and academic environments to such an extent that the distinction between these two terms is not clear. Therefore, it is important to correctly define these two terms to eliminate the confusion created by diverse views held within business and academia about digitisation and digitalisation. 'Digitisation' is all about the conversion of analog information into digital information, while 'digitalisation' refers to the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to digital business.

(Kavadias, Ladas and Loch, 2016) disagreed with the idea that technology is solely responsible for the transformation of an industry. They argue that even though new technologies are often major factors, they have never been fully responsible for the industry on their own, figure 1 shows what they believe in.

(Westerman, 2017) supports their view by saying that "technology doesn't provide value to a business, but that technology's value comes from doing business differently because technology makes it possible. In the digital world, a strategic focus on digital sends the wrong message. Creating a digital strategy can focus the organization in ways that don't capture the true value of digital transformation. You don't need a digital strategy. You need a better strategy, enabled by digital."

The above arguments mean that there is a need to look at industry transformation processes holistically, and beyond just technology as the main influencing factor. Nwaiwu (2018) stated that "investigating industry transformation especially in the era of digital technologies requires a theoretical foundation that cuts across industry and academia, that harmonises positions sufficiently with a view to conceptualise and interpret developments within industry as it relates to the impact of digital technologies. This would enable a better understanding of the concerning factors that are responsible for industry transformation".

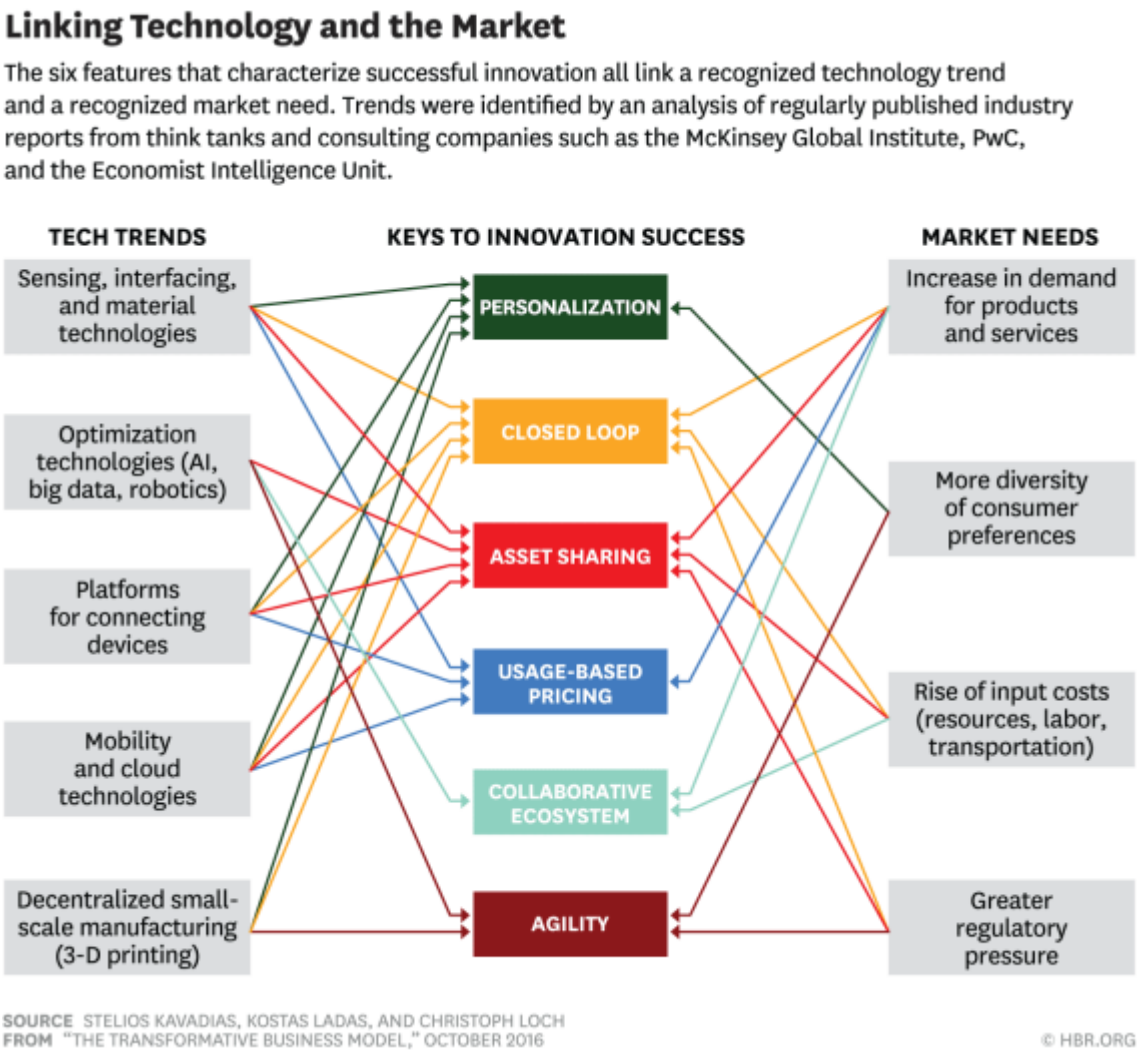


Figure 1. Link between technology and market needs.

1.3 Research problem

The effects of various digital technologies in the mining industry due to the Fourth Industrial Revolution (4IR) phenomenon means that mining organisations can mine smarter, improve safety, reduce cost, develop new insights from their current operation, and contribute towards the sustainable economic and social development of the country. However, the required level of digital maturity, the applicable digital transformation model in terms of what to digitally transform within the mining value chain, as well as understanding the mechanism required to drive maximum adoption and successful implementation of these digital technologies across all levels of the organisation remains unclear and challenging. (SAIIA, 2019). Furthermore, the mining industry has unique challenges given the sheer distance between mining operations, its extraction, the logistics-transport nexus, its product beneficiation, then exports, and the financial markets and the marketing components. An example is the coal - extracted in Emalahleni, Mpumalanga, transported to Richards Bay port, and then exported to China and India; or supplied to an Eskom power plant whereby it generates electricity for the national grid, so vital for economic development. All these elements of the local and regional value chains need to be measured in terms of efficiency and tracking for accounting purposes. This required a world-class ICT Strategy and Digital system and network to accommodate a huge multinational like Company X.

1.4 Research objectives

The research objectives will assess and apply the digital transformation journey of a South African mining company. The following objectives will be analysed:

a) To contextualise Digital Transformation of a South African mining company in the broader context of effective stakeholder engagement, technology implementation, and adoption through evaluation and application of various digital transformation theoretical frameworks.

b) Understanding the roadmap of the Digital Transformation journey (Digital@Company X Program), and it's application, and benchmark it with

proven theoretical frameworks to establish an appropriate framework for digital transformation in mining.

Analysing results of this 4IR digital transformation will help in further drawing salient conclusions for Company X approach to digital transformation and possible use by other stakeholders in the mining sector.

1.5 Research Questions

1. According to Digital@Company X Program roadmap, what are the areas of focus to digitally transform the mine (What to transform)?

    a. Exploring the most appropriate Digital Transformation Framework for Digital@Company X Program and the reasons to choose it.

2. How to effectively engage all stakeholders in the implementation of the digital transformation strategy (Digital@Company X Program) to ensure the adoption and successful implementation of digital technology initiatives?

1.6 Significance of the study

The study is intended to benefit a wide variety of stakeholders, especially senior leadership of corporate, divisional managers, regulators, unions, academics, analysts, ICT associations, 4IR Commission of SA, and business leaders interested in the latest trends and technology concept of digital transformation within the context of mining.

The following table shows the significance of this study to various stakeholders having certain roles within the company.

Table 1. Stakeholders and the significance of the study.

Stakeholder	Role and Significance of the study
Executives (e.g. CEO)	The senior executives are significant stakeholders as they are the lead sponsors of digital@Company X, and they provide the resources and budgeting. Staying ahead of the competition and constantly changing or modifying business models when required is one of the top priorities for senior executives, and this study will provide insights on how to achieve that in the digital world within the context of mining.
Senior Managers, Middle Managers, Junior Managers	They are the users of the new IT system, and they are interested in the productivity, efficiency, and ease of use of the system. This is Linked to the Diffusion of Innovation Theory in the literature review. These managers can either endorse or lead to the failure of any technology system which does not fulfil their interest as indicated above; hence they are a key stakeholder. This study will demonstrate the theoretically proven ways of getting the end-users interest in using any technology that will fulfil their needs and that of the company.

Board of Directors (BOD)	They are the Sponsors and are accountable to the shareholders. They need to comply with the Corporate Governance and King 4 code. BOD's focus on Maximising Return on Investment (ROI) to shareholders is fundamental to the concept of digital technologies unlocking shareholder value at the mines. The study is significant to these stakeholders as it provides ways in which value can be unlocked through digital transformation and still run operations sustainably.
Unions	Unions represent employees to ensure their well-being in the form of health and safety regulations is taken care of, and that employers comply with employment regulations. Unions are an important stakeholder that needs to be consulted whenever there is any organisational change in the company, either through an introduction of technology that may either positively or negatively impact their members. This study will help labour unions understand the concept of digital transformation and its applicability within the mining environment to enhance the health and safety of the employees, and the benefits it has to every union member when the mine is digitally enabled to be effective and productive.
Regulators	The Department of Mineral Resources (DMR) mandate in enforcing and ensuring mines adhere to the Health and Safety standards through various Mine

	Health and Safety Act Regulations will benefit from gaining insights on how the policies can be enhanced to force mining operations into adopting certain digital technologies which will improve the health and safety of the employees. Despite many efforts to rehabilitate mining operations, mining continues to disturb the ground through the extraction of mineral resources leaving the environment in a state not anywhere close to the virgin ground. The Department of Environmental Affairs will, through this study, develop a better understanding of how digital transformation can be used to minimise environmental impact, and how it can be used to do environmental reporting, and manage the Carbon footprint because IT makes it easy and possible to do so, even in real-time. These regulators will however not get a step-by-step way of doing it but will have an appreciation of the possibilities brought by digital transformation initiatives and goals within mining.

1.7 Delimitations of the study

This qualitative case study will focus on the Company X Resources mining company. The study will focus on the executives, senior management, middle management and junior managers within the company.

The research will be bound to the coal sector. This study will include a broader comparison of some key theoretical and conceptual digital transformation frameworks, as well as key concept analysis from the study done by Capgemini on what executives

across different industries see as the key area of focus to digitally transform their businesses (Capgemini.com, 2011). Company X not willing to share its digital framework.

1.8 Definition of terms

Information Society: The society in which the creation, distribution, and manipulation of information have become the most significant economic and cultural activity. An Information Society may be contrasted with societies in which the economic underpinning is primarily Industrial or Agrarian. The machine tools of the Information Society are computers and telecommunications, rather than lathes or ploughs.

Digital Economy: The “digital economy” is a term for all those economic processes, transactions, interactions and activities that are based on digital technologies. The digital economy is different from the internet economy in that the internet economy is based on internet connectivity, whereas the digital economy is more broadly based on any of the many digital tools used in today's economic world.

ICT Policy: Is a policy put into place by governments' and stakeholders' who are committed to the process of bringing digital technology to all individuals and communities so that they can have access to information

ICT Strategy: Is a plan of action to create an information technology capability for maximum, and sustainable value for an organization.

Corporate Governance: Corporate governance is the system of rules, practices, and processes by which a firm is directed and controlled. Corporate governance essentially involves balancing the interests of a company's many stakeholders, such as shareholders, senior management executives, customers, suppliers, financiers, the government, and the community. Since corporate governance also provides the framework for attaining a company's objectives, it encompasses practically every sphere

of management, from action plans and internal controls to performance measurement and corporate disclosure.

King Code IV: A set of voluntary principles and leading practices. Drafted to apply to all organisations, regardless of their form of incorporation

Management Information Systems (MIS): is a computer system consisting of hardware and software that serves as the backbone of an organization's operations. An MIS gathers data from multiple online systems, analyses the information, and reports data to aid in management decision-making

Digital Maturity: A snapshot of the extent to which a business has digitally transformed and is "ready" for the market in which it finds itself (Armstrong, 2019).

Digital Transformation: The process to get from the current level of digital maturity to an aspired future state of digital maturity (Armstrong, 2019).

Digital Transformation Roadmap: Is an approach to defining and managing a digital transformation effort. It provides a structured way to move through the many programs needed to realize success. The roadmap begins with an assessment of the digital maturity of the business today and moves on to a definition of a future vision.

Fourth Industrial Revolution (4IR): 4IR is the term used to describe the current and developing environment in which disruptive technologies are changing the way we live and work (It as the advent of "cyber-physical systems" involving entirely new capabilities for people and machines). These disruptive technologies include the Internet of Things (IoT), Robotics, virtual reality (VR), Augmented Reality (AR), Big Data, Cloud Computing, Blockchain, Additive Manufacturing (3D Printing) and Artificial Intelligence (AI).

- **IoT:** Is a system of interrelated computing devices, mechanical and digital machines provided with unique identifiers (UIDs) and the ability to transfer data

over a network without requiring human-to-human or human-to-computer interaction.

- **Robotics**: It is an area of the 4IR that focuses on the development and use of robots. Robots are computer-based devices programmed to perform functions ordinarily ascribed to humans. Robots manipulate objects in the physical world based on collected data and sensing of information to mimic humans, and due to their programmability nature as devices, they mostly carry out various routine or repetitive tasks.
- **Big Data:** These are extremely large data sets that may be analysed computationally to reveal patterns, trends, and associations, to help in decision making.
- **Cloud Computing:** Cloud computing is about using computer facilities, both hardware, and software that are owned by an external party. Under cloud computing, operating systems, hardware, applications and IT storage no longer reside in local premises, rather it is externally based, on the cloud, and is available on-demand.
- **Artificial Intelligence:** refers to the creation of intelligent machines that can function and reason, to some extent, like human beings in solving real-life problems. AI gives machines with the ability that enables them to adapt and learn as tasks are carried out. AI machines can perceive, learn, reason, adapt, problem solves, plan, manipulate and move objects.
- **Additive Manufacturing (3D Printing):** The 3D printing process builds a three-dimensional object from a computer-aided design model, usually by successively adding material layer by layer, hence it is called additive manufacturing. The process enables the production of complex shapes using less material than traditional manufacturing.
- **Virtual Reality:** It is the use of computer technology to create a simulated environment. Unlike traditional user interfaces, VR places the user inside an

experience. Instead of viewing a screen in front of them, users are immersed and able to interact with 3D worlds.

- **Augmented Reality:** A technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view.
- **Blockchain:** This is a shared, immutable ledger for recording transactions, tracking assets and building trust. It can further be described as a simple yet ingenious way of passing information from A to B in a fully automated and safe manner. One party to a transaction initiates the process by creating a block. This block is verified by thousands, perhaps millions of computers distributed around the net. The verified block is added to a chain, which is stored across the net, creating not just a unique record, but a unique record with a unique history.

1.9 Assumptions

- All respondents to interviews and survey questions can answer the set questions.
- Stakeholders in mining company X shall share relevant information, reports, etc in a reasonable manner
- Respondents will answer all questions honestly without any form of bias. This assumption is made based on the respondents' understanding and assurance by the author that the information will be used solely for academic purposes and that it will not put their careers at risk.
- On some interview questions, the respondents will agree to make available any form of supporting documentation or evidence to support their views. The assumption is made under a condition that any form of supporting evidence on some questions may be requested.

CHAPTER 2. LITERATURE REVIEW

2.1 Introduction

The **Diffusion of Innovations Theory** seeks to explain how, why, and at what rate do new ideas and technology spread. This Theory was proposed by Everret Rodgers. Rogers argues that diffusion is the process by which an innovation is communicated over time among the participants in a social system. Adoption is a decision of "full use of an innovation as the best course of action available" and rejection is a decision "not to adopt an innovation"(Rogers, 1982). Rogers defines diffusion as "the process in which an innovation is communicated through certain channels over time among the members of a social system". As expressed in this definition, innovation, communication channels, time, and social system are the four key components of the diffusion of innovations. When promoting innovation to a target population, it is important to understand the characteristics of the target population that will help or hinder the adoption of the innovation.

"The Diffusion of Innovations Theory has been used successfully in many industries including communication, agriculture, public health, criminal justice, social work, and marketing. In public health, the Diffusion of Innovation Theory is used to accelerate the adoption of important public health programs that typically aim to change the behaviour of a social system. For example, an intervention to address a public health problem is developed, and the intervention is promoted to people in a social system with the goal of adoption (based on Diffusion of Innovation Theory). The most successful adoption of a public health program results from understanding the target population and the factors influencing their rate of adoption."

The final result of this diffusion is that human beings, as part of a social structure, follow a brand-new concept, action or object (LaMorte, 2019). Adoption approach when someone does something different than what they should have done before (i.e., purchase or use a brand new object, assemble and execute a brand new action, and so on) (LaMorte, 2019).

The key to adoption is that the character should see the idea, behaviour or product as new or innovative. It is this way that diffusion is viable (LaMorte, 2019).The adoption of a new idea, behaviour or product (i.e., "innovation") is no longer taking place simultaneously in a social system; as a substitute, it is a method by which a few people are more capable of undertaking innovation than others (LaMorte, 2019).

Researchers have established that those who pursue invention early have different features than those who embrace innovation later on. It is very important to understand the characteristics of the target population when promoting innovation to the target population, so that one can help or obstruct the adoption of innovation (LaMorte, 2019).

Digital technologies continue to change how people live or interact with their working environment. However, there is a general lack of consensus on which theoretical framework is acceptable and enough to help companies, and digital transformation practitioners better understand the process of realising digital business transformation within an organisation.

This proposed research will strive to unpack the key concepts related to digital technologies and the transformation process to embed them in an organisation. The literature review in the next sections provides a wider view of these concepts based on prior researches conducted. Based on the reviewed literature, a theoretical framework will be chosen, and a proposition will be formulated based on this study.

According to a publication by Capgemini Consulting (Capgemini.com, 2011), the application and the use of technology to radically improve performance or extend the reach of enterprises is an ongoing and current topic of discussion for many organisations across the world. It indicates that many executives in various industries have embarked on using digital advances such as analytics, mobility, social media and smart embedded devices to improving their use of traditional technologies such as ERP to change customer relationships, internal processes, and value propositions. However, other executives realised an urgent need to pay close attention to their industry. This is prompted by an observation on the speed that digital technology disrupted media industries in the past decade. Successful digital transformation journeys focused mainly

on how to drive change from the top to the bottom, with a clear focus on how change must be driven rather than what could be done when looking at the endless opportunities presented by digital technologies.

Business leaders tend to focus their digital transformation journey across three segments of their organisation, the customer experience, operational processes, and business models. Based on a comparative analysis of literature done on journals and articles relevant to this subject, a lack of alignment between industry-based research and academic-based research about digital business transformation was established.

Nwaiwu (2018) conducted qualitative desk research using reputable business and scientific data sources by applying an academic approach to assess various theoretical and conceptual frameworks that are considered to be relevant to the subject of digital business transformation, and that contribute to expanding the general understanding of the digital transformation of businesses. The assessment conducted aimed at understanding the suitability and robustness of these frameworks in addressing digital transformation.

Based on a comparative analysis of literature done on journals and articles relevant to this subject, a lack of alignment between industry-based research and academic-based research about digital business transformation was established.

(Schmarzo, 2016) views digital business transformation as the process of “integrating the growing body of digital technologies and the resulting customer, product and operational data (insights) into an organization‘s physical value creation capabilities to yield new sources of intellectual capital (data and analytics), competitive differentiation and customer insight.”

The following conceptual frameworks, theoretical frameworks, and models are classified as being relevant to the subject of digital transformation and will be discussed in detail in the next sections:

- Diffusion of Innovations Theory by Everret Rogers
- Digital Technology Applications by Capegemini Consulting

- Six Keys to Success Framework by Kavadia et al. (2016).
- Digitisation Piano Digital Business Transformation Framework by Wade (2015).
- The Digital Reinvention Framework by Berman et al. (2016).
- Digital Innovation Strategy Framework by Nylén & Holmström (2015).
- Technology Acceptance Model (TAM)
- Digital Transformation Framework, by Corver and Elkhuizen (2014).
- Digital Orchestra Framework
- Digital Transformation Framework, by Matt et al.
- Digital Enterprise Integrative Management Framework by Bowersox et al. (2005).
- The Unified Theory of Acceptance and Use of Technology (UTAUT) Framework by Venkatesh et al. (2003).

2.2 Definition of topic or background discussion

Mining is about the extraction of natural resources from the ground, and the concept of digital mining with technology as an enabler sounds like a farfetched phenomenon. Big technology companies like Google, Facebook, and Amazon are leading international organisations in the application of digital technologies. Mining remains an industry with an opportunity to transform from the traditional ways of doing business and adapt to the new era. Key to this transformation, there is an existing opportunity to conduct an assessment of the said organisation to understand the relevance of various frameworks and models applicable to embark on a digital transformation journey.

These following concepts will be discussed in the study:

- Digital maturity
- Digital transformation

2.3 Diffusion of Innovations Theory

Diffusion of Innovation Theory, developed by E.M. Rogers in 1962, is one of the oldest social science theories. It originated in communication to try and explain how, over time,

an idea or any product gains momentum and gets to spread through a specific population. The result of this spread is that people, as part of a social system, adopt a new idea, behaviour, or product.

Diffusion research has focused on five areas:

- The characteristics of an innovation which may influence its adoption.
- The decision-making process that occurs when individuals consider adopting a new idea, product or practice.
- The characteristics of individuals that make them likely to adopt an innovation.
- The consequences for individuals and society of adopting an innovation.
- Communication channels used in the adoption process.

Rogers proposed that the following four elements influence the spread of a new idea:

- The innovation itself.
- The communication channels.
- The time.
- The social system.

Diffusion research centers on the conditions which increase or decrease the likelihood that a new idea, product, or practice will be adopted by members of a given culture. Diffusion of innovation theory predicts that media as well as interpersonal contacts provide information and influence opinion and judgment. Diffusion is the “process by which an innovation is communicated through certain channels over some time among the members of a social system”. An innovation is “an idea, practice, or object that is perceived to be new by an individual or other unit of adoption”. “Communication is a process in which participants create and share information with one another to reach a mutual understanding”(Rogers, 1982).

This process relies heavily on human capital. The innovation must be widely adopted to self-sustain. Within the rate of adoption, there is a point at which an innovation reaches

critical mass. The information flows through networks. The nature of networks and the roles opinion leaders play in them determine the likelihood that the innovation will be adopted. Innovation diffusion research has attempted to explain the variables that influence how and why users adopt a new information medium, such as the Internet. Opinion leaders exert influence on audience behaviour via their personal contact, but additional intermediaries called change agents and gatekeepers are also included in the process of diffusion.

When promoting an innovation, there are different strategies used to appeal to the different adopter categories. There are five established adopter categories, and while most of the general population tends to fall in the middle categories, it is still necessary to understand the characteristics of the target population. Rogers defines an adopter category as a classification of individuals within a social system based on innovativeness:

- **Innovators** - These are people who want to be the first to try the innovation. They are venturesome and interested in new ideas. These people are very willing to take risks and are often the first to develop new ideas. Very little, if anything, needs to be done to appeal to this population.

- **Early Adopters** - These are people who represent opinion leaders. They enjoy leadership roles and embrace change opportunities. They are already aware of the need to change and so are very comfortable adopting new ideas. Strategies to appeal to this population include how-to manuals and information sheets on implementation. They do not need the information to convince them to change.

- **Early Majority** - These people are rarely leaders, but they do adopt new ideas before the average person. That said, they typically need to see evidence that the innovation works before they are willing to adopt it. Strategies to appeal to this population include success stories and evidence of the innovation's effectiveness.

- **Late Majority** - These people are sceptical of change and will only adopt an innovation after it has been tried by the majority. Strategies to appeal to this population include information on how many other people have tried the innovation and have adopted it successfully.

- **Laggards** - These people are bound by tradition and very conservative. They are very sceptical of change and are the hardest group to bring on board. Strategies to appeal to this population include statistics, fear appeals, and pressure from people in the other adopter groups.

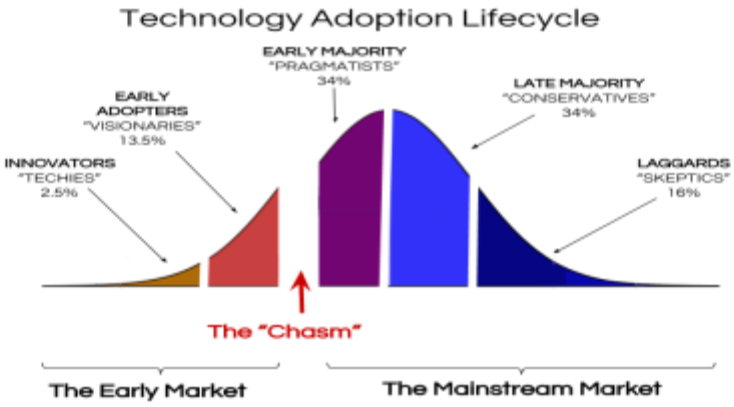


Figure 2. Technology penetration bell-curve

Rate is usually measured by the length of time required for a certain percentage of the members of a social system to adopt an innovation. The rates of adoption for innovations are determined by an individual's adopter category.

Opinion leaders have the most influence during the evaluation stage of the innovation-decision process and on late adopters. Also, opinion leaders typically have greater exposure to the mass media, more cosmopolitan, greater contact with change agents, more social experience and exposure, higher socioeconomic status, and are more

innovative than others. In regional and rural areas, more innovation takes place in communities that have stronger inter-personal networks.

Innovations are often adopted by organizations through two types of innovation-decisions:

- The collective innovation decisions.
- The authority innovation decisions.

The collective decision occurs when adoption is by consensus. The authority decision occurs by adoption among very few individuals with high positions of power within an organization. Unlike the optional innovation-decision process, these decision processes only occur within an organization or hierarchical group. Within an organisation certain individuals are termed "champions" who stand behind innovation and breakthrough opposition.

The phases in which an individual adopts innovation and in which diffusion is achieved include recognition of the need for innovation, the decision to accept (or reject) innovation, the actual use of innovation to check it, and the continued use of innovation (LaMorte, 2019).

There are 5 key factors that affect the adoption of innovation, and each of these factors play a particular role in the five adopter categories (LaMorte, 2019).

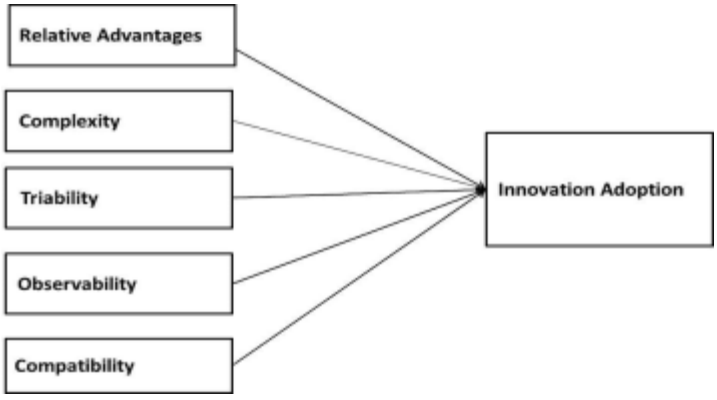


Figure 3. Personal Innovativeness and User Involvement model

Relative Advantage - The degree of which innovation is considered to be superior to the design, system, or commodity that it substitutes (LaMorte, 2019).

Compatibility - How compatible innovation is with the beliefs, perceptions and expectations of future customers (LaMorte, 2019).

Complexity - How complicated it is to grasp and/or utilize an innovation (LaMorte, 2019).

Tradability - The degree to which the product may be tested or evaluated before a decision about adoption is made (LaMorte, 2019).

Observability - The degree to which innovation provided reaches measurable outcomes (LaMorte, 2019).

To critique this theory, according to Damsgaard and Lyytinen (2001) diffusion arena, innovation, and adopter decisions are influenced by the industry structure, cultural structures, economic (macro, meso, and micro) constraint, market context, technological constraints, and technical constraints.

According to these authors, the Diffusion of Innovations Theory (DOI) falls short of the theoretical constructs that help in addressing how complex networked technologies may or will diffuse. It does not offer adequate constructs in dealing with collective adoption behaviours.

They believe that DOI researchers will have a likelihood of providing a faithful account of the diffusion of complex and networked innovations if they consider the following issues as a necessary step going forward.

- Seek to understand the local complex, networked, and learning intensive features of the technology.
- Seek to understand the critical role of market making and institutional structures in shaping the diffusion arena.
- Focus on critical process features and all key players in the diffusion arena.

- Develop multi-layered theories of diffusion that factor out mappings between different layers and locales.
- Use alternative theoretical perspectives that help extend analysis beyond questions of efficient choice.
- Good candidates include political models, institutional models, and theories of team behaviour in conflict cooperative games.
- Recognize the need for varying time scales when seeking to account for what happened and why.
- Develop theories at the site and with multiple levels of analysis

2.4 Digital Transformation Review

Digital transformation is related to the process of moving the current level of digital maturity to a desired future state of digital maturity by using technology as an enabler for new ways of thinking. This concept is related to organizational change and culture. To understand how organisations can drive change in a digital world, it is also critical to understand the organisational culture. There is a consensus that culture does exist, and it plays a significant role in shaping the behaviour of any organisations (Watkins, 2013).

Irrespective of any new or old technology an organisation is using, re-envisioning and driving change involves management and people change (Capgemini.com, 2011). Leadership is essential in the digital transformation journey.

Many transformation initiatives that failed within many companies have been linked to a poor understanding of change being a transformative process by organisational leaders and managers (Kotter, 2006).

The qualitative study done by Capgemini Consulting focussed on 157 executives and business leaders in 50 companies across 15 different countries covering a broad range of industries (Figure 1) with the exclusion of South Africa. The researcher of this qualitative study will be narrowing down the study to focus on Company X as a mining company based in South Africa. A comparison and a test on some of the findings by

Capgemini Consulting on business leaders will be done at a company level involving the board, executives, and establish any linkages of results with employees at different levels.

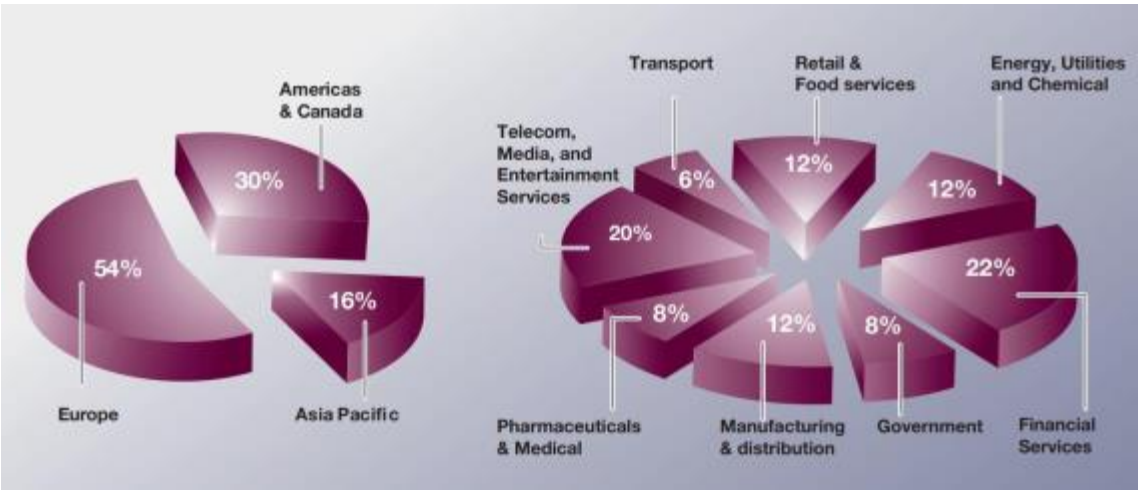


Figure 4. Business leaders Interviews conducted in various industries and countries. (Capgemini.com, 2011)

2.4.1 *Link between IT transformation and Digital Transformation*

(Capgemini.com, 2011)

According to Armstrong (2019), IT transformation is a superset of digital transformation as a key enabler and should not be confused as being the same (Figure 2)

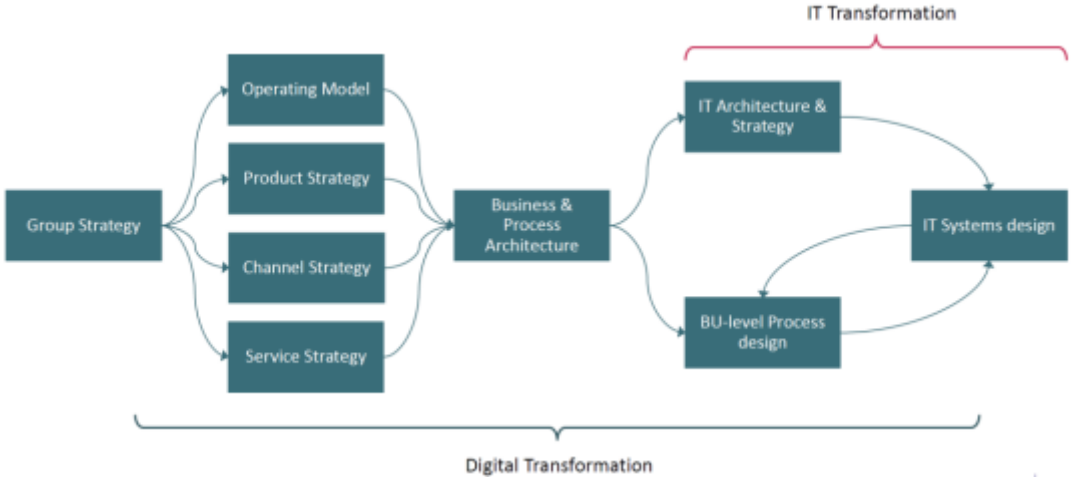


Figure 5. A way to think about digital transformation. (Armstrong, 2019)

2.4.2 *Digital Maturity and Leading in the Digital World*

Leadership in any organisation is fundamental to any form of change. Digital leadership is ‘‘a leader’s contribution to the transition toward a knowledge society and their knowledge of technology’’ (Klutz and Firlej, 2016). Digital leaders must keep up with the ongoing global revolution, and they are required to understand the technology revolutionary force as just an enabler. According to Kluz & Firlej (2016) publication on the World Economic Forum (WEF) about how to become a leader in the digital age, outlines that traditional leadership styles still exist. These styles co-exist with a mixture of other sets of skills such as being able to identify technological trends across different sectors, understanding your knowledge limitations as a leader and ways to acquire the missing knowledge through existing resources. Leaders are then required to blend these sets of skills required to lead in the digital world (Kane et al., 2019). These skills include transformative vision, forward-looking, understand technology, have strong leadership, and they must be change-oriented.

Change takes years, it is not an event, and it requires careful consideration when undertaken to avoid pitfalls because even highly skilled managers make mistakes (Kotter, 2006). According to Kotter (2006), the following steps can be taken to by leaders in the order stated to increase the probability of any change or transformative process a chance to succeed.

- Establish a sense of urgency.
- Form a powerful guiding coalition.
- Create a vision.
- Communicate the vision.
- Empower others to act on the vision.
- Plan for and create short term wins.
- Consolidate improvements and produce more change.
- Institutionalize new approaches.

Digital maturity refers to the extent to which a business has digitally transformed and is ready for the market in which it finds itself (Armstrong, 2019). It has two fundamental dimensions, leadership capabilities and digital capabilities (Westerman, Bonnet and McAfee, 2014). The two dimensions are further described as leadership & strategy, the digital enablement & adoption (Armstrong, 2019) as indicated in Figure 3. These elements provide a means of assessment on where the organisation is in terms of digital mastery (Westerman, Bonnet and McAfee, 2014).

Figure 6. Digital Maturity elements. (Armstrong, 2019)

There are four levels of digital mastery (Figure 4), the beginners, Fashionistas, Conservatives and Digital Masters also known as Digirati (Westerman, Bonnet and McAfee, 2014).

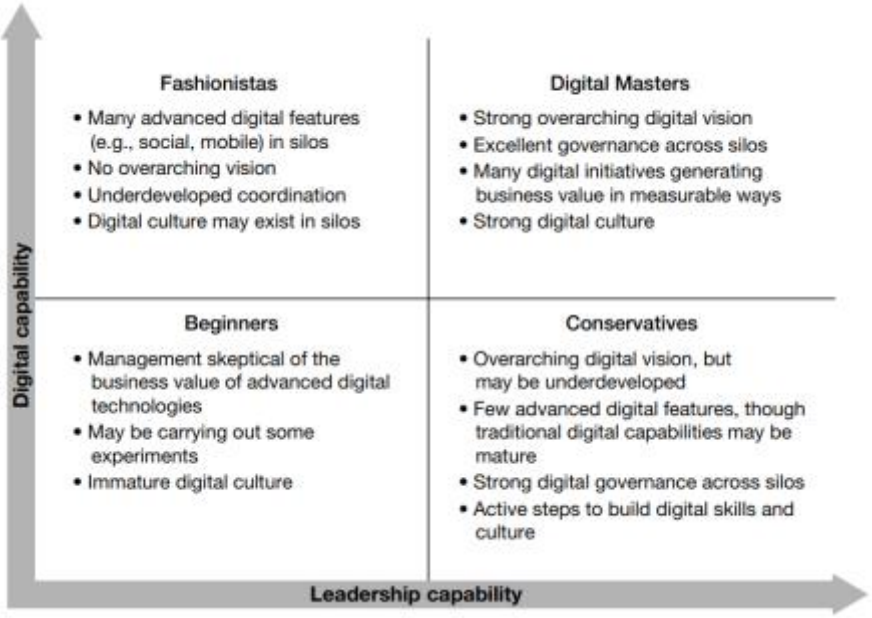


Figure 7. Four levels of digital mastery. (Westerman, Bonnet and McAfee, 2014)

2.5 Digital Technology Applications by Capgemini Consulting

Across multiple industries shown in figure 1, most business leaders tend to focus their digital transformation journey across three segments of their organisation, customer experience, operational processes, and business models (Figure 6). This model has nine critical building blocks for digital technology applications, which form part of the digital transformation journey. The pace at which different organisations are moving depends on where they are in the journey.

2.5.1 *Business Model*

Failure to change the way an organisation does business in a digital world may lead to its death. Organisations are digitally modifying their traditional businesses to remain relevant, and businesses are scaling up into a global business due to enablement brought by these technologies and the integrated nature of information, while new businesses start as digital entities form the beginning.

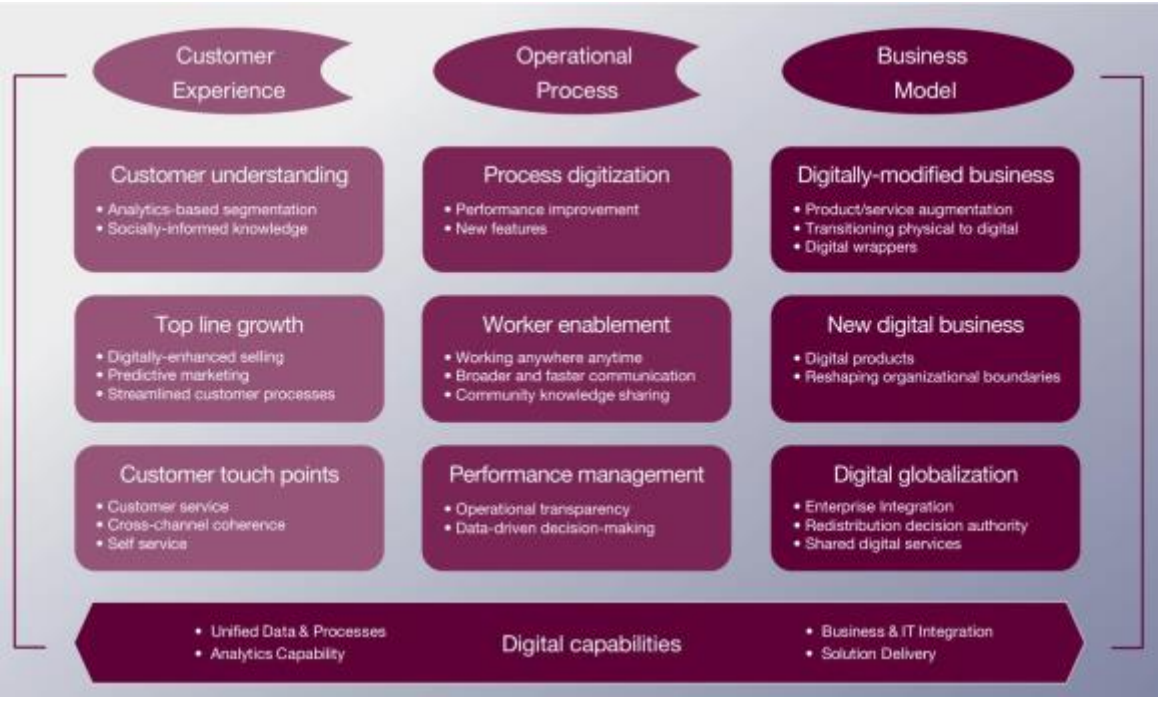


Figure 8. Three main focus pillars of digital transformation in organisations (Capgemini.com, 2011)

2.5.2 *Operational Process*

Transformation of internal processes, either through digitisation of the process in the form of automation on the nonautomated approach, forms part of the operational process improvement in the digitalisation journey. The connectivity of people brought by digital technologies enables remote working and enhances collaboration among individuals in different areas. Visualisation of work processes improves decision making, and it also increases accountability due to transparent performance management.

2.5.3 *Customer Experience*

Digital technologies are enabling companies to be customer centric. Improving customer services has become easier. An enhanced way of understanding various market segments through customer data creates a means of keeping up with what customers

need. The provision of integrated customer experience is a critical component of these digital technologies.

2.5.4 *Digital Capabilities*

Digital capabilities are the key building blocks that sit across the nine digital technology applications. The ability of digital capabilities to provide analytics helps companies become competitive in their sphere of operation. These capabilities provide the advantage of having unified data and processes by breaking down existing silos. The link between Business and Information Technology (IT) departments has become a critical component of the capabilities than ever before. Lastly, the spread of critical skills to various solution providers often makes integrations difficult, so having a strong internal IT team makes the journey of digital transformation easier.

2.4.4.1 Unified Data and Processes

A digital platform of integrated data and processes is a key technology component needed for digital transformation. Several large successful companies often operate in silos, with disparate systems, data definitions, and business processes (Capgemini.com, 2011). The first step to digital transformation for many organisations is an investment in integrating data and all processes across the entire value chain of the company. Web-based companies have an added advantage through analytics and personalisation due to integrated and unified process when compared to traditional old firms. Companies involved in multi-channel operations find it difficult to operate without a digital platform.

2.4.4.2 Solution Delivery

Due to most IT departments having solid development methods in place focused on well-defined requirements and mature technologies, the emerging digital technologies often require companies to look outside the firm for skills and capabilities to modify processes or build new methods onto the data and process. As a result of the knowledge of emerging

technologies spread across silos of several external vendors, integration often becomes difficult. Analytics also require skills that IT departments do not always possess.

2.4.4.3 Analytics Capabilities

Various executives across different industries highlight the importance of information management and analytics through data mining to create new insights (Capgemini.com, 2011). Firms with integrated data platforms and can perform analytics at different levels of the organisation and improve decision making processes or response rates to any form of change in the business. Building analytics capabilities can be an expensive exercise as it requires special skills and a change in business management. Data analytics can be a competitive advantage.

2.4.4.4 Business and IT Integration

Any firm with a lack of IT and Business relationship will find it difficult to embark on a digital transformation journey. Digital transformation requires a strong relationship between IT and business executives. A common understanding will help the IT executives recommend and suggest technology interventions that will help business executives meet their goals. Digital transformation in many companies tends to be strategically driven by the Chief Information Officer (CIO). Companies with a concrete IT/Business relationship are in a better position to start a digital transformation journey.

2.6 Six Keys to Success Framework

The Six Keys to Success Framework was proposed by (Kavadias, Ladas and Loch, 2016), it attempts to link technologies and markets, the fundamental notion being that “no new technology can transform an industry unless a business model can link it to an emerging market need.” The framework was proposed based on the outcome of in-depth analysis of 40 companies that had launched new business models in different industry segments, and an extensive review of frequently published industry reports by major

think-tanks such as PwC, EY, Mckinsey Global Institute, and the Economist Intelligence Unit (EIU).

The findings from these 40 companies were closely related with the findings obtained by Bradley (2015) in the 'Digital Vortex' framework which shows how companies in various industry segments (Figure 7) are being affected by digital disruption, i.e. "it represents the inevitable movement of industries towards a digital centre in which business models and value chains are digitised to the maximum extent" (Bradley et al., 2015).

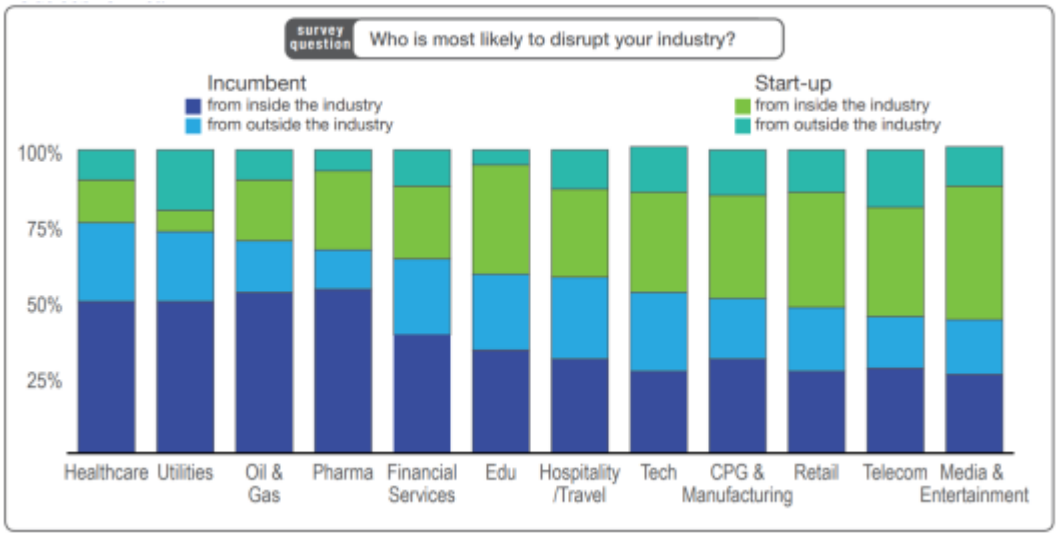


Figure 9. Disruptors in various industries.

2.7 Digitisation Piano Digital Business Transformation Framework "Digital Piano"

This framework was proposed by Wade (2015), it was also published in a report by the Global Centre for Digital Business Transformation. The framework attempts to explain how successful digital transformation must eventually lead to organisational change, which in turn, must lead to improved performance for the firm through a nexus that connects digital technologies and modern business models.

The theoretical premise for this conceptual framework is that: the application of digital technologies to achieve a successful transformation should lead to a significant organisational transformation which should cover the following areas within the organisation's structure (Wade, 2015) :

- Business model.
- Internal structure (how the company is organised).
- People (the company's human resource assets).
- Processes (how the company does things).
- ICT capability.
- Its offerings (products or services offered by the company).
- Its engagement models (how the company engages with external stakeholders).

The framework lacks sufficient empirical evidence that tests its Proposition when compared to the Six Keys to Success framework.

2.8 Digital Orchestra Framework

This framework is published through the Global Center for Digital Business Transformation (an initiative of Cisco Corporation and IMD) and it takes into consideration the following ten key areas (Figure 8) of focus that organisations should do during a digital transformation journey (Wade et al., 2017):

Figure 10. Orchestrating Digital Business Success Model.

- Offerings.
- Channels (Go-to-Market).
- Customers.
- Partners.
- Workforce (Engagement).
- Processes.
- IT Capability (Operations).
- Structures.
- Incentives.
- Culture (Organisation).

The framework seeks to address the following set of questions that are top-of-mind for the hundreds of senior executives with whom the center has engaged:

- How should we execute our digital transformation?
- Where do we start?
- What is the sequencing of actions?
- In different areas of the business, what precisely should we change, and to what extent?

The fundamental premise of this framework is that the organisation must decide what kind of value they want to create and explore strategic options to achieve it. The Digital Orchestra framework was proposed as a replacement for the Digital Piano framework.

2.9 The Digital Reinvention Framework

The Digital Reinvention framework (Berman, Korsten and Marshall, 2016) was proposed by these authors based on the notion that "for successful digital reinvention, organisations need to pursue a new strategic focus, build new expertise, and establish new ways of work." According to this framework, for traditional organisations to achieve successful digital reinvention (digital business transformation), they must pursue a fundamental

bottom-up reinvention of strategy, operations, and technology. This means the company should be maintaining an overarching focus on experience and not on productivity.
"The Digital Reinvention Framework proposes a path to achieving a digitally transformed organisation through an experience-first approach that focuses on the adoption of digital drivers (digital technologies such as cloud computing, cognitive and analytics, mobile, Blockchains, IoT, etc.), built on a foundation of three key organisational priorities that are: the pursuit of a new focus, development of new expertise, and the establishment of new ways of working".

The main limiting factor about this framework is the fact that it remains theoretical without any form of empirical evidence that tests its Proposition.

2.10 Digital Innovation Strategy Framework

The Digital Innovation Strategy is proposed by Nylén & Holmström (2015). The framework leaves out traditional businesses as it focuses on diagnosing and improving digital products and services by assessing where they are currently and the path required to improve digital products and services (Nylén and Holmström, 2015).

The framework is focusing on these three broad categories:

- Products – cover user experience and value proposition.
- Environment – covers digital evolution scanning.
- Organisation - covers skills and improvisation.

2.11 Technology Acceptance Model (TAM)

Davis (1989) proposed the Technology Acceptance Model framework, and a third version of the framework now exists (TAM3). It helps explain the usage of technology within a specific context, and the usage could either be the ease of use or the usefulness of that specific technology as perceived by the users. The perceived usefulness can be defined as the extent to which a person believes that using an IT will enhance their job

performance, and the perceived ease of use is the degree to which a person believes that using a technology will be free of effort.

For the framework to continuously be a useful tool for analysis and to understand various factors that influence technology usage and adoption, the model needs to continuously evolve. “The research on individual-level IT adoption and use is mature and has provided rich theories and explanations of the determinants of adoption and use decisions, TAM being a theoretical framework product of one of such research is highly predictive of IT adoption and use, one of the major criticism against the model has been its lack of actionable guidance to practitioners” (Venkatesh and Bala, 2008).

TAM had some inadequacies which lead to a proposed update and the theoretical expansion of the model, TAM2 was then further developed by Venkatesh & Davis (2000). They did so by identifying and theorising about the perceived usefulness – subjective norm, image, job relevance, output quality, result demonstrability, and perceived ease of use – experience and voluntariness (Venkatesh and Davis, 2000).

Venkatesh & Bala (2008) further updated the model to come up with TAM3. It is a combination of the TAM2 model of the determinants of perceived ease of use by Venkatesh and Davis with that of Venkatesh (Venkatesh, 2000). TAM3 postulates three new relationships that were not empirically tested in TAM2. In TAM3, Venkatesh & Bala (2008) proposed that “experience will moderate the relationship between the following – perceived ease of use and perceived usefulness; computer anxiety and perceived ease of use; and, perceived ease of use and behavioural intention.”

TAM has sufficient empirical evidence to support its viability key models that predict user intentions and behaviour towards the use and adoption of technology. Considering this model concerning the adoption and use of digital technologies from an organisational point of view, predicting digitalisation based on the perceptions of ease of use and the usefulness of digital technologies becomes inadequate to understand the dynamics that continuously drive organisational decisions to take the digital route.

2.12 Digital Transformation Framework, by Corver and Elkhuizen

According to Corver and Elkhuizen (2014), Digital business transformation is built on the following four pillars.

- The Customer
- The Product
- The organisation
- The processes and systems

Corver & Elkhuizen (2014) believe that this framework will be useful and add value to any organisation developing a digital vision or build new business models focused on digital opportunities. “Successful organizations operate with a clear business direction, using a vision and roadmap that define the way forward. Without these crucial strategic instruments, businesses would focus only on solving today’s problems and fail to create continuous value for their stakeholders” (Corver and Elkhuizen, 2014). According to these authors that proposed this framework, digital transformation often begins with the customer. The authors strongly believe that a process of knowing and understanding the customers better is the first step before any improvements to service levels offered to them, followed by a process of working on the digitisation of customer experience.

2.13 Digital Transformation Framework, by Matt, Hess, and Benlian

The framework is a basic academic foundation that has not been tested and validated as a framework that can be used for understanding digitalisation (Matt, Hess and Benlian, 2015). The model describes various building blocks for digital transformation along four dimensions (use of technologies, changes in value creation, structured changes, and financial aspects) which it considers to be important.

With the consideration that the primary key aspect of any business is growth and profit, the framework places financial aspects at the centre of the model as it serves as a primary driver of motivation.

2.14 Digital Enterprise Integrative Management Framework

According to the authors that proposed this framework, they believe that true supply chain excellence can only be achieved through digital business transformation (Bowersox, Closs and Drayer, 2005).

This framework breaks the transformation into three processes:

- Enterprise core processes – Which is mainly focused on the maximising of customer value.
- shared real-time information and operational connectivity – this creates a response-based/demand-driven network of supply chain relationships among participating business entities.
- Commitment to operational excellence – manifested in the form of customer-centricity.

The framework intends to try and link the achievement of true collaboration within a supply chain with digital business transformation as a precondition for true collaboration to start occurring. The authors stated that “Companies today participate in extended supply chains, where real operational efficiency and revenue enhancement come from greater visibility, integration, and synchronization among connected partners”

The framework is academic, it has not been tested and validated with empirical evidence that supports its applicability.

2.15 The Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh, Morris, Davis GB and Davis FD

UTAUT is a combination of key concepts found through various research work in explaining ICT usage behaviour (Venkatesh et al., 2003). The key concepts come from the Theory of Planned Behaviour (TPB), innovation diffusion theory (IDT), Technology Acceptance Model (TAM), motivation model, and the social cognitive theory to develop a unified theory for technology acceptance (Negahban and Chung, 2014).

The framework proposes that the business is likely to accept, use and adopt technology if the environmental, social influence and economic factors are all present. The UTAUT framework with its empirical evidence continues to be useful in explaining variance in behavioural intention towards the use of any piece of technology.

2.16 Comparison of the Frameworks

Nwaiwu (2018) conducted a comparison exercise of various frameworks based on their applicability to digitalisation in any industry (Table 1). The following assessment criteria has been used for the comparison:

c) The ability of the framework to help organisations understand where they currently are positioned in their digital transformation journey.

d) Their ability to help organisations understand what needs to be transformed.

e) Their ability to help organisations understand how they can achieve digital transformation.

Nwaiwu (2018) stated that “It is pertinent to note that an overwhelming number of conceptual frameworks on digitalisation have their roots in an industry publication, and academia offers nothing except for the TAM, which cannot be expressly taken as a framework for digitalisation. Quite ironically, only the TAM framework has been subjected to academic validation when compared to the rest as a scientifically rigorous framework backed by theory. The models were compared via their ability to assess the current state

of digital transformation within an organisation. Based on this parameter, only three of the six frameworks reviewed can help an organisation understand their current position in the digital transformation journey – the Six Keys to Success, Digital Piano, and Digital Innovation Strategy frameworks. The next parameter that was considered focuses on 'what to transform' within the organisation; for this parameter, the Digital Piano framework provides the most comprehensive coverage with seven areas suggested for the organisation, while the TAM3 framework has the least with zero areas suggested. The Six Keys to Success quite remarkably only focuses on the business model as the area to cover but does this by linking technologies identified with market opportunities. This makes the framework more of a diagnostic tool than a 'how-to' tool. The final parameter considered is 'how to transform' parameter. For this parameter, only two – the Digital Innovation Strategy and TAM3 – fail to provide a minimum guide on how organisations can achieve digital business transformation. Also, none of the frameworks reviewed so far offer any detailed approach on how to achieve digital business transformation."

Table 2. Comparison of relevant conceptual and theoretical frameworks.

Conceptual Framework	Assess the current state of Digitalisation	What to transform (number of items)	What to transform (list of items)	What to transform (Is it detailed?)	How to transform (actions to take)	How to transform (Are actions to be taken detailed?)	Origin of a framework (Business or Academia?)	Framework scientifically validated?
Six Keys to Success	Yes	1	Yes	Yes	Business Model, Organisation structure, Human resources, Internal processes, IT capabilities, Products/ Services, Stakeholders engagement	Yes	Business	No
Digitisation Piano	Yes	7	Business Model, Organisation structure, Human resources, Internal processes, IT capabilities, Products/ Services, Stakeholders	Yes	Process of digital transformation should lead to organisational change and development of digital business agility	No	Business	No
Digital Orchestra	No	10	Offerings, Channels (Go-to-Market); Customers, Partners, Workforce (Engagement); Processes, IT Capability (Operations); and Structures, Incentives, Culture (Organisation)	Yes	Organisation's leadership must determine what type of value they want to create, and decide the strategic options for achieving it	Yes	Business	No
Digital Reinvention	No	3	New Expertise (human resources, orchestrated ecosystem), New Focus (business	No	To achieve digital reinvention, organisations must pursue a bottom-up reinvention of strategy	No	Business	No

			models, market/customer activation), New Ways to Work (responsive operations, actionable insights)					
Digital Innovation Strategy (digital goods and services only)	Yes	3	Product (user experience, value proposition), Environment (digital evolution scanning), Organisation (skills/human resources, improvisation	Yes	No specific strategy direction is suggested, the framework is focused exclusively on digital products/ services	No	Academia	No
Technology Acceptance Model 3 (TAM3)	No	0	No specific item(s) listed by this framework	No	No specific strategy direction is suggested, the framework seeks to understand technology adoption from a 'person' point of view.	No	Academia	Yes
Digital Transformation Framework by Corver and Elkhuizen	No	4	Customer, Product, Organisation, Processes, and Systems	Yes	Digital transformation should be with understanding the customer, then move to cover the three other areas	No	Business	No
Digital Transformation Framework by Matt et al.	No	4	The user of technologies, Change in value creation, Structural changes, financial aspects	No	Digital transformation should serve as a central concept to integrate the entire coordination, privatisation, and implementation of digitalisation.	No	Academia	No
Digital Enterprise Integrated Management Framework	No	5	Financial stewardship, Integrated operations, Customer accommodation, Measurement and metrics,	Yes	By linking the achievement of 'true collaboration' within a supply chain with digital business transformation	Yes	Academia	No

			Human resources developmen t					
The Unified Theory of Acceptance and Use of Technology 2 (UTAUT2)	No	0	No specific item(s) listed by this framework	No	No specific strategy direction is suggested, the framework seeks to understand technology adoption from a 'person' point of view.	No	Academia	Yes

(Berman, Korsten and Marshall, 2016)Framework Comparison

2.17 Digital Transformation Concerns for Sustainable Development

There is an anticipated changing nature of jobs and fear of employment opportunities disappearing across various industries due to digital technologies that form part of the Fourth Industrial Revolution (4IR) by society. A minimal discussion about sustainable development is important, particularly about Artificial Intelligence (AI) as one of the technologies that keep raising questions about the future of mining due to digital transformation, and future employment concerns in the mining sector.

The Center on Global Economic Governance hosted a panel discussion on "Artificial Intelligence: Implications for Governance and Public Policy" on February 23, 2018 (Gilmartin, 2019). It clear that AI has become good at playing a variety of games; however, it is the potential influence on the public policy that remains critical. The issue of employment and jobs being at risk became one of the critical factors which Ronaldo Lemos (a visiting professor at Columbia SIPA) highlighted as an important Policy question on how to keep AI in the public interest. He also noted that AI often transcends political preferences. As published in the World Economic Forum, unemployment is one of the listed ethical issues brought by Artificial Intelligence (Bossmann, 2019).

As part of the South African National Development Plan (NDP) (National Planning Commission, 2019) to grow an inclusive economy, building capabilities, enhancing the capacity of the state, and promoting leadership and partnerships throughout the society, the following remain the key priorities of focus.

- Raising employment through faster economic growth
- Improving the quality of education, skills development, and innovation
- Building the capability of the state to play a developmental, transformative role.

The South African Mining charter is also driving this agender as a conduit to the aims of the NDP.

The 2030 Agenda for Sustainable Development with 17 Sustainable Development Goals was adopted at the UN Sustainable Development Summit in New York in September 2015 (Sustainabledevelopment.un.org, 2019).

Digital technologies have the potential to either be against or enhance some of the following global key goals; hence, it is worth mentioning them.

Goal 1. End poverty in all its forms everywhere

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Goal 3. Ensure healthy lives and promote well-being for all at all ages

Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Goal 5. Achieve gender equality and empower all women and girls

Goal 6. Ensure availability and sustainable management of water and sanitation for all

Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all

Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Goal 10. Reduce inequality within and among countries

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

Goal 12. Ensure sustainable consumption and production patterns

Goal 13. Take urgent action to combat climate change and its impacts*

Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

Goal 17. Strengthen the means of implementation and revitalize the global partnership for sustainable development.

2.18 Conclusion of the Literature Review

Digital transformation requires a strong leadership focus with an ability to learn new skills to complement old ones to lead in the digital world. Developing a digital strategy with a road map indicating the relationship of various parts of the value chain forms part of the journey to successful digital transformation.

A starting point to begin digital transformation is a solid relationship between IT department and business executives. A common digital platform with integrated data and processes is a fundamental technology component of any successful digital transformation process. Business executives view digital transformation process to be driven by customers, competitors, and employees.

Digital maturity assessments provide a view of where the company is in terms of the digital transformation journey, and it helps companies map the path to the desired state.

The application of digital technologies is broad and remains a topic of contention in many industries, including mining. The fear of job losses due to the wave of digital technologies across many industries shows that many people have a lack of understanding of the new or potential opportunities brought by these technologies. There is still a lack of knowledge as to whether these technologies, which form part of the 4IR will be against or help achieve all the 17 Sustainable development Goals.

Based on the analysis of the different frameworks and their capabilities, the **Digital Piano** model will be used throughout the research due to its ability to assess the current state of the organisation on the digital transformation journey, and the key areas of focus for transformation. Amongst all the frameworks, the Digital Piano provides the most comprehensive coverage of what needs to be transformed:

- The Business Model.
- Organisation structure.
- Human resources.
- Internal processes.
- IT capabilities.
- Products/ Services.
- Stakeholders engagement.

Due to the limitations of these frameworks on actions to be taken to transform, the Leading Change Model by (Kotter, 2006) on how to transform will be used for triangulation purposes in assessing the companies sequence of actions to affect digital business transformation.

2.18.1 *Proposition 1*

4IR in the mining sector is spurring the uptake and application of digital technologies while significantly changing the industry structure of mining as we know it, therefore the digital

transformation of the internal processes within the mining value chain is the key area of focus for a mining Company X.

2.18.2 *Proposition 2*

Various theoretical and conceptual digital transformation frameworks exist, however, the Digital Piano digital transformation framework is the most appropriate for company X's digital transformation journey. This framework is the most appropriate as it covers various aspects of the company from systems, processes and people.

2.18.3 *Proposition 3*

Embarking on the digital transformation journey of company X in the 4IR era requires the co-operation and participation of all stakeholders to ensure successful implementation and adoption of digital technology initiatives.

CHAPTER 3. RESEARCH METHODOLOGY

3.1 Research approach

Digital Maturity is a snapshot of the extent to which a business has digitally transformed and is “ready” for the market in which it finds itself (Armstrong, 2019). The maturity measure has a standard survey to be used for data collection.

Digital Transformation is the process to get from the current level of digital maturity to an aspired future state of digital maturity (Armstrong, 2019). Several qualitative questions are created to understand this phenomenon through a series of interviews.

The researcher will be using a qualitative research approach to answer the research questions. This approach allows the researcher to use more than one or more of the available tools as a guide and potentially help in developing designs throughout the research process while comparing and interpreting the results. This approach is appropriate for this research as it is concerned with understanding rather than explanation. The naturalistic perspective and the interpretive understanding of human experience is fundamental to this research; hence, this approach is also preferential; it is multiparadigmatic in focus.

3.2 Research design

This research will be in the form of a case study. Digital transformation and adoption of related technologies in mining is the key subject of this research, and the ability of the case study approach in drawing attention to what can be learned in a single case makes it a feasible method to consider. Change management for any digital technology implementation involves a behavioural change for adoption purposes, and because a case study is considered as a way of conceptualizing and encapsulating human behaviour (Schram, 2006) it is a reasonably acceptable approach for this research.

This research approach will involve in-depth and detailed data collection though interviews from multiple stakeholders within Company X. The casing method has the potential to produce new theory and knowledge (Yin, 2003) which the researcher envisages other mining companies seeking to embark on a digital transformation mining journey may use as a baseline for testing in their approach.

3.3 Data collection methods

The data for this research will be collected in the form of one-to-one interviews. This method is a predominant mode of collecting information or data in qualitative research. It is critical to the success of this research as it will provide the respondents and the researcher an opportunity to meet and build trust. The researcher will acquire information through direct interchange with the respondents. This approach provides an opportunity to be creative and ask further questions or seek clarity on various responses.

The interviews will be structured. The structured interview will assist the researcher in obtaining information about the experiences of the respondents about the questions asked, which is critical to understanding the research objectives from the experience of respondents. The structured interview through a list of prepared questions will assist the researcher with data analysis and development or comparison of emerging themes.

3.4 Population and sample

3.4.1 *Population*

The South African mining industry is broad and given the amount of time required to conduct this research, time will be a constraint to cover all the mining companies. This research will be conducted at Company X, which is a diversified mining resources company. Company X has launched a program called Digital@Company X to roll out digital technology solutions across its coal mines, and this makes them an interesting subject for this particular research. Among other digital technology rollout programs in place, Company X has invested in a new digital twin mine with capabilities that enable

the management team to connect and manage the mine remotely (Exxaro.com, 2019) (Kilian, 2018).

3.4.2 *Sample and sampling method*

The researcher will be using purposive sampling, which is one of the non-probability sampling methods. This method is appropriate due to the experience of the researcher in the mining sector, and the ability to make good decisions on which individuals need to be considered as part of the samples.

Mxolisi Mgojo (Exxaro.com, 2019), the CEO of Exxaro said "There was a time when people came from over the world to learn from Exxaro and we're determined to return to that time. Exxaro is the benchmark for digitalisation in South Africa; not only in mining but across business generally and we want to be the benchmark globally. Digitalisation is not just a buzz word for Exxaro, it is fast becoming part of our culture. **Everyone at Exxaro, from the cleaner and security guard to the engineers, accountants and management has bought into the idea that we need to relearn then unlearn then relearn again as we transform digitally**."

Based on the acknowledgment that to digitally transform the mine, everyone needs to buy into the idea as per one of the leading CEO in the south African mining sector, the samples for this research at Company X will include the executives and senior management responsible for driving this digital vision.

The interviews are conducted face-to-face through a series of arranged meetings, one interview per person will be done. Clarity from the respondents may be required after the interview if needed.

Table 3: Profile of respondents

Level of Authority	Description of respondents	Number to be sampled
Level 1	**Executive Management** (Exco team, Strategy)	2
Level 2	**Senior Management** (Functional Heads, General managers, Head of Departments)	5
Level 3	**Middle Management** (Operational managers)	4
Level 4	**Junior Management** (Involved in execution, frontline management)	3
	TOTAL number of respondents	14

3.5 The research instrument

This research will be in the form of face-to-face interview questions in Appendix A. (Armstrong, 2019)Interview questions created are also based on the research objective and the literature review conducted.

3.6 Procedure for data collection

- Respondents will be approached directly to conduct face-to-face interviews. Interviews will be recorded, and handwritten notes will only be taken where recording is not permissible or possible.

3.7 Data analysis and interpretation

Inductive thematic analysis of the data will be utilised to identify themes and patterns in the collected data. This methodology will also allow the researcher to understand how different participants experience the researched phenomenon (Braun and Clarke, 2006).

The researcher is obligated to observe their processes, analyse, and report on the analytical process (Patton, 2002), this means being able to monitor and report on procedures used throughout the work.

The following will be done to ensure adequate data analysis and interpretation is sufficient

- The researcher will look for underlying similarities in different themes identified and look out for any deviations that may be indicative of an existing pattern.
- The researcher will re-read the text, re-examine any non-textual data, replay any form of recording done with the participants to become more familiar with the data collected.
- Transcribing the text in sufficient detail to avoid missing out keywords and to critically evaluate the meaning of these words used by participants or provided in the form of documentation and or visuals.
- A line-by-line analysis of each interview will be done to create themes and codes, and this will allow the researcher to link and establish a relationship among different emerging themes.

The researcher will analyse the data frequently throughout the research based on the ongoing preliminary findings.

In conclusion, the research will slightly follow the process outlined below, bearing in mind that these activities do move in circles, and they are not linear (Marshall and Rossman, 2011).

- Planning process recording data.
- Collection of data and performing preliminary analyses.

- Continuous management of the data when additional data is obtained.
- Generation of various categories and coding of the data.
- Continuously test the emergent understanding and search for an alternative explanation.
- Final interpretation and presentation of data.

3.8 Limitations of the study

- The flexibility of the thematic method may lead to a lack of consistency and cohesion on themes developed from the data (Holloway and Todres, 2003).
- English is not a home language for every participant, and this may be a limiting factor towards getting detailed responses from various individuals.

3.9 Validity and reliability OR transferability and dependability

The concept of transferability, credibility, dependability, and confirmability in qualitative research (Lincoln and Guba, 1986) provides a way of assessing the quality of the research. These qualitative research authors believe that these four constructs better reflect the assumptions of the qualitative research approach more accurately.

3.9.1 *Transferability*

The study will focus on one company, and that does not meet the transferability criteria. To ensure the generalisability of the research findings, particularly within the South African mining industry, the researcher will also use data collected through a study conducted by Capgemini Consulting for triangulation purposes due to similar constructs been addressed by this study and that of the Digital Piano framework.

3.9.2 *Credibility*

To make the research credible and demonstrate that the findings were derived from the data, the researcher will have timed and prolonged engagements with all the identified

participants of the research. The researcher will perform an in-depth analysis and description showing the complexities of variables and interactions that are embedded in data. This will make the research credible. The Leading Change Model by (Kotter, 2006) on how to transform will be used for triangulation purposes in assessing the companies sequence of actions to effect digital business transformation.

3.9.3 *Dependability and Conformability*

An ability to reconstruct or audit the outcome of the research is critical, Data collected in the form of interviews will be readily available in the appendix, as well as in written or digital format archives. The method used for the analysis of the data is outlined for easier reference to processes and steps taken to conclude.

3.10 Demographic profile of respondents

The respondents will be a combination of males and females, young and senior citizens working for Company X. It will depend on the current demographic profile of Company X and not that defined by the researcher.

3.11 Ethical considerations

The researcher will do the following to ensure that the research is ethical

- The researcher will start by writing a formal request to the Manager Digital & Business Optimisation at Company X to ask for a meeting to discuss the essence of the study to be conducted and ask for permission to do so.
- The researcher will also request the company's code of ethics to ensure the study is not in breach of the internal code of conduct.
- Once the permission has is granted, the researcher will request the Manager Digital & Business Optimisation to write an introductory email to a list of mapped stakeholders critical to the success of this research as outlined by the author. The researcher will inform the Manager Digital & Business Optimisation that research

participants must be informed in the distributed conversation that participation is voluntary, and failure to participate will not have any consequences to them.

- Each stakeholder will be made aware of the purpose of the study conducted, the duration of the study, the procedure of the study, and any potential risks associated with this study.
- The researcher will always familiarise himself with all the company values and procedures to be followed when onsite for interviews with key stakeholders.
- Reciprocity is important in this research; the company will make its resources available to the researcher, and the researcher will give back to the company by sharing data collected and results that can be used to improve the researched aspect of the business. There will be no monetary or physical gifts to be shared amongst the involved parties except for the research report.
- The study will be designed with care to ensure sensitivity.
- Time is a precious resource, and the researcher will respect all meeting times of involved stakeholders.
- The researcher will not fake data or skew data results to support his Proposition.
- The researcher will not publish the results earlier without completing the necessary analysis. Results will be discussed with the company before release.
- To ensure privacy and confidentiality is always maintained, no names will be published, unless respondents agree to have their names published. The researcher will assure the respondents by signing Non-Disclosure agreements with each one of them.
- Transparency is important, and the researcher will make everyone aware of who might have access to this information and how its safety will be maintained.
  The researcher will not oppose any views raised by the respondents, and cultural difference is always to be respected.

CHAPTER 4. PRESENTATION OF RESULTS

4.1 Introduction

The presentation of the results of this study is in the form of direct quotations from the interview respondents. The results are extracted during the data fragmentation process from the transcripts. To demonstrate how various themes emerged for each research question, themes are extracted, and views are reported across the sample of respondents. Results for each research question are summarised and categories are created based on extracted themes.

Fourteen interviews were conducted with employees of Company X based on these criteria:

1. Respondents all fall into one of the following hierarchical categories and level of influence at the organisation:
    - Executive (Level 1)
    - Senior Managers (Level 2)
    - Middle Managers (Level 3)
    - Junior Managers (Level 4)
2. Respondents either have direct or Indirect involvement in creating, executing, approving, and/or implementing the digital strategy and its budget for Company X.

All the participating respondents are experienced and knowledgeable to participate in this research.

The following table provides a high-level profile of each respondent in the selected sample.

Table 4. Demographic profile, experience and highest qualification of respondents in the sample.

Respondent	Gender	Age Range	Highest Qualification	Working Experience Years
Respondent 1 Senior Manager	Female	30-40	Postgraduate	9
Respondent 2 Senior Manager	Male	40-50	Postgraduate	15
Respondent 3 Senior Manager	Male	30-40	Undergraduate	12
Respondent 4 Junior Manager	Male	20-30	Undergraduate	5
Respondent 5 Middle Manager	Female	30-40	Undergraduate	15
Respondent 6 Middle Manager	Male	30-40	Postgraduate	13

Respondent 7 Junior Manager	Male	30-40	Postgraduate	17
Respondent 8 Junior Manager	Female	40-50	Postgraduate	26
Respondent 9 Senior Manager	Female	40-50	Postgraduate	23
Respondent 10 Middle Manager	Male	40-50	Undergraduate	21
Respondent 11 Middle Manager	Female	30-40	Undergraduate	13
Respondent 12 Senior Manager	Male	30-40	Undergraduate	8
Respondent 13 Executive	Male	40-50	Postgraduate	28
Respondent 14 Executive	Male	Over 50	Postgraduate	33

Total years' experience	**242**

According to table 4, respondents have a combined experience of 242 years in the mining industry. This means that the respondents have experience in their area of expertise.

Figure 9 below shows the percentage contribution of respondents according to their level of authority or hierarchy in the organisation.

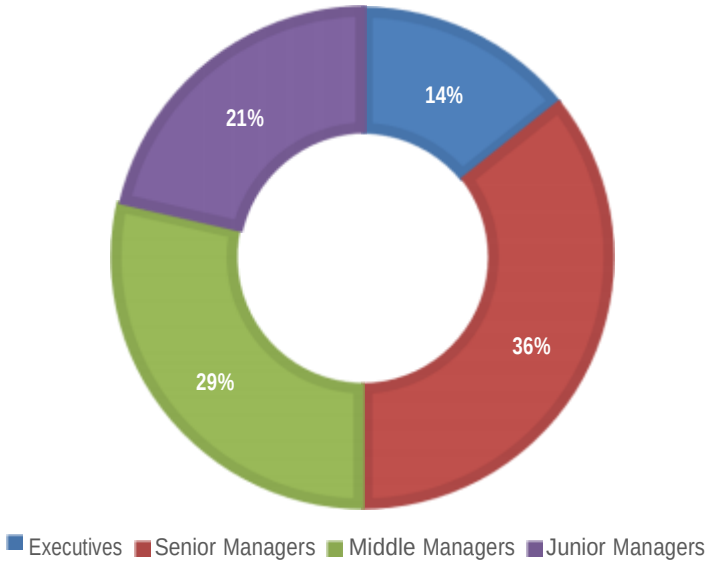


Figure 11. Balance of respondents according to hierarchy in the organisation.

The following graph indicates that 57% of the respondents have a postgraduate qualification, while 43% only have an undergraduate qualification.

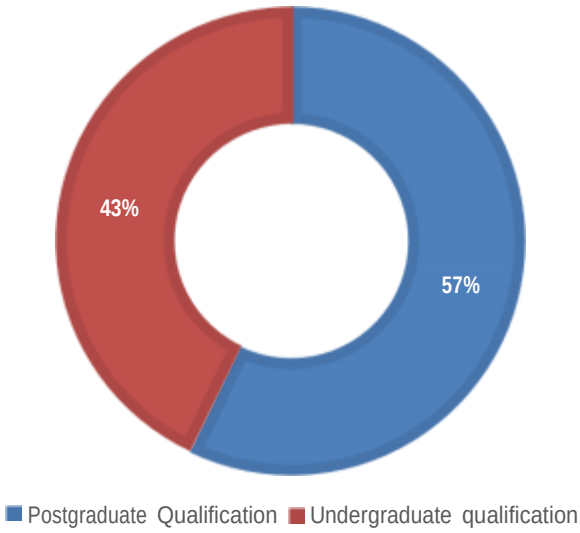


Figure 12. Balance of qualifications of respondents in the sample.

According to the graph below, 64% of the respondents are male, and 36% of the respondents are female.

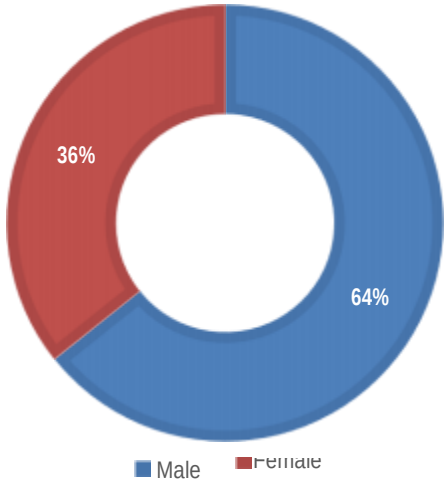


Figure 13. Balance of male and female respondents.

4.2 Results pertaining to Research Question 1 (RQ1)

RQ1 - According to Digital@Company X Program roadmap, what are the areas of focus to digitally transform the mine (What to transform)?

4.2.1 *Themes extracted from Research Question 1*

The following key themes were extracted from RQ1:

- Debottlenecking.
- Processes.
- Realtime data,
- IT Infrastructure.
- Value Chain Visualisation.
- Integrated Operations Centres.
- Descriptive Analysis.
- Predictive Analysis.
- Integration.
- Quick Decision Making.
- Data-Driven Mine.
- Value Chain Optimisation.
- Drilling, Blasting, Loading, and Hauling.
- Work Transformation.
- Changing Behaviour.
- Departmental Transformation.
- Eliminating Silos.
- Training, Reskilling.
- Change Management.
- Stakeholder Engagement.
- Mine to Customer.
- Pit to Port.

- Business Intelligence.
- Business Improvement.
- Employee Effectiveness, Employee Enablement
- Shareholder Returns
- Key Performance Indicators
- People Transformation
- Customer Satisfaction
- Single Platform

The following table illustrates the 8 categories created from the extracted themes.

Table 5. RQ1 categories created from the extracted themes.

Categories	**Extracted Themes**
Digital Capability	IT Infrastructure Descriptive Analysis Predictive Analysis
Human Resources	Training Change Management Reskilling Stakeholder Engagement
Worker Enablement	Quick Decision Making Employee Enablement

	Employee Effectiveness
Culture	Work Transformation Changing Behaviour Departmental Transformation People Transformation
Customer Experience	Customer Satisfaction Mine to Customer
Process Digitisation	Processes Debottlenecking Value Chain Visualisation Drilling Blasting Loading Hauling Pit to Port
Unified Data	Integrated Operations Centres Realtime data Integration

	Data-Driven Mine Eliminating Silos Single Platform
Performance Management	Value Chain Optimisation Business Intelligence Business Improvement Shareholder Returns Key Performance Indicators

4.2.2 *Respondent views from Research Question 1.*

Table 6. A variety of responses pertaining to Company X's area of focus to digitally transform the mine through its Digital@Company X program road map.

‘’You need to focus on your bottleneck areas. Ensure that your process basics are correct before digitizing. Creating real-time data Focusing on IT infrastructure to enable Focus on data structures Enable visualisation of the value chain Establishment of IOC's to optimise utilisation of data science to move from descriptive to predictive and prescriptive Creating the appropriate org structures to support''
‘Look, first of all you need to understand the pain point of the system and start by addressing those. We talk a lot about decision making, which we believe it is important to turnaround our business, so with that said, integrating various parts of the mine and helping our people make quick decisions is what our road map is mainly focusing on''
''For us, our focus is on the entire value chain optimization. Our roadmap is focused on having data-driven operations centres for the mine, where everyone can see what is happening across the whole chain''
‘’We have many functions such as drilling, blasting, load and hauling at the mines, and we focus on digitizing these critical areas to ensure optimal mining of material. Empowering our employees in execution is important, so we make sure that our roadmap has a clear focus on the use of analysed data

to help them do their work better by focusing on what has a potential to impact their production, so the use of visual data that makes sense is key in our roadmap ''

'We want to transform how people work in different departments. Visualisation is the most important thing for us, because there is power in seeing what is going on in real-time, but what you do with what you see is what we intend driving by changing behaviour of our employees"

''A lot of people work in silos, so we need to be break them down, so we focus on integrating all departments on a single platform. Our IT infrastructure is important, we make sure that we have that to serve the purpose of our digital transformation efforts"

'Our processes are what we want to focus on to digitally transform our mine. These processes basically include anything from mining to the customer. Look, if you cannot enable your people to make better decisions, then it's pointless to do digital in your mine, so our road map key area is to enable that by using data in our integrated Ops centres''

'Value chain visualization to help identify bottlenecks is a major focus for us, because it allows us to see where we can improve. Proactive and high response rate to emerging issues is a big deal for us, so our model is about ensuring smooth operating mines and making sure that the whole mine is visible at all times in real-time"

'We have a number of focus areas to digitally transform, first of all we recognize the importance of generated data which mines normally do not use to their advantage, so we focus on getting data from different sources in order to help digitize our drilling, blasting, finance, marketing, logistics and load and haul operations. Our processes in general are the focus area of our digital transformation strategy, and the value chain from the mine to the customers, and being able to see every step of the way is critical in our roadmap"

'We are interested in transforming the value chain, we believe that an integrated operation will yield maximum benefits because working in silos leads to many inefficiencies in the mines. Our people are also important, part of the key elements is training and making sure our people have the right skills ''

'We want to change how work is done by improving real-time decision making in our processes, so for us digital transformation means we focus on bottlenecks and breaking silos in our value chain by ensuring we simplify how our work is done. Stakeholder engagement is important, as well as enabling decision making is what i would say we are driving for in our road map ''

'For us, we look at digital transformation holistically, in a sense that our strategy needs to be taken into consideration before we decide what needs to be transformed, with that said, our core focus is to transform all parts of the value chain from pit to port or pit to client. For us, the key elements is to visualize the entire value chain and achieve our KPIs. Value is measured in terms of the impact on key KPI's. Ideally, the existence of a value driver tree helps. There is involvement from the Business Improvement department to help quantify"

'We look at what will add value to the business and our customers, so we care about transforming any part of the business that will yield better customer satisfaction, generate income for our shareholders and keep the employees working effectively at all the times, which means we must transform all our processes in the mine. I must say that continuous improvement through the use visualized data is significant in our roadmap"

'We have a strong focus on debottlenecking our system, thus we put a lot of energy in putting together digital technologies that will enable our entire value chain to operate optimally, however, we do understand the importance of enabling employees in every sphere of our business to gain the relevant skills that will enable them to help us transform the business. We also value the power of a visual value chain because that helps us make informed decisions driven by data at our fingertips. At our mine, value chain optimization and visibility is the key to our roadmap"

4.2.3 *Summary of results from Research Question 1*

Research question one received responses regarding Company X's key areas of focus to digitally transform the mine using Digital@Company X roadmap/program (What to transform).

All 14 respondents provided their views according to what the Digital@Company X roadmap aims to achieve. The following eight categories were generated based on the emerging themes from the interviews: Digital Capability, Human Resources, Worker Enablement, Culture, Unified Data, Customer Experience, Process Digitisation, and Performance Management.

Views given by the respondents show a common understanding of what the roadmap aims to achieve across the organisation. There is a strong focus on digitally transforming the whole value chain by focusing on the various processes that constitute it. According to the respondents, visualisation of the entire value chain is critical.

Respondent 9 was specific on which process needs to be digitised (Drilling, blasting. Loading and hauling operations from the mine, marketing, and logistics). IT infrastructure as the area of focus was mentioned by two respondents.

According to Respondent 10, change management in a form of training is also a key component of the digital transformation journey. There is also a strong appreciation of stakeholder engagement throughout the process.

It is also understood by the respondents that the focus will not only be process-related but will enable workers to work smart by through the use of real-time data to make decisions, eliminate silos and be able to predict possible process interruptions or possible failures ahead of time. Integrated Operations Centres as a hub to visually see, and manage the operations based on real-time data were mentioned by Respondent 1 and 7.

Respondent 1, 8 and 15 mentioned digital technology focuses on eliminating bottlenecks within the value chain as one of the main objectives of having a digitally driven mine.

Customers and shareholders form part of the value chain and are important. Respondent 13 emphasises the need to create value for customers and shareholders through digitisation of various parts of the business.

There is a general understanding of what the roadmap is aiming to achieve by all the respondents, with the ultimate goal being able to continuously improve the business while change how various departments and people work to achieve the Key Performance Indicators critical to the success of the mine.

4.3 Results pertaining to Research Question 2 (RQ2)

How to effectively engage all stakeholders in the implementation of the digital transformation strategy (Digital@Company X Program) to ensure the adoption and successful implementation of digital technology initiatives?

4.3.1 *Themes extracted from Research Question 2*

The following key themes were extracted from RQ2

- Ineffective change management.
- Poor communication.

- Lack of vision understanding.
- Lack of Digital Strategy Understanding.
- Lack of understanding.
- Lack of buy-in.
- Longer projects.
- Project Value Realisation
- Resistance to change.
- Reskilling,
- Lack of adoption.
- No incentives.
- Labour Unions
- Employees
- Practicality of technologies

The following table illustrates the categories created from the extracted themes.

Table 7. RQ2 categories created from the extracted themes.

Categories	**Extracted Themes**
Poor Change Management	Ineffective change management Poor communication Resistance to change Reskilling
Unclear Vision	Lack of vision understanding Lack of vision understanding.

	Lack of Digital Strategy understanding. Lack of understanding. Lack of buy-in
Stakeholder Involvement	Labour Unions Employees
Ease of Use and Adoption	Practicality of technologies Lack of adoption Project Value Realisation Lack of Motivation (No Incentives)

4.3.2 *Respondent views from Research Question 2.*

Table 8. A variety of responses pertaining to effective stakeholder engagement in driving digital transformation implementation and adoption for Digital@Exxaro program.

'Change management. Understanding of digitisation - so education and also ensuring that you do have a plan to lift competencies and skills and can answer the question of how jobs will be affected''
'We ensure communication takes place at all levels''
'We have training and are informed as well as involved in various discussions about digital transformation''
'Skilling of individuals is important. We upskill people''
'Look, people are asked to have their input on what they think should be done, and that is important''
'Consultations with the employees and union representatives is taking place''

'We have regular project meetings and briefings to keep everyone informed"

'It is important that everyone is engaged because if we don't, we run a risk of having project failures. We have communication structures that also help us stay engaged to everyone"

'Adoption is important, and it can be a tricky exercise, more especially when people can't see the value, so we try by all means to quantify benefits we are seeing and communicate back to different stakeholders. We also involve everyone in the process to have input because it becomes easy to have buy-in. 'From what I have seen, it is clear that the way we communicate what the business intends doing with these technologies is very important, we had instances where we thought people do not support what we are doing by not fully participating in these projects, only to realise later that the problem was lack of understanding on what we want to achieve as a business "

'The only way to stay winning in this game is to make sure we have a strong change management process to ensure adoption, and that what we are doing and we can see the results"

'Stakeholder engagements, change management and progress meetings with feedback on the performance or improvements we are seeing helps us in getting the adoption we need for successful implementations"

'We make sure that our digital work is practical to everyone, in that case, it is therefore easy to have adoption"

'This is a good question, because if you do not have adoption, you will keep spending money on something that does not work, so we train and skill our people to make sure we get the adoption we want and the benefits of digital"

'Sometimes these digital initiatives do not fail because we do not know what we are doing, they fail because people sometimes don't understand the vision or the reasons why we do what we are doing, so stakeholder engagement to make sure we are aligned with everyone, that makes it easier for people to buy in, including the union because some people think technology will make them lose jobs, so we make sure we communicate a clear picture for everyone and keep them informed throughout. It is important."

4.3.3 *Summary of results from Research Question 2*

This research question received various views by respondents on how to effectively engage stakeholders within Company X during the process of driving digital transformation implementation and adoption.

The following six categories were generated based on the emerging themes from the interviews: Poor Change Management, Unclear Vision, Value Realisation, and Lack of Motivation.

The views provided by the respondents indicated the importance of effective change management as an enabler in the digital transformation process. Respondent 1, 4, and

13 indicated the importance of training and reskilling of individuals to improve their competencies and involvement in the digital transformation journey.

Respondent 14 believes that digital transformation initiatives fail because stakeholders involved do not understand the value and why this journey is important, hence communication and stakeholder engagement to provide clarity and align every person is important. This respondent further echoes the issue of job losses among one of the fears that may lead to a lack of adoption. Respondent 1 also touched on how they must answer a question on how jobs will be affected.

According to Respondent 9, Adoption and being able to quantify the benefits brought by digital transformation processes is critical. The respondent further elaborates that if various stakeholders cannot see the value of this exercise, it makes the whole journey a bit difficult, hence the mine needs to quantify the benefits and communicate back to the stakeholders while involving stakeholders throughout the process for their input.

Respondent 12 indicated the importance of making digital technologies practical to the users to drive adoption. Whereas Respondent 6 believes that engagement with the Labour Unions is critical to the success of these technology implementations and adoption. Respondent 5 indicated that various stakeholders are asked to have input on what they think should be done by the organisation in line with the digital transformation journey.

There is an appreciation for the lack of buy-in from various stakeholders being one of the driving factors that would lead to poor adoption of digital technologies, and resistance to change can be attributed to poor change management.

4.4 Summary of total results

Different stakeholders ranging from level 1 to level 5 within the organisation were interviewed. From the outset of this research study, there is a high level of understanding among respondents on what needs to be digitally transformed across the mine, and the purpose of such digital transformation.

According to the 14 Respondents, the following aspects which emerged from the responses, form part of what the Digital@Company X program aims to achieve through digital transformation efforts:

- Digital Capability
- Human Resources
- Worker Enablement
- Culture
- Customer Experience
- Process Digitisation
- Unified Data
- Performance Management

Apart from the unanimous responses that the key focus to digitally transform the mine is the entire value chain and its components, respondents 13 was the only respondent to mention the return on investment to shareholders as one of the critical components that underpin the efforts to digitise operations.

The second component of this research study focused on the effective ways to engage various stakeholders within the value chain to enhance the implementation and adoption of digital technologies within Company X as part of its digital transformation journey. The following categories based on several responses were generated:

- Poor Change Management
- Unclear Vision
- Value Realisation
- Stakeholder Involvement
- Ease of Use and Adoption

The majority of the respondents, especially Respondent 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, and 14 emphasised the importance of stakeholder engagement across all levels and change management practices that include communication being a key driver to enable adoption and effective inclusivity of employees across the organisation. Respondent 12 is a senior

manager in the organisation, and he mentioned the importance of ensuring digital technologies are practical and easy to use by everyone to drive adoption.

All respondents seem to have a common understanding and appreciation of the ways to effectively engage with the stakeholders to implement and enable the adoption of technologies within its operations. Training and reskilling of employees as part of the change management was mentioned by Respondent 1, 3, 4, and 13.

CHAPTER 5. DISCUSSION OF THE RESULTS

5.1 Introduction

The purpose of this research was to investigate and understand the areas of focus to digitally transform the mine (what to transform) according to the Digital@Company X program/roadmap, and the approach to effectively engage various stakeholders to enable implementation and adoption of the digital technology initiatives in the roadmap. The ambition was to understand these concepts in the context of Company X as a mining house to ultimately produce or recommend a relevant framework that enables other mining companies, various stakeholders and digital transformation agents in mining to use as a benchmark to effectively approach or embarking on a journey to digitally transform a mine.

A total of 14 employees across four different levels of management (Executives, Senior Managers, Middle Managers, and Junior Managers) at Company X were interviewed within two months to provide input into this research study. As much as the related literature reviewed helps in providing answers based on the themes generated from the interviews, these interviews provided an opportunity to test the theoretically proven digital transformation frameworks in the context of Digital@Company X in practice, and in particular for a mining company.

This chapter looks at the findings presented in chapter 4 from the qualitative structured interviews and compares them literature review theory. For each section that follows, the results corresponding to each of the two research questions will be discussed, while demonstrating the relationship between the relevant literature and the outcomes of the interviews conducted by the researcher.

5.2 Discussion pertaining to Research Question 1

Research Question 1: According to Digital@Company X Program roadmap, what are the areas of focus to digitally transform the mine (What to transform)?

The first research question intended to understand what Company X intends to transform (what to transform) through its Digital@Company X program. Responses to this question would help in understanding the applicable digital transformation framework in the context of a mining firm.

Most respondents reported that the following factors are the key areas of focus to digitally transform the mine according to the Digital@Company X roadmap/program: Digital Capability, Human Resources, Worker Enablement, Culture, Customer Experience, Process Digitisation, Unified Data and Performance Management.

The finding of **Digital Capability** being the focus area in terms of the IT infrastructure as highlighted by Respondent 1 and 6 agree with the Digital Piano framework proposed by Wade (2015). This framework covers ICT Capability as one of the components to be transformed. The theoretical premise for this conceptual framework is that: the application of digital technologies to achieve a successful transformation should lead to the significant organisational transformation which should cover the following areas within the organisation's structure: **ICT capability,** Internal structure (how the company is organised), People (the company's human resource assets), Processes (how the company does things), Business model, Its offerings (products or services offered by the company), and Its engagement models (how the company engages with external stakeholders).

In agreement with the Digital Capability as an umbrella for IT capability and infrastructure as the focus area, the Digital Orchestra Framework (Wade et al., 2017) supports this view by respondents. This framework states the following areas of focus being fundamental to the digital transformation roadmap/journey: IT Capability (Operations), Customers, Offerings, Processes, Structures, Incentives, Culture (Organisation), Workforce (Engagement), Channels (Go-to-Market) and Partners.

Thirdly, this finding further agrees with the Six Keys to Success Framework proposed by (Kavadias, Ladas and Loch, 2016) that IT Capabilities should be among the areas of focus in the digital transformation journey. The Digital Capability component that respondents agree on, is related with the findings obtained by Bradley (2015) in the 'Digital Vortex' framework which shows how companies in various industry segments are being affected by digital disruption, i.e. "it represents the inevitable movement of industries towards a digital centre in which business models and value chains are digitised to the maximum extent" (Bradley et al., 2015). This framework highlights the following components as critical to how the organisation needs transform: Business Model, Organisation structure, Human resources, Internal processes, **IT capabilities**, Products/ Services, Stakeholders engagement.

The Finding of **Unified Data**, as extracted from the respondents, incorporates Integrated Operations Centres, Realtime data, Integration, Data-Driven Mine, Eliminating Silos and Single Platform, agrees with the Digital Enterprise Integrative Management Framework (Bowersox, Closs and Drayer, 2005). These authors believe that true supply chain excellence can be through digital business transformation. This framework breaks the transformation into three processes:

- Enterprise core processes – Which is mainly focused on the maximising of customer value.
- shared real-time information and operational connectivity – this creates a response-based/demand-driven network of supply chain relationships among participating business entities.
- Commitment to operational excellence – manifested in the form of customer-centricity.

The Digital Enterprise Integrative Management Framework links the achievement of true collaboration within a supply chain with digital business transformation as a precondition for true collaboration to start occurring. The authors stated that "Companies today participate in extended supply chains, where real operational efficiency and revenue enhancement come from greater visibility, integration, and

synchronization among connected partners". The majority of the respondents based on what the research question one intended to unpack, agrees with this view as part of the Digital@Company X roadmap focus.

Most of the respondents mentioned digitisation of various processes (**Process Digitisation**) within the value chain as one of the focus areas, this view is in line with the Digital Transformation Framework, by Corver and Elkhuizen. Corver & Elkhuizen (2014) believe that this framework will be useful and add value to any organisation developing a digital vision or build new business models focused on digital opportunities. According to Corver and Elkhuizen (2014), Digital business transformation is built on the following four pillars. The Customer, The Product., The Organisation, and **The Processes and Systems**.

This Process Digitisation approach is further supported by the previously mentioned frameworks such as the Digital Orchestra Framework (Wade et al., 2017), the Six Keys to Success Framework proposed by (Kavadias, Ladas and Loch, 2016), the Digital Piano framework proposed by Wade (2015), and the Digital Enterprise Integrative Management Framework (Bowersox, Closs and Drayer, 2005).

Respondent 7 and 13 mentioned customers and customer satisfaction (**Customer Experience**) as one of the pillars of its digital transformation roadmap. Corver & Elkhuizen (2014) echoed that digital transformation often begins with the customer. These authors strongly believe that a process of knowing and understanding the customers better is the first step before any improvements to service levels offered to them, followed by a process of working on the digitisation of customer experience.

The finding of **Human Resources** (in the form of reskilling, training, change management, and stakeholder engagement), and **Performance Management** which is closely related to **Worker Enablement** (quick decision making, and overall effectiveness) is an integral part of the Digital@Company X roadmap. Supporting this finding from literature is The Digital Reinvention Framework (Berman, Korsten and Marshall, 2016) proposed based on the notion that "for successful digital reinvention, organisations need to pursue a new strategic focus, build new expertise, and establish

new ways of work." According to this framework, for traditional organisations to achieve successful digital reinvention (digital business transformation), they must pursue a fundamental bottom-up reinvention of strategy, operations, and technology. This means the company should be maintaining an overarching focus on experience and not on productivity. This Digital Reinvention Framework proposes an appropriate pathway to achieving a digitally transformed organisation through an experience-first approach that focuses on the adoption of digital technologies such as cloud computing, cognitive and analytics, mobile, Blockchains, IoT, and other, built on a foundation of three key organisational priorities that are: the pursuit of a new focus, development of new expertise, and the establishment of new ways of working".

The Digital Innovation Strategy proposed by Nylén & Holmström (2015), agrees to a focus on the organisation, particularly by covering skills. The Digital Orchestra Framework (Wade et al., 2017) also supports the workforce enablement as one of the priority areas when embarking on a digital transformation journey.

Further to support this finding at Company X is the non-academic qualitative study done by Capgemini Consulting firm in 2011 which focussed on 157 executives and business leaders in 50 companies across 15 different countries covering a broad range of industries which among other findings established that **Worker Enablement** and **Performance Management** are part of what the majority of the business leaders tend to focus their digital transformation efforts on.

The findings from respondent 5 were about **Culture** (changing behaviours, changing how various mining departments and people work), this is further supported by the Digital Piano Framework proposed by Wade (2015) and the Digital Orchestra Framework.

5.3 Discussion pertaining to Research Question 2

Research Question 2: How to effectively engage all stakeholders in the implementation of the digital transformation strategy (Digital@Company X

Program) to ensure the adoption and successful implementation of digital technology initiatives?

The second research question intended the effective way to engage all stakeholders to drive adoption and successful implementation of the Digital@Company X digital transformation program. Various responses to this question would help in understanding the ways to drive adoption and change in the context of digital transformation within a mining firm.

The majority of respondents believe that the following factors about the research question one is important: **Ease of Use and Adoption**, **Poor Change Management**, **Unclear Vision**, and **Stakeholder Involvement**.

(Westerman, Bonnet & McAfee, 2014) stated that Digital transformation starts when you create a transformative vision of how your firm will be different in the digital world, and then engage your employees to make the vision a reality. Establishing the right digital governance model is critical since it acts as the rudder to steer your digital initiatives in the right direction. The findings of this research study agree with this view.

The finding on the **Ease of Use and Adoption** emerged from 9, 12 and 13. Respondent 9 emphasised that adoption is important in their digital transformation journey and that if stakeholders do not see the value and benefits, it can make the journey a bit difficult. Respondent 11 further elaborates on the adoption phenomenon by stating that practicality and the ease of use of digital technologies to be implemented are critical in driving adoption. Respondent 13 further echoed that if you do not have adoption, the whole journey can be an absolute waste of money.

These views echoed by these three respondents have literature that supports them when referring to technology adoption. Davis (1989) proposed the Technology Acceptance Model framework, and a third version of the framework now exists (TAM3). It helps explain the usage of technology within a specific context, and the usage could either be the ease of use or the usefulness of that specific technology as perceived by the users. The perceived usefulness can be defined as the extent to

which a person believes that using an IT will enhance their job performance, and the perceived ease of use is the degree to which a person believes that using technology will be free of effort. This view by Davis (1989) validates the above respondents.

However, For the framework to continuously be a useful tool for analysis and to understand various factors that influence technology usage and adoption, the model needs to continuously evolve. “The research on individual-level IT adoption and use is mature and has provided rich theories and explanations of the determinants of adoption and use decisions, TAM being a theoretical framework product of one of such research is highly predictive of IT adoption and use, one of the major criticism against the model has been its lack of actionable guidance to practitioners” (Venkatesh and Bala, 2008). TAM had some inadequacies which lead to a proposed update and the theoretical expansion of the model, TAM2 was then further developed by Venkatesh & Davis (2000). They did so by identifying and theorising about the perceived usefulness – subjective norm, image, job relevance, output quality, result demonstrability, and perceived ease of use – experience and voluntariness (Venkatesh and Davis, 2000).

Venkatesh & Bala (2008) further updated the model to come up with TAM3. It is a combination of TAM2 model of the determinants of perceived ease of use by Venkatesh and Davis with that of Venkatesh (Venkatesh, 2000). TAM3 postulates three new relationships that were not empirically tested in TAM2. In TAM3, Venkatesh & Bala (2008) proposed that “experience will moderate the relationship between the following – perceived ease of use and perceived usefulness; computer anxiety and perceived ease of use; and, perceived ease of use and behavioural intention.”

Further to support the ease of use and adoption of these digital technologies as indicated by the respondents is The Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh, Morris, Davis GB and Davis FD. UTAUT is a combination of key concepts found through various research work in explaining ICT usage behaviour (Venkatesh et al., 2003). The key concepts come from the Theory of Planned Behaviour (TPB), innovation diffusion theory (IDT), Technology Acceptance

Model (TAM), motivation model, and the social cognitive theory to develop a unified theory for technology acceptance (Negahban and Chung, 2014). The framework proposes that the business is likely to accept, use and adopt technology if the environmental, social influence and economic factors are all present. The UTAUT framework with its empirical evidence continues to be useful in explaining variance in behavioural intention towards the use of any piece of technology.

This adoption finding is further justified through the Diffusion of Innovations Theory proposed by Everret Rodgers. This theory seeks to explain how, why, and at what rate do new ideas and technology spread. Rogers argues that diffusion is the process by which an innovation is communicated over time among the participants in a social system. Adoption is a decision of "full use of an innovation as the best course of action available" and rejection is a decision "not to adopt an innovation" (Rogers, 1982). Rogers defines diffusion as "the process in which an innovation is communicated through certain channels over time among the members of a social system". As expressed in this definition, innovation, communication channels, time, and social system are the four key components of the diffusion of innovations. When promoting innovation to a target population, it is important to understand the characteristics of the target population that will help or hinder the adoption of the innovation. The Diffusion of Innovations Theory has been used successfully in many industries including communication, agriculture, public health, criminal justice, social work, and marketing. In public health, the Diffusion of Innovation Theory is used to accelerate the adoption of important public health programs that typically aim to change the behaviour of a social system. Rogers further defines an adopter category as a classification of individuals within a social system based on innovativeness:

- **Innovators** - These are people who want to be the first to try the innovation. They are venturesome and interested in new ideas. These people are very willing to take risks and are often the first to develop new ideas. Very little, if anything, needs to be done to appeal to this population.
- **Early Adopters** - These are people who represent opinion leaders. They enjoy leadership roles and embrace change opportunities. They are already aware of

the need to change and so are very comfortable adopting new ideas. Strategies to appeal to this population include how-to manuals and information sheets on implementation. They do not need the information to convince them to change.

- **Early Majority** - These people are rarely leaders, but they do adopt new ideas before the average person. That said, they typically need to see evidence that the innovation works before they are willing to adopt it. Strategies to appeal to this population include success stories and evidence of the innovation's effectiveness.

- **Late Majority** - These people are sceptical of change and will only adopt an innovation after it has been tried by the majority. Strategies to appeal to this population include information on how many other people have tried the innovation and have adopted it successfully.

- **Laggards** - These people are bound by tradition and very conservative. They are very sceptical of change and are the hardest group to bring on board. Strategies to appeal to this population include statistics, fear appeals, and pressure from people in the other adopter groups

With mining being seen as a traditional labour-intensive sector lagging in terms of technology, Company X can be classified as an Early Adopter of these digital technologies within the South African Mining industry.

The majority of the respondents agree that **Change Management**, **Vision** and **Stakeholder engagement** is important in enabling adoption and implementation of the Digital@Company X Program. According to Kotter (2006), change takes years, and it is not an event and further states that it requires careful consideration when undertaken to avoid pitfalls because even highly skilled managers make mistakes. Many transformation initiatives that failed within many companies have been linked to a poor understanding of change being a transformative process by organisational leaders and managers (Kotter, 2006). According to Kotter (2006), the following steps can be taken to by leaders in the order stated to increase the probability of any change or transformative process a chance to succeed:

- Establish a sense of urgency.
- Form a powerful guiding coalition.
- Create a vision.
- Communicate the vision.
- Empower others to act on the vision.
- Plan for and create short term wins.
- Consolidate improvements and produce more change.
- Institutionalize new approaches

Leaders are required to blend different set of skills to lead and drive change, be forward-looking, understand technology, have strong leadership in the digital world (Kane et al., 2019). These skills include a transformative vision.

The Digital Piano Framework and the Digital Orchestra Framework also supports the ideology of stakeholder engagement.

5.4 Conclusion of the discussion of the results

With a particular focus on the Digital@Company X roadmap components on what to transform, the respondents in the research question one are aligned with the theory reviewed in the literature. Despite the **Proposition Two** of the study stating that the appropriate framework for digital transformation within the mining context is the Digitisation Piano Digital Business Transformation Framework, it has become evident that the framework to apply in the mining context has components of other theoretical and conceptual frameworks in terms of what to transform. According to the findings and comparison with literature, a combination of the following frameworks show relevancy in terms of the digital transformation approach in the context of mining.

- Digital Piano framework
- Digital Orchestra Framework
- Six Keys to Success Framework
- Digital Enterprise Integrative Management Framework

- Digital Transformation Framework, by Corver and Elkhuizen
- The Digital Reinvention Framework
- Digital Innovation Strategy Framework

In addition to research question one and related literature, **Proposition One** can be validated that the Digital transformation of the internal processes within the mining value chain is the key area of focus.

The second research question about effective engagement to drive adoption and implementation of digital technologies had the majority of the respondents indicating the Ease of Use and Adoption, Poor Change Management, Unclear Vision, Value Realisation, Stakeholder Involvement as critical components of the roadmap.

The Technology Acceptance Model (TAM) showed to have sufficient empirical evidence to support their viability key models that predict user intentions and behaviour towards the use and adoption of technology. Considering this model about the adoption and use of digital technologies from an organisational point of view, predicting digitalisation based on the perceptions of ease of use and the usefulness of digital technologies becomes inadequate to understand the dynamics that continuously drive organisational decisions to take the digital route.

The UTAUT seeks to understand technology adoption from a 'person' point of view, while the Diffusion of Innovation Theory focuses on:

- The characteristics of an innovation which may influence its adoption.
- The decision-making process that occurs when individuals consider adopting a new idea, product or practice.
- The characteristics of individuals that make them likely to adopt an innovation.
- The consequences for individuals and society of adopting an innovation.
- The Communication channels used in the adoption process.

In conclusion, the theory and findings from this research strongly agree with **Proposition Three** which states that a lack of stakeholder engagement and adoption will lead to the failure of digital transformation initiatives.

CHAPTER 6. CONCLUSIONS & RECOMMENDATIONS

6.1 Introduction

The introduction of digital technologies in mining means that mining organisations can mine smarter, improve safety, reduce cost, develop new insights from their current operation, and contribute towards the sustainable economic and social development of the country in a broader perspective.

However, the understanding of the transformational process in terms of what needs to be digitally transformed within a mine, and the process of ensuring effective implementation, stakeholder engagement and adoption of these technologies is critical to the success of the journey.

This study aimed to assess and explore the digital transformation journey of Company X mining company to understand the relevant or appropriate digital transformation framework applicable in the context of mining by asking respondents what needs to be transformed according to their roadmap, and link this to the existing theoretical and conceptual frameworks. This would help provide a baseline model or approach to be considered by other mining organisation that wants to undertake a similar journey.

Further to this study, the research aimed to understand the effective ways to engage various stakeholders to drive the implementation and adoption of the digital@Company X program initiatives. The technology adoption and use component of this research are strongly supported by the theoretically proven Technology Acceptance Model.

This chapter presents the conclusions of the findings and further provides recommendations based on the findings that emerged from the two research questions. The suggestions for further readings are provided at the end to conclude the study.

6.2 Conclusions regarding Research Question 1

Research Question 1: According to Digital@Company X Program roadmap, what are the areas of focus to digitally transform the mine (What to transform)?

The following propositions for research question one were made based on the literature review:

- 4IR in the mining sector is spurring the uptake and application of digital technologies while significantly changing the industry structure of mining as we know it, therefore the digital transformation of the internal processes within the mining value chain is the key area of focus for a South African mining firm.
- Various theoretical and conceptual digital transformation frameworks exist, however, the Digital Piano digital transformation model is the most appropriate for a South African mining company's digital transformation journey.

To conclude the study on this research question, the following areas emerged as the key areas of focus to digitally transform the mine according to the Digital@Company X roadmap:

- Digital Capability
- Human Resources
- Worker Enablement
- Culture
- Customer Experience
- Process Digitisation
- Unified Data
- Performance Management

From the qualitative data, it is important to state that 100% of the interviewed executives, junior managers, middle managers, and senior managers believe that the introduction of the digital technologies within Company X will lead to worker enablement through digitised processes that will eventually improve decision making

by using the power of visualised data. 50% of the executives indicated the importance of customer experience in their digital transformation journey. 65 % of the respondents indicated the importance of unified data by having integrated operations centres, whereas 36% mentioned performance management as the key area of focus, and only 14% of the respondents mentioned IT infrastructure to enhance digital capability as another focus area for the internal digital transformation journey.

According to the first proposition made, it is evident from the research that digitalisation of the internal process within the mining value chain is an important focus area. This proposition is further supported by the majority of the reviewed literature. In conclusion to this research question backed by the findings and literature, it is evident that the proposition made in this research is accurate.

The second proposition proposed the Digital Piano framework as the most appropriate or relevant transformation model to be used by any mining firm intending to embark on a digital transformation journey. The remarks on this proposition would be validated by comparing what is transformed in practice according to Digital@Company X roadmap to what various frameworks focus on in terms of digital transformation. The findings were not entirely in agreement with the proposition. Based on what is currently done at Company X, the combination of these following frameworks in the context of the mining firm proves to be more appropriate than using a specific model.

- Digital Piano framework
- Digital Orchestra Framework
- Six Keys to Success Framework
- Digital Enterprise Integrative Management Framework
- Digital Transformation Framework, by Corver and Elkhuizen
- The Digital Reinvention Framework
- Digital Innovation Strategy Framework

To conclude the two propositions made in research question one, for a mining firm to mine smarter, improve safety, reduce operational cost, improve the effectiveness and efficiency of the employees and various internal processes in the digital world, it is

important to approach digital transformation holistically through a clear focus on process digitisation along the values chain to obtain maximum technological benefits. Finally, It is also important to use a combination of various theoretical and conceptual digital transformation frameworks to ensure the best practice approach that will help avoid leaving out critical areas that may be significant to the success of the mining company's digital transformation efforts.

Mining has various processes and stakeholders involved in every phase, from exploration, extraction, ore processing and sales. Therefore, a mining company will have to further perform a detailed analysis to develop an approach of what to transform within each process.

6.3 Conclusions regarding Research Question 2

Research Question 2: How to effectively engage all stakeholders in the implementation of the digital transformation strategy (Digital@Company X Program) to ensure the adoption and successful implementation of digital technology initiatives?

The following proposition for research question two was made based on the literature review:

- Embarking on the digital transformation journey in the mining sector in the 4IR era requires the co-operation and participation of all stakeholders to ensure the successful implementation and adoption of digital technology initiatives.

In the conclusion of this second research question, the following themes or findings emerged based on the responses received from the majority of the respondents:

- Poor Change Management
- Unclear Vision
- Value Realisation
- Stakeholder Involvement
- Ease of Use and Adoption

According to findings gathered from the respondents, it is evident that there is a clear understanding of what could lead to the failure of digital technology interventions within Company X. Respondents further echoed the importance of change management, vision, stakeholder engagement, the value brought by these technologies as well as the importance of Ease of use to drive adoption. These findings are strongly supported through literature as discussed in chapter five of this research. Various managers (Senior, Middle and Juniors) are the users of any new technology initiative that is implemented in the mine. These managers have a strong interest in the practicality of any IT system implemented to drive productivity and efficiency, and the ease of use of the system is an important factor for them. They are a key stakeholder in the process, and if initiatives are just driven from the top without their input, that might lead to poor adoption if they do not fulfil their operational needs.

Senior managers at the operations are responsible for overseeing the implementation of these digital technology initiatives and it is important to note the 80 % of them believe that the ease of use or application of these technologies will lead to easier adoption by the workers and the organisation as a whole. 57% of the respondent indicated the importance of stakeholder involvement in the digital transformation journey to have success. Further to the findings, 86% of the respondents believe that having good change management practices in place is critical. 50% of the executives interviewed echoed the importance of understanding the vision.

To further elaborate on these statistical findings, we can use the extent to which the Diffusion of Innovations theory applies to Company X case. The DOI theory states that Innovation, communication channels, time, and social system are the four key components of the diffusion of innovations, and when promoting innovation to a target population, it is important to understand the characteristics of the target population that will help or hinder the adoption of the innovation. We can further conclude that this theory applies to Company X. However, due to the non-complexity of technologies implemented by Company X, the academic argument to critique DOI theory by Damsgaard and Lyytinen (2001) does not apply to this case as a result of its main concern being around the diffusion of complex networked technologies.

The TAM (Technology Acceptance Model) theoretical framework helps explain the usage of technology within a specific context, and the usage could either be the ease of use or the usefulness of that specific technology as perceived by the users. Therefore, based on the 80% of the respondents believing that the ease of use of these technologies and the perceived usefulness in terms of practical application will lead to easier adoption indicates that TAM is accurate in the case of Company X. It will be extremely important for a mining firm to have an inclusive approach with the workers to ensure the practicality of digital solutions being implemented to drive adoption.

In conclusion, the third proposition is validated through the research findings and literature that any lack of effective stakeholder engagement when pursuing a digital transformation roadmap or efforts within a mining firm will lead to a lack of adoption and ineffective implementation.

Therefore, a clear understanding of these factors will drive the Company X team to have an effective approach to its Digital@Company X program. This finding will also help other mining companies to ensure these factors are well catered for in their approach when embarking on a digital transformation journey. Executives will greatly benefit from this understanding to ensure they can stay ahead of the competition or remain competitive by applying this knowledge to drive the effective digital transformation of their mining companies. These technology initiatives will enhance the health and safety of employees, and when this benefit is realised, the labour unions and sector regulators will significantly drive policy changes that advocates for the implementation and adoption of certain technologies.

6.4 Recommendations

Firstly, before embarking on any digital transformation exercise in terms of what to transform and which is the applicable or appropriate digital transformation model to be used, the leadership team must create and follow an integrated digital transformation compass (Westerman, Bonnet & McAfee, 2014) with the following four pillars (Frame,

Focus, Mobilise and Sustain), these pillars address the ways to effectively engage various stakeholders within an organisation in driving effective implementation and adoption of digital technologies. These pillars are significantly important for executives and all the managers in the organisation to follow:

- **Framing the digital challenge**: The organisation must build awareness of digital opportunities and threats. This process involves well-thought crafting of the vision that the top team is aligned with, and the assessment of the organisation's digital maturity to know where to start.
- **Focus Investment**: The vision needs to be translated into an actionable roadmap. The building of cross-silo governance structures is important. Funding must be made available for the mechanism and investment of the transformation journey.
- **Mobilise the organisation**: This involves sending unambiguous signals of the digital transformation ambitions and the change needed though active internal marketing. The workforce must be engaged to co-create solutions and actively involving those that will be required to drive change across all stakeholders to avoid creating solutions that are not practical and not easy to use. New behaviours must be set, and the whole organisation must be evolved towards a more innovative culture through active encouragement and a shift driven by the use of digital technologies to change how people work and collaborate.
- **Sustain the transition**: Necessary foundation skills must be built, this involves having a ramp-up plan for digital competencies in the organisation, creating a well-structured digital platform as well as building a strong IT-business relationship. Rewards structures must be aligned to overcome traditional barriers, and these must be aligned to the transformation initiatives. Lastly, the progress of digital transformation must be monitored, measured and iterated whenever it is necessary, therefore a management process to aid this component is crucial and needs to be put in place.

When the above process and its significance is understood and undertaken, then a mining company may embark on a detailed process that needs to run concurrently

while linking with the first pillar of framing the digital challenge. This detailed process is about what to digitally transform and understanding the applicable digital transformation framework to use in that transformation process. Based on the findings from literature and the research, the combination of the following frameworks must be used to create an effective digital transformation roadmap that has no gaps and can work for a mine:

- Digital Piano framework
- Digital Orchestra Framework
- Six Keys to Success Framework
- Digital Enterprise Integrative Management Framework
- Digital Transformation Framework, by Corver and Elkhuizen
- The Digital Reinvention Framework
- Digital Innovation Strategy Framework

This means a mining company needs to put together components from various frameworks to create an Integrated Digital Transformation Framework for Mining (IDTFM). Inclusive of various frameworks components, the recommended framework will focus on:

- Digital and IT Capabilities
- Human Resources
- Worker Enablement
- Culture Transformation
- Customer Satisfaction and Experience
- Process and Systems Digitisation
- Unified Data and Integrated Operations Centres
- Performance Management
- Business Model
- Environment

- Product Quality
- Organisational Structure
- Stakeholder Engagement

Choosing a single framework from the literature to apply to the mine as a relevant digital transformation strategy may have a dire digital transformation process or journey that leads to poor implementation, lack of adoption and wastage of resources with no realisation of intended digital benefits if it does not holistically cover various aspects of the mine or organisation as a whole.

Lastly, the Diffusion of Innovations Theory has been used successfully in many industries including communication, agriculture, public health, criminal justice, social work, and marketing, therefore it can also be applied in a case of a mining firm to ensure adoption of innovations brought in the form of digital technology implementations. TAM is also applicable in the context of a mining firm.

To further conclude, regulators and labour unions have to be regularly engaged throughout the journey. This will help them in creating purposeful policies and frameworks that drive the uptake of digital technologies in mining to improve productivity and employee wellbeing through best practice health and safety technology interventions.

6.5 Suggestions for further research

This study was not focused on how to transform various processes or parts of the mining value chain. In the limitation section of this study, it has been acknowledged that the study is that of a single case of Company X mine within the coal sector in Mpumalanga Province of South Africa, which constitute a purposive and convenience sample. It is recommended that a comparative study be conducted within other local companies within the coal sector and other commodities. The study must be expanded internationally too. This will help determine the strong reliability of the findings from this study.

Apart from Company X being determined a leader in digital technology implementation within the context of South African Mining, an international comparison will further help in yielding interesting and relevant results that will determine the extent to which a South African mining firm compares with international companies in the same coal mining sector and other commodities.

The literature and the findings from the research were high level and not providing detail on various aspects of the digital transformation journey as per the objectives set out from the beginning, therefore, further research to critically analyse various components of the digital transformation roadmap in mining, their actual implementation process, stakeholder engagement practices, and adoption will add significant value to the body of knowledge. Lastly, the concept of digital mining has to be researched thoroughly across the world to help expand the digital technology body of knowledge within the mining industry.

REFERENCES

Armstrong, B. (2019). Digital Transformation and Change Management.

Berman, S., Korsten, P. and Marshall, A. (2016). A four-step blueprint for digital reinvention. Strategy & Leadership, [online] 44(4), pp.18-25. Available at: http://public.dhe.ibm.com/common/ssi/ecm/gb/en/gbe03752usen/gbe03752-usen-08_GBE03752USEN.pdf [Accessed 12 Oct. 2019].

Bossmann, J. (2019). Top 9 ethical issues in artificial intelligence. [online] World Economic Forum. Available at: https://www.weforum.org/agenda/2016/10/top-10-ethical-issues-in-artificial-intelligence/ [Accessed 20 May 2019].

Bowersox, D., Closs, D. and Drayer, R. (2005). The Digital Transformation: Technology and beyond. [online] Available at: https://search.proquest.com/docview/221201326?accountid=15518 [Accessed 7 Oct. 2019].

Braun, V. and Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), pp.77-101.

Capgemini.com. (2011). Digital_Transformation__A_Road-Map_for_Billion-Dollar_Organizations. [online] Available at: https://www.capgemini.com/wp-content/uploads/2017/07/Digital_Transformation__A_Road-Map_for_Billion-Dollar_Organizations.pdf [Accessed 30 Jul. 2019].

Corver, Q. and Elkhuizen, G. (2014). A Framework for Digital Business Transformation. [online] Cognizant.com. Available at: https://www.cognizant.com/InsightsWhitepapers/a-framework-for-digital-business-transformation-codex-1048.pdf [Accessed 3 Oct. 2019].

Damsgaard, J., & Lyytinen, K. (2001). What's Wrong with the Diffusion of Innovation Theory?. *Diffusing Software Product And Process Innovations*, *59*, 173-19.

Company X.com. (2019). Company X pioneering digital transformation | Company X. [online] Available at: https://www.Company X.com/media-centre/2019/Company X-pioneering-digital-transfo-rmation [Accessed 4 Aug. 2019].

Gilmartin, K. (2019). Summary: Artificial Intelligence and the Implications for Governance and Public Policy | Center on Global Economic Governance. [online] Cgeg.sipa.columbia.edu. Available at: https://cgeg.sipa.columbia.edu/summary-artificial-intelligence-and-implications-governance-and-public-policy [Accessed 11 Jun. 2019].

Holloway, I. and Todres, L. (2003). The Status of Method: Flexibility, Consistency and Coherence. Qualitative Research, 3(3), pp.345-357.

James, N. (2019). Research organisations look to technology to reverse deep-level mining decline. [online] Mining Weekly. Available at: https://www.miningweekly.com/article/research-bodies-turning-to-technology-to-reverse-decline-of-deep-level-mining-2019-04-05 [Accessed 9 Jun. 2019].

Kane, G., Phillips, A., Copulsky, J. and Andrus, G. (2019). How Digital Leadership Is(n't) Different. [online] MIT Sloan Management Review. Available at: https://sloanreview.mit.edu/article/how-digital-leadership-isnt-different/ [Accessed 10 Aug. 2019].

Kavadias, S., Ladas, K. and Loch, C. (2016). The 6 Elements of Truly Transformative Business Models. [online] Harvard Business Review. Available at: https://hbr.org/2016/10/the-transformative-business-model?cm_sp=Article-_-Links-_-Comment [Accessed 10 Oct. 2019].

Kilian, A. (2018). Company X goes digital at new Mpumalanga coal mine. [online] Engineering News. Available at: https://www.engineeringnews.co.za/article/Company X-goes-digital-at-new-mpumalanga-coal-mine-2018-07-05 [Accessed 2 Jul. 2019].

Klutz, A. and Firlej, M. (2016). How to be a leader in the digital age. [online] World Economic Forum. Available at: https://www.weforum.org/agenda/2016/05/how-to-be-a-leader-in-the-digital-age/ [Accessed 5 Aug. 2019].

Kotter, J. (2006). Leading Change Why Transformation Efforts Fail. [online] Wdhb.org.nz.Available at: https://www.wdhb.org.nz/assets/Uploads/Documents/d0b6f78cf6/rttc_leading-change-by-j-kotter-harvard-business-review.pdf [Accessed 30 Jul. 2019].

LaMorte, W., 2019. Diffusion Of Innovation Theory. [online] Sphweb.bumc.bu.edu. Available at: <https://sphweb.bumc.bu.edu/otlt/MPH-Modules/SB/BehavioralChangeTheories/BehavioralChangeTheories4.html> [Accessed 11 December 2019].

Lincoln, Y. and Guba, E. (1986). But is it rigorous? Trustworthiness and authenticity in naturalistic evaluation. New Directions for Program Evaluation, 1986(30), pp.73-84.

Marshall, C. and Rossman, G. (2011). Designing qualitative research. 5th ed. Los Angeles: Sage, pp.205-225.

Matt, C., Hess, T. and Benlian, A. (2015). Digital Transformation Strategies. Business & Information Systems Engineering, 57(5), pp.339-343.

Mineralscouncil.org.za. (2019). Mining in SA - Minerals Council South Africa. [online] Available at: https://www.mineralscouncil.org.za/sa-mining [Accessed 17 Jul. 2019].

National Planning Commission. (2019). The National Development Plan. [online] Available at: https://nationalplanningcommission.wordpress.com/the-national-development-plan/ [Accessed 22 Jul. 2019].

Negahban, A. and Chung, C. (2014). Discovering determinants of users perception of mobile device functionality fit. Computers in Human Behavior, 35, pp.75-84.

Nwaiwu, F. (2018). Review and Comparison of Conceptual Frameworks on Digital Business Transformation. Journal of Competitiveness, [online] 10(3), pp.86-100. Available at: https://doi.org/10.7441/joc.2018.03.06 [Accessed 13 Oct. 2019].

Nylén, D. and Holmström, J. (2015). Digital innovation strategy: A framework for diagnosing and improving digital product and service innovation. Business Horizons, 58(1), pp.57-67.

Patton, M. (2002). Qualitative research & evaluation methods. 3rd ed. Thousand Oaks, California: SAGE Publications, Inc., pp.429-541.

Projectsiq.co.za. (2019). Mining in South Africa. [online] Available at: https://www.projectsiq.co.za/mining-in-south-africa.htm [Accessed 20 Jul. 2019].

Rogers, E. (1982). Diffusion of Innovations. 3rd ed. New York: The Free Press, pp.1-375.

Schmarzo, B. (2016). Digital Business Transformation Framework. [online] CIO. Available at: https://www.cio.com/article/3130103/digital-business-transformation-framework.html [Accessed 9 Oct. 2019].

Schram, T. (2006). Conceptualizing and proposing qualitative research. 2nd ed. Upper Saddle River, NJ: Pearson Education Inc, p.107.

Sustainabledevelopment.un.org. (2019). Sustainable Development Goals .:. Sustainable Development Knowledge Platform. [online] Available at: https://sustainabledevelopment.un.org/?menu=1300 [Accessed 12 Aug. 2019].

Venkatesh, V. (2000). Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation, and Emotion into the Technology Acceptance Model. Information Systems Research, 11(4), pp.342-365.

Venkatesh, V. and Bala, H. (2008). Technology Acceptance Model 3 and a Research Agenda on Interventions. Decision Sciences, 39(2), pp.273-315.

Venkatesh, V. and Davis, F. (2000). A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. Management Science, 46(2), pp.186-204.

Venkatesh, V., Morris, M., Davis, G. and Davis, F. (2003). User Acceptance of Information Technology: Toward a Unified View. MIS Quarterly, 27(3), p.425.

Wade, M. (2015). Digital Business Transformation A Conceptual Framework. [online] IMD business school. Available at: https://www.imd.org/research-knowledge/reports/framework/ [Accessed 13 Oct. 2019].

Wade, M., Noronha, A., Macaulay, J. and Barbier, J. (2017). Orchestrating Digital Business Transformation. [online] IMD business school. Available at: https://www.imd.org/research-knowledge/reports/digital-orchestra/ [Accessed 2 Oct. 2019].

Watkins, M. (2013). What Is Organizational Culture? And Why Should We Care?. [online] Harvard Business Review. Available at: https://hbr.org/2013/05/what-is-organizational-culture [Accessed 2 Jul. 2019].

Westerman, G. (2017). George Westerman | Your Company Doesn't Need a Digital Strategy. [online] MIT Sloan Management Review. Available at: https://sloanreview.mit.edu/article/your-company-doesnt-need-a-digital-strategy/ [Accessed 8 Oct. 2019].

Westerman, G., Bonnet, D. and McAfee, A. (2014). Leading digital. Boston: Harvard Business Review Press.

Yin, R. (2003). Case Study Research. 3rd ed. Thousand Oaks, CA: Sage Publications, pp.3-79.

APPENDIX A : PARTICIPANT AGREEMENT FORM

Thank you for agreeing to an interview with me. The purpose of my research is to assess the digital transformation journey of Company X by focusing on what to digitally transform and the effective ways of stakeholder engagement to ensure adoption and successful implementation of digital technologies.

I guarantee that none of this information will be attributable to you in any way. Should I be so fortunate as to be able to publish my research, I will take measures to ensure your anonymity. Please know that the ethics committee of the University of the Witwatersrand and the Wits Business School is stringent on this matter and my own academic reputation would be at stake if this were not the case.

I, _____agree to participate in the research study conducted by Mahene Patrice Benzane.

The purpose and nature o the study has been explained to me in writing and verbally.

My participation is voluntary, and I understand that I can withdraw at any time during the study without any repercussions.

I understand and give permission that the extracts from the interview may be quoted and published in the research report. I also give permission for the interview to be audio-recorded.

I also understand that confidentiality will be ensured in the research report and that no identifying features will be attached.

Signed: _____ Date: _____

APPENDIX B: ETHICS CLEARANCE CERTIFICATE

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

SCHOOL OF GRADUATE SCHOOL OF BUSINESS ADMINISTRATION ETHICS COMMITTEE
CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE **PROTOCOL NUMBER: WBS/BA361196/898**

PROJECT TITLE	Assessing digital transformation within a South African mining firm
INVESTIGATOR	Mr Mahene Benzane
SCHOOL/DEPARTMENT OF INVESTIGATOR	MM (Digital Business)
DATE CONSIDERED	10 DECEMBER 2019
DECISION OF THE COMMITTEE	Approved unconditionally
RISK LEVEL	MINIMAL RISK
EXPIRY DATE	28 FEBRUARY 2021

ISSUE DATE OF CERTIFICATE 17 February 2020 **CHAIRPERSON** _____
(Dr MDJ Matshabaphala)

cc: Supervisor: Mr Patel

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

I fully understand the conditions under which I am are authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

_____ _____/_____/_____
Signature **Date**

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

APPENDIX C: PERMISSION LETTER

This is the permission letter signed by a manager responsible for Company X's business optimisation and the digitalisation program.

11 December 2019

Dear Mr Mahene Benzane

Approval to conduct research: Assessing digital transformation within a South African mining firm

remains committed in making a difference in the society, and we believe this study is aligned to our purpose.

We are pleased to inform you that your request to conduct the Master of Management In Digital Businesses research with us has been granted, and we look forward to being of great assistance to you.

Yours sincerely

Manager Business Optimisation & Digital

APPENDIX D: INTERVIEW GUIDE

Pertaining to Research Question 1:

According to Digital@Company X program roadmap, what are the areas of focus to digitally transform the mine (What to transform).

- According to your digital transformation roadmap, what does Company X deem necessary as areas of interest to digital transformation of the mine?

Pertaining to Research Question 2:

How to effectively engage all stakeholders in the implementation of the digital transformation strategy (Digital@Company X Program) to ensure the adoption and successful implementation of digital technology initiatives.

- How are various stakeholders engaged to ensure the success of this program?
- How do you ensure adoption of these digital technology initiatives?

Profile questions:

Your participation in this research is anonymous, however, please provide the following information:

GENDER:

AGE RANGE: Under 30, 30-40, 40-50 Over 50

HIGHEST QUALIFICATION:

JOB LEVEL:

WORKING EXPERIENCE YEARS:

APPENDIX E: EXAMPLE OF TRANSCRIPTION

This appendix shows an example of one of the 14 transcripts. To preserve anonymity, it shows the full transcript for one respondent who was coded as respondent 9.

INTERVIEW TRANSCRIPT

Respondent: Respondent 9

Duration: 00:52:36

Date: Thursday 2 March 2020

Interviewer: Thank you once again for making time to meet and participate in my research.

Respondent: It's a pleasure, let's get going.

Interviewer: Alright. I will start with the first question. According to your digital transformation roadmap, what does Company X deem necessary as areas of interest to digital transform the mine?

Respondent: Look, that's an important question and I will try to give you a comprehensive answer in terms of our roadmap focus. Firstly, one has to acknowledge the importance and reason for embarking on this journey, because mines are known to be last adopters of technology, so you need to know why you are doing it, But to answer your question, Our processes in general are the focus area of our digital transformation strategy, and the value chain from the mine to the customers, and being able to see every step of the way is critical in our roadmap.

Interviewer: Thanks for that response, may you please elaborate more on what you mean by the processes being a key area of focus?

Respondent: okay cool, see we have a number of focus areas to digitally transform, first of all we recognize the importance of generated data which mines normally do not

use to their advantage, so we focus on getting data from different sources in order to help digitize our drilling, blasting, finance, marketing, logistics, and load and haul operations.

Interviewer: My second question is, how are various stakeholders engaged to ensure the success of this program?

Respondent: Look, we also involve everyone in the process to have input because it becomes easy to have buy-in. so that how we foster our engagement with stakeholders.

Interviewer: With that said, the following last question is a follow-up question linked to the previous one and seeks further expansion. So how do you ensure adoption of these digital technology initiatives??

Respondent: For us an an organisation, adoption is important, and it can be a tricky exercise, more especially when people can't see the value, so we try by all means to quantify benefits we are seeing and communicate back to different stakeholders. From what I have seen, it is clear that the way we communicate what the business intends doing with these technologies is very important, we had instances where we thought people do not support what we are doing by not fully participating in these projects, only to realise later that the problem was lack of understanding on what we want to achieve as a business.

Interviewer: Thank you for that detailed response, so according to these challenges and some of the learnings you indicated, how do you go about ensuring adoption?

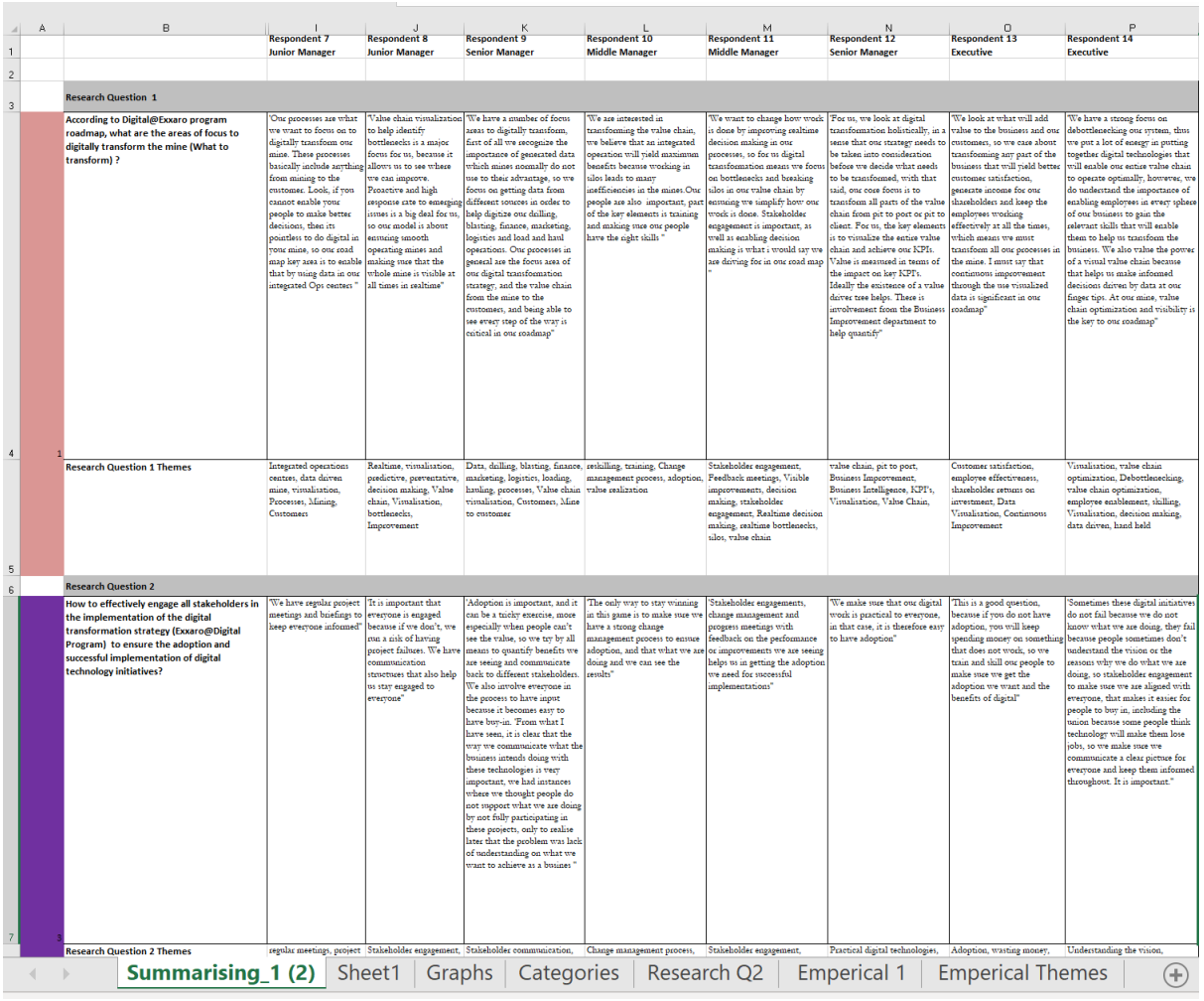
Respondent: So proper change management is important and its the answer to this

Interviewer: Alright, thank you very much for making time to engage with me and participating in this process. I really appreciate it.

Respondent: You are welcome, feel free to contact me should you need clarity. Good luck

APPENDIX F: EXAMPLE OF CODING PER THEME

This appendix shows a segment of the thematic coding sheet containing responses from all 14 respondents coded by numb



		Respondent 7 Junior Manager	Respondent 8 Junior Manager	Respondent 9 Senior Manager	Respondent 10 Middle Manager	Respondent 11 Middle Manager	Respondent 12 Senior Manager	Respondent 13 Executive	Respondent 14 Executive
3	Research Question 1								
4	According to Digital@Exxaro program roadmap, what are the areas of focus to digitally transform the mine (What to transform) ?	"Our processes are what we want to focus on to digitally transform our mine. These processes basically include anything from mining to the customer. Look, if you cannot enable your people to make better decisions, then its pointless to do digital in your mine, so our road map key area is to enable that by using data in our integrated Ops centres "	"Value chain visualization to help identify bottlenecks is a major focus for us, because it allows us to see where we can improve. Proactive and high response rate to emerging issues is a big deal for us, so our model is about earning smooth operating mines and making sure that the whole mine is visible at all times in realtime"	"We have a number of focus areas to digitally transform, first of all we recognize the importance of generated data which mines normally do not use to their advantage, so we focus on getting data from different sources in order to help digitize our drilling, blasting, finance, marketing, logistics and load and haul operations. Our processes in general are the focus area of our digital transformation strategy, and the value chain from the mine to the customers, and being able to see every step of the way is critical in our roadmap"	"We are interested in transforming the value chain, we believe that an integrated operation will yield maximum benefits because working in silos leads to many inefficiencies in the mines.Our people are also important, part of the key elements is training and making sure our people have the right skills "	"We want to change how work is done by improving realtime decision making in our processes, so for us digital transformation means we focus on bottlenecks and breaking silos in our value chain by ensuring we simplify how our work is done. Stakeholder engagement is important, as well as enabling decision making is what i would say we are driving for in our road map "	"For us, we look at digital transformation holistically, in a sense that our strategy needs to be taken into consideration before we decide what needs to be transformed, with that said, our core focus is to transform all parts of the value chain from pit to port or pit to client. For us, the key elements is to visualize the entire value chain and achieve our KPIs. Value is measured in terms of the impact on key KPI's. Ideally the existence of a value driver tree helps. There is involvement from the Business Improvement department to help quantify"	"We look at what will add value to the business and our customers, so we care about transforming any part of the business that will yield better customer satisfaction, generate income for our shareholders and keep the employees working effectively at all the times, which means we must transform all our processes in the mine. I must say that continuous improvement through the use visualized data is significant in our roadmap"	"We have a strong focus on debottlenecking our system, thus we put a lot of energy in putting together digital technologies that will enable our entire value chain to operate optimally, however, we do understand the importance of enabling employees in every sphere of our business to gain the relevant skills that will enable them to help us transform the business. We also value the power of a visual value chain because that helps us make informed decisions driven by data at our finger tips. At our mine, value chain optimization and visibility is the key to our roadmap"
5	Research Question 1 Themes	Integrated operations centres, data driven mine, visualisation, Processes, Mining, Customers	Realtime, visualisation, predictive, preventative, decision making, Value chain, Visualisation, bottlenecks, Improvement	Data, drilling, blasting, finance, marketing, logistics, loading, hauling, processes, Value chain visualisation, Customers, Mine to customer	reskilling, training, Change management process, adoption, value realization	Stakeholder engagement, Feedback meetings, Visible improvements, decision making, stakeholder engagement, Realtime decision making, realtime bottlenecks, silos, value chain	value chain, pit to port, Business Improvement, Business Intelligence, KPI's, Visualisation, Value Chain,	Customer satisfaction, employee effectiveness, shareholder returns on investment, Data Virtualisation, Continuous Improvement	Visualisation, value chain optimization, Debottlenecking, value chain optimization, employee enablement, skilling, Visualisation, decision making, data driven, hand held
6	Research Question 2								
7	How to effectively engage all stakeholders in the implementation of the digital transformation strategy (Exxaro@Digital Program) to ensure the adoption and successful implementation of digital technology initiatives?	"We have regular project meetings and briefings to keep everyone informed"	"It is important that everyone is engaged because if we don't, we run a risk of having project failures. We have communication structures that also help us stay engaged to everyone"	"Adoption is important, and it can be a tricky exercise, more especially when people can't see the value, so we try by all means to quantify benefits we are seeing and communicate back to different stakeholders. We also involve everyone in the process to have input because it becomes easy to have buy-in. "From what I have seen, it is clear that the way we communicate what the business intends doing with these technologies is very important, we had instances where we thought people do not support what we are doing by not fully participating in these projects, only to realise later that the problem was lack of understanding on what we want to achieve as a busines "	"The only way to stay winning in this game is to make sure we have a strong change management process to ensure adoption, and that what we are doing and we can see the results"	"Stakeholder engagements, change management and progress meetings with feedback on the performance or improvements we are seeing helps us in getting the adoption we need for successful implementations"	"We make sure that our digital work is practical to everyone, in that case, it is therefore easy to have adoption"	"This is a good question, because if you do not have adoption, you will keep spending money on something that does not work, so we train and skill our people to make sure we get the adoption we want and the benefits of digital"	"Sometimes these digital initiatives do not fail because we do not know what we are doing, they fail because people sometimes don't understand the vision or the reasons why we do what we are doing, so stakeholder engagement to make sure we are aligned with everyone, that makes it easier for people to buy in, including the union because some people think technology will make them lose jobs, so we make sure we communicate a clear picture for everyone and keep them informed throughout. It is important."
8	Research Question 2 Themes	regular meetings, project	Stakeholder engagement,	Stakeholder communication,	Change management process,	Stakeholder engagement,	Practical digital technologies,	Adoption, wasting money,	Understanding the vision,

Summarising_1 (2) | Sheet1 | Graphs | Categories | Research Q2 | Emperical 1 | Emperical Themes

		Respondent 1 Senior Manager	Respondent 2 Senior Manager	Respondent 3 Senior Manager	Respondent 4 JuniorManager	Respondent 5 Middle	Respondent 6 Middle	Respondent 7 Junior Manager	Respondent 8 Junior Manager	Respondent 9 Senior Manager	Respondent 10 Middle Manager	Respondent 11 Middle Manager	Respondent 12 Senior Manager	Respondent 13 Executive	Respondent 14 Executive			
	Research Question 1															**Similarities**	**Differences**	**Own reconciliation**
1	**According to Digital@Exxaro program roadmap, what are the areas of focus to digitally transform the mine (What to transform) ?**	"You need to focus on your bottleneck areas. Ensure that your process basics are correct before digitizing. Creating real time data Focusing on IT infrastructure to enable Focus on data structures Enable visualisation of the value chain Establishment of IOC's to optimise Utilisation of data science to move from descriptive to predictive and prescriptive Creating the appropriate org structures to support"	'Look, first of all you need to understand the pain point of the system and start by addressing these. We talk a lot about decision making, which we believe it is important to turnaround our business, so with that said, integrating various parts of the mine and helping our people make quick decisions is what our road map is mainly focusing on"	'For us, our focus is on the entire value chain optimization. Our roadmap is focused on having data driven operations centers for the mine, where everyone can see what is happening across the whole chain"	'We have many functions such as drilling, blasting, load and hauling at the mines, and we focus on digitizing these critical areas to ensure optimal mining of material. Empowering our employees in execution is important, so we make sure that our roadmap has a clear focus on the use of analyzed data to help them do their work better by focusing on what has a potential to impact their production, so the use of visual data that makes sense is key in our roadmap "	'We want to transform how people work in different departments. Visualisation is the most important thing for us, because there is power in seeing what is going on in realtime, but what you do with what you see is what we intend driving by changing behavior of our employees"	'A lot of people work in silos, so we need to be break them down, so we focus on integrating all departments on a single platform. Our IT infrastructure is important, we make sure that we have that to serve the purpose of our digital transformation efforts"	'Our processes are what we want to focus on to digitally transform our mine. These processes basically include anything from mining to the customer. Look, if you cannot enable your people to make better decisions, then its pointless to do digital in your mine, so our road map key area is to enable that by using data in our integrated Ops centers "	'Value chain visualization to help identify bottlenecks is a major focus for us, because it allows us to see where we can improve. Proactive and high response rate to emerging issues is a big deal for us, so our model is about ensuring smooth operating mines and making sure that the whole mine is visible at all times in realtime"	'We have a number of focus areas to digitally transform, first of all we recognize the importance of generated data which mines normally do not use to their advantage, so we focus on getting data from different sources in order to help digitize our drilling, blasting, finance, marketing, logistics and load and haul operations. Our processes in general are the focus area of our digital transformation strategy, and the value chain from the mine to the customers, and being able to see every step of the way is critical in our roadmap"	'We are interested in transforming the value chain, we believe that an integrated operation will yield maximum benefits because working in silos leads to many inefficiencies in the mines. Our people are also important, part of the key elements is training and making sure our people have the right skills "	'We want to change how work is done by improving realtime decision making in our processes, so for us digital transformation means we focus on bottlenecks and breaking silos in our value chain by ensuring we simplify how our work is done. Stakeholder engagement is important, as well as enabling decision making is what i would say we are driving for in our road map "	'For us, we look at digital transformation holistically, in a sense that our strategy needs to be taken into consideration before we decide what needs to be transformed, with that said, our core focus is to transform all parts of the value chain from pit to port or pit to client. For us, the key elements is to visualize the entire value chain and achieve our KPIs. Value is measured in terms of the impact on key KPI's. Ideally the existence of a value driver tree helps. There is involvement from the Business Improvement department to help quantify"	'We look at what will add value to the business and our customers, so we care about transforming any part of the business that will yield better customer satisfaction, generate income for our shareholders and keep the employees working effectively at all the times, which means we must transform all our processes in the mine. I must say that continuous improvement through the use visualized data is significant in our roadmap"	'We have a strong focus on debottlenecking our system, thus we put a lot of energy in putting together digital technologies that will enable our entire value chain to operate optimally, however, we do understand the importance of enabling employees in every sphere of our business to gain the relevant skills that will enable them to help us transform the business. We also value the power of a visual value chain because that helps us make informed decisions driven by data at our finger tips. At our mine, value chain optimization and visibility is the key to our roadmap"	-Respondent 1 and 2 boasts about the one card system which integrates with the Gautrain. This taking the intervention towards the much anticipated integrated public transport system. -Respondent 1 highlights that for improved monitoring of the intervention a telematics system was installed to give electronic notifications of service, it also tracks the busses in terms of routes, You ring-fence and say this bus can only travel in this geographical area. Advanced technology is used for the tracking of buses. Respondent 5 further adds that every bus is fitted with monitoring and communication equipment. -Respondent 1 and 4 also indicate that the BRT system are 'state of the art systems' which are on par with proper standards and produce accurate reporting for M&E. They have not encountered problems relating to the systems in use.	-Although Respondent 2 acknowledges that they use world class systems, there is a need to maximize on other functions that are available in the system. -Respondent 3 indicates that the systems have proper back-up functionalities to ensure that information is protected even during system down-times. -Respondent 4 highlights that for the period he has work on the BRT, they have not received major audit discrepancies from the Auditor General, this implying that their monitoring processes are satisfactory. -Respondent 8 indicates that the City of Tshwane has a 20-year masterplan relating to transport as a result the BRT intervention is aligned to it and critical for the municipality to be guided by this plan to ensure the successful implementation of the plan.	BRT operations are run by using "state of the art" or "world class" systems which produce accurate reporting for M&E. The systems have proven to have proper back-up functionalities to ensure that information is protected even during system down-times. Although Respondent 2 acknowledges the good in using high class systems, there is a need to maximize on other functions that are available in the system. One Respondent indicates that as result of these good systems in place which have made monitoring and compliance processes easier, the unit has not received negative audit opinions from the Auditor General. One respondent highlighted that the BRT unit has clearly aligned the BRT intervention to the 20-year transport masterplan and continuous implementation of
	Research Question 1 Themes	Bottlenecks, Correct processes, Realtime data, data, IT Infrastructure, Visualisation, Integrated Operations Centres, Descriptive analysis, predictive analysis	Understanding and addressing system pain points, Quick decision making, Integration	Data driven mine, value chain visualization, Value chain optimization	Drilling, Blasting, loading, hauling, optimal mining, data use, Empowering through information	realtime, changing behavior, visualisation, Work transformation, Departmental transformation, People transformation	Eliminating Silos, Integrating departments, Single platform, IT Infrastructure	Integrated operations centres, data driven mine, visualisation, Processes, Mining, Customers	Realtime, visualisation, predictive, preventative, decision making, Value chain, Visualisation, bottlenecks, Improvement	Data, drilling, blasting, finance, marketing, logistics, loading, hauling, processes, Value chain visualisation, Customers, Mine to customer	reskilling, training, Change management process, adaption, value realization	Stakeholder engagement, Feedback meetings, Visible improvements, decision making, stakeholder engagement, Realtime decision making, realtime bottlenecks, silos, value chain	value chain, pit to port, Business Improvement, Business Intelligence, KPI's, Visualisation, Value Chain,	Customer satisfaction, employee effectiveness, shareholder returns on investment, Data Visualisation, Continuous Improvement	Visualisation, value chain optimization, Debottlenecking, value chain optimization, employee enablement, skilling, Visualisation, decision making, data driven, hand hold			
	Research Question 2																	
3	**How to effectively engage all stakeholders in the implementation of the digital transformation strategy (Exxaro@Digital Program) to ensure the adoption and successful implementation of digital technology initiatives?**	'Change management. Understanding of digitisation - so education and also ensuring that you do have a plan to lift competencies and skills and can answer the question of how jobs will be affected"	'We ensure communication takes place at all levels"	'We have training and are informed as well as involved in various discussions about digital transformation"	'Skilling of individuals is important. We upskill people"	'Look, people are asked to have their input on what they think should be done, and that is important"	'Consultations with the employees and union representatives is taking place"	'We have regular project meetings and briefings to keep everyone informed"	'It is important that everyone is engaged because if we don't, we run a risk of having project failures. We have communication structures that also help us stay engaged to everyone"	'Adaption is important, and it can be a tricky exercise, more especially when people can't see the value, so we try by all means to quantify benefits we are seeing and communicate back to different stakeholders. We also involve everyone in the process to have input because it becomes easy to have buy-in. 'From what I have seen, it is clear that the way we communicate what the business intends doing with these technologies is very important, we had instances where we thought people do not support what we are doing by not fully participating in these projects, only to realise later that the problem was lack of understanding on what we want to achieve as a business "	'The only way to stay winning in this game is to make sure we have a strong change management process to ensure adaption, and that what we are doing and we can see the results"	'Stakeholder engagements, change management and progress meetings with feedback on the performance or improvements we are seeing helps us in getting the adaption we need for successful implementations"	'We make sure that our digital work is practical to everyone, in that case, it is therefore easy to have adaption"	'This is a good question, because if you do not have adaption, you will keep spending money on something that does not work, so we train and skill our people to make sure we get the adaption we want and the benefits of digital"	'Sometimes these digital initiatives do not fail because we do not know what we are doing, they fail because people sometimes don't understand the vision or the reasons why we do what we are doing, so stakeholder engagement to make sure we are aligned with everyone, that makes it easier for people to buy in, including the union because some people think technology will make them lose jobs, so we make sure we communicate a clear picture for everyone and keep them informed throughout. It is important."	none	discussed at different levels and ranks of seniority within the city. Information is disseminated from the lowest level to the highest and is able to reach the attention it requires for further action to make the system fully functional. Disputes relating to performance are escalated even up to the City manager depending on severity. Respondent 4 stresses that importance of being appraised of reports from other units within the BRT as it may directly or indirectly impact on your work. The weakness found is that sometimes internal people do not submit reports timeously. -Respondent 4 highlights that access to information enables the city to take informed decisions e.g. the viability of routes of that are not performing in terms of the number of people or in terms of the revenue. -Respondent 4 highlight that on a monthly basis they run spot checks at various sites and stations to assess whether the implementation of the BRT is implemented accordingly. -Respondent 1 notes that there is no congruency in administration and political support. As the "Areyeng" unit we battle to solicit inputs from the political structures however internal department provide support	experiences in the implementation of M&E processes for the BRT system and the below paragraph explain some of the encounters. Two respondents shared that access to M&E information has enabled the city to take informed decisions on the BRT system. M&E information is discussed at different levels and ranks of seniority within the city. Information is disseminated from the lowest level to the highest and is able to reach the attention it requires for further action to make the system fully functional. However, one respondent indicated dissatisfaction on the lack of feedback from senior structures on the implementation of the BRT intervention even though there is consistent reporting and further disputed consultation processes
	Research Question 2 Themes	Job losses, change management, skills, competencies, training	Communication	Stakeholder engagement, training, involvement, inclusivity	Skills, training	Input from various stakeholders	Labour union, consultations	regular meetings, project feedback	Stakeholder engagement, communication structures, project	Stakeholder communication, Project Adaption, Feedback, quantify benefits, values	Change management process, adaption, value realization	Stakeholder engagement, Feedback meetings, Visible improvements	Practical digital technologies, easy daption	Adaption, wasting money, reskilling, training, value created	Understanding the vision, stakeholders engagement, buy-in, labor union, Job losses, communication			

Summarising_1 (2) | Sheet1 | Graphs | Categories | Research Q2 | Emperical 1 | Emperical Themes