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Risks associated with the adoption of emerging 4IR technologies in South Africa

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Supervisor: Dr Manessah Alagbaoso

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, 2023

ABSTRACT

This study investigates the risks associated with the adoption of emerging fourth industrial revolution (4IR) technologies by organisations operating within South Africa. The adoption of emerging technologies introduces risks that prevent improved competitiveness of the organisation. Using a qualitative approach, this research explores these risks by applying a thematic analysis of interview data found in the gathered insights of 12 senior leaders from five industries and six professional disciplines involved in risk management practices within South African organisations. The study identifies a coherent linkage between the sources of challenge in emerging technologies, identified risks, and the potential for categorising and prioritising of these risks within a risk taxonomy. This study emphasises the need for collaboration between risk professionals and senior leadership to manage the uncertainty associated with technology adoption effectively. Furthermore, this study recommends a structured and responsible enterprise risk management strategy for organisations when navigating the complexities of emerging technology adoption. Finally, the research suggests further investigation into expanding the definition of emerging technologies beyond AI, big data, and IoT, and to consider the specific risks faced by early adopters in the South African context.

Keywords: Emerging technology, enterprise risk management, fourth industrial revolution, risk management, technology adoption, uncertainty

DECLARATION

I, Brett Williams, 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 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: Brett Justin Williams Signature: ***B J Williams***

Signed at: Paulshof, Sandton

DEDICATION

This research is dedicated to professionals directly and indirectly involved in the delivery of enterprise risk management practices.

ACKNOWLEDGEMENTS

I would like to acknowledge and thank my supervisor, Dr Manessah Alagbaoso, for providing thoughtful guidance, insight and support. Thank you.

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LIST OF ACRONYMS

4IR	Fourth Industrial Revolution
AI	Artificial intelligence
COSO	Committee of Sponsoring Organizations of the Treadway Commission
ERM	Enterprise risk management
ESG	Environmental, societal, and governance
IoT	Internet of things
ISO	International Organization for Standardization
RPA	Robotics process automation

CHAPTER 1: INTRODUCTION

1.1 Statement of purpose

This research examines the risks associated with the adoption of emerging technologies within organisations in South Africa.

1.2 Background of the study

Organisations globally are being faced with pressures, both internal and external, to remain relevant in times of great uncertainty. These pressures have been further fuelled in the age of the 4IR, with emerging technologies increasing productivity and competitiveness, reducing barriers to entry, generating competitive efficiencies, and changing the ways in which customers realise value (Avenyo et al., 2022; Marra et al., 2003; Usai et al., 2021). The adoption of emerging technologies is no longer a reality of potential avenues for digital transformation but, rather, is a necessary element of a competitive business strategy (Correani et al., 2020). The fourth industrial revolution (4IR) has seen the rise of emerging technologies, which is altering the way in which organisations across the world innovate through business strategy (Müller & Voigt, 2018; Usai et al., 2021). Past studies have examined the implications of the fourth industrial revolution as well as digital transformation at an organisational level (Correani et al., 2020; Tamvada et al., 2022; Usai et al., 2021)

The uncertainty associated with the adoption of emerging technologies exposes organisations to an inherent change in risk profile, be this through an increase in exposure to existing risks and the addition of several new risks to the organisation, or, potentially, both (Tamvada et al., 2022; Tupa et al., 2017). While these risks are initially perceived to be technological, multiple other risk types are impacted either negatively or positively, presenting an opportunity for additions to the current literature (Birkel et al., 2019; Schutte & Marx, 2018). Furthermore, studies have explained that emerging technologies may be employed as a multi-stakeholder enterprise risk strategy to mitigate uncertainty (Linkov et al., 2018). The associated uncertainty is a challenge for organisations trying to make a

meaningful step in adopting emerging technologies and actively managing the associated risks (Birkel et al., 2019).

1.3 Research problem

Previous studies have focused on developed economies and have rarely viewed the risks associated with emerging economies regarding the adoption of emerging technologies. While past studies have, to some extent, explored risks of the fourth industrial revolution on emerging economies, the focus has largely been on that of SMEs operating in a manufacturing-focused environment, creating additional opportunity for an expansion to the literature on large organisations operating in South Africa (Tamvada et al., 2022). Research on the adoption and risks of emerging technologies have, for example, been focused on the connected home and organisation-level risks such as privacy (Li et al., 2021).

An expansion of this thinking is viewed through the lens of moral risks placed on organisations adopting emerging technologies in South Africa and the role regulators and policy makers have on such risks (Ostrowick, 2021). These risks are not unique to a single environment. Countries worldwide are currently dealing with the risks associated with emerging technologies due to the nature of emerging technologies and their ability to connect elements on such a broad scale. It is evident that the context surrounding an organisation, be it environmental and organisational factors, play a significant role in determining the specific risks experienced from a geopolitical standpoint (Beumer, 2018).

The uncertainty associated with the adoption of emerging technologies is an extremely broad concept, as it addresses the overall lack of knowledge and understanding of the potential impacts. Uncertainty can largely be a factor in determining a risk (Smit, 2012). In addition to the above, uncertainty may or may not include the risks associated with the adoption of emerging technologies nor refer entirely to the negative impact an organisation may or may not have to endure in pursuit of its objectives. The risks associated with an organisation are specific to instances of potential material loss and a largely considered a negative impact to an organisation (Tang & Nurmaya Musa, 2011). This presents an opportunity to expand on the knowledge of risks associated with the adoption of

emerging technologies within South Africa. A country with an extremely unique operating environment plagued with unique challenges, i.e., unreliable power supply, high levels of criminal activity and uncertain economic times. An environment where risk ignorance is detrimental to the success of the managerial team (Smit, 2012).

Applying the findings in the literature above, it is fair to assume that adopting emerging technologies may result in new risks for an organisation operating in the South African context (Tupa et al., 2017). In the pursuit of long-term success, there is a dependency upon adequately assessing the risk associated with adopting emerging technologies before, during and after adoption (Prewett et al., 2020). The assessment of risk under the fourth industrial revolution is of such importance. Past studies have expanded on the proposed structure to risk management practices in an effort to ensure the greatest value is derived from the application of risk management practices for South African organisations (Smit, 2012). This need for risk management practices is further evident by the notion of the evolution of risk management into enterprise risk management over the past 15 years, being a step in the right direction to effectively deal with organisations adopting emerging technologies (Rodríguez-Espíndola et al., 2022).

Limited research addresses the many risks posed by adopting emerging technologies and the subsequent risk categories by large organisations operating in a developing country context. This research report aims to outline the evolving risk profile by identifying and classifying risks presented by adopting emerging technologies within South Africa.

1.4 Research objectives

Based on the research problem articulated in the section above, the research objectives for this study are as follows:

- Research Objective 1: Identify the sources of challenge associated with the adoption of emerging technologies.

- Research Objective 2: Identify the risks associated with the adoption of emerging technologies.
- Research Objective 3: Categorise and prioritise the risks associated with the adoption of emerging technologies.

1.5 Rationale

This study aims to further the empirical knowledge and subsequently add to the literature of local findings on risks associated with the adoption of emerging technologies in developing economies such as South Africa (Tupa et al., 2017). This empirical evidence contributes to the pool of knowledge conducted by international studies in the field of risk management under the fourth industrial revolution, with the significance based on drawing parallels between the existing knowledge of risks faced by organisations in a South African context (Tamvada et al., 2022). The impact of this on South African organisations is a deeper understanding of the similarities in their risk exposures, the material nuances of their risk environment and sources of challenge in a developing economy (Tupa et al., 2017). The benefits of this study extend to large organisations operating in economic conditions similar to South Africa's in the context of a developing economy.

Firstly, To provide a holistic view of risks associated with the adoption of emerging technologies, this study was conducted through the elaboration of risks identified by organisations that have and are currently employing at least one category of emerging technologies within their organisation. Secondly, linking these identified risks under emerging technology adoption with changes in organisational risk profiles. Lastly, new and existing risks were identified as those having a material impact on organisational objectives and were determined when not effectively managed and mitigated after the adoption of emerging technologies (Rodríguez-Espíndola et al., 2022).

1.6 Delimitations of the study

Delimitations of the study at hand are as follows:

i) The scope of organisations covered within this study was restricted to those organisations with business operations within South Africa, either publicly listed or privately held, and excluded any organisations considered to be head offices in South Africa with primary operations being conducted outside of the geographical borders of South Africa.

ii) For the purposes of this study, emerging technologies under the fourth industrial revolution was encompassed by the following three technologies, also known as the virtuous triangle (Armstrong & Lee, 2021):
   1) Internet of things (IoT)
   2) Big data
   3) Artificial intelligence (AI)

iii) Insights collected throughout this study were targeted towards middle and senior-level managers of organisations who, within an organisation, adopted at least one of the ten technologies classified as emerging technologies during the fourth industrial revolution. The study excluded any insights from participants of organisations who have not adopted one of the ten emerging technologies.

1.7 Definition of terms

Table 1: Definitions of terms

Term	Definition	Source
Emerging technology	"A relatively fast growing and radically novel technology characterised by a certain degree of coherence persisting over time and with the potential to exert a considerable impact on the socio-economic domain(s) which is observed in terms of the composition of actors, institutions and the patterns of interactions among those, along with the associated knowledge production processes. Its most prominent impact, however, lies in the future and so in the emergence phase is still somewhat uncertain and ambiguous".	(Rotolo et al., 2016)
Fourth industrial revolution	"A world in which virtual and physical systems of manufacturing globally cooperate with each other in a flexible way,	(Schwab, 2017)

Term	Definition	Source
	which enables the absolute customisation of products and the creation of new operating models".	
Risk	"The possibility of something bad happening at some time in the future; a situation that could be dangerous or have a bad result".	(Hornby, 2015)
Uncertainty	"A situation in which something is not known, or something that is not known or certain".	(Mclntosh, 2013)

1.8 Assumptions

The following assumptions were made about the participants for the purposes of this study:

i) They have an understanding of formal risk management standards and practices being applied within the organisation they are employed.
ii) They have adequate knowledge of the enterprise-wide risks affecting the organisation in which they are employed.
iii) They provided honest feedback and an adequate representation of fact not based on notions of fiction or perceptions.

1.9 Chapter outline

The following chapters, commencing with Chapter 2, present a comprehensive review of the literature relating to the fourth industrial revolution technologies and the risks associated with adopting these technologies. The research proceeds to identify risk categories, which are determined by applying a suggested risk model suitable to the research presented in this chapter. The identified risks are, therefore, aggregated into logical risk categories through which their impact is further assessed. The continuation of Chapter 3 outlines a research methodology used to gather findings on the risks experienced by organisations that adopted the identified technologies of the fourth industrial revolution and the consequential changes to risk profiles. Chapter 4 presents the study findings succinctly and contextually, structured in accordance with the research

propositions, allowing for the discussion of findings and the formulation of Chapter 5. Based on the identified codes and resultant themes, Chapter 5 presents a detailed discussion of the identified themes in accordance with the research propositions. The final chapter, Chapter 6, discusses the conclusions drawn from this study, constructed per the research objectives stated in the chapter above.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The application of fourth industrial revolution technologies goes beyond the ability to inform and automate, setting the technologies apart from previous technologies. The adoption of emerging technologies, therefore, presents organisations with new and significant opportunities and with material risks and challenges, denoted by the ability to i) increase their intelligence, in certain instances beyond their human counterparts, ii) utilise digital applications to gather intelligence in the form of big data and, ii) create market disruptions through new avenues of collaboration and innovation (Bailey et al., 2019). Thus, organisations can fundamentally change how they operate and how the industry in which they conduct business operates by dealing with uncertainty, complexity and innovation cycles (Ardito et al., 2018; Tamvada et al., 2022). In order to realise these long-term benefits, organisations need to be purposeful in implementing and integrating emerging technologies (Piccarozzi et al., 2018). The possible outcome is strengthening the business case for integrating enterprise risk management practices within an organisational environment (International Organization for Standardization, 2009).

Consequently, the adoption of emerging technologies presents great opportunity and equally sizable risk (Bailey et al., 2019; Tamvada et al., 2022). Emerging technologies present yet another opportunity where organisations may minimise adverse outcomes and maximise the benefits of emerging technologies through the adoption of an enterprise risk management framework. Such frameworks are aimed at effectively deploying resources to address the uncertainty of business operations.

The focus of this study is to understand the risks associated with the adoption of emerging technologies. As such, the following chapter reviews the literature on the adoption of emerging technologies, followed by the appropriate use of risk management practices to identify the risks faced by organisations through the construction of a risk taxonomy, commonly known as risk categorisation. This literature review enables the formulation and articulation of research questions,

propositions or hypotheses, which address the research objectives detailed in Chapter 1.

2.2 Background discussion

This section is a review of the literature on the adoption of emerging technologies, leading to a discussion of the challenges associated with implementing emerging technologies and culminating in a discussion of the sources of challenge presented by emerging technologies.

2.2.1 Emerging technologies

Literature denotes emerging technologies associated with the fourth industrial revolution by their ability to ‘change the status quo and embody the following five attributes: (i) radical novelty, (ii) relatively fast growth, (iii) coherence, (iv) prominent impact, and (v) uncertainty and ambiguity (Rotolo et al., 2016). Technologies which exhibit these attributes, underpinned by the technologies of the third industrial revolution, identify the front-running technologies for the fourth industrial revolution as robotics and RPA, the internet of things (IoT), big data, cybersecurity, biotechnology, cloud computing, artificial intelligence, virtual and augmented reality, additive manufacturing, and blockchain (Armstrong & Lee, 2021). It is conceded that the above technologies, at present, exhibit all these attributes and, as such, were defined as emerging technologies. The classification of ‘emerging technologies’ was held until the technologies did not fit all attributes, at which point they would cease to be emerging technologies (Litvinski, 2018).

Emerging technologies have the ability to merge the digital world with that of the physical realm, mimicking the abilities of their human counterparts while doing so (Armstrong & Lee, 2021). For this reason, digital technologies support a radical change in how organisations conduct business (Litvinski, 2018). This change leads to the discussion of the effective adoption and implementation of emerging technologies. While the benefits of such technologies have been discussed broadly in the preceding literature of Chapter 1, the organisational ability to adopt such technologies, typically through a digital transformation strategy, would be

challenged in many ways should the correct building blocks not be present, i.e. a framework depicting an actionable guide to match strategy formulation and implementation of emerging technologies (Correani et al., 2020). The next section reviews literature related to the implications of emerging technologies.

2.2.2 Implications of emerging technologies

The global competitive landscape is dominated by organisations growing their market share by adopting emerging technologies and forging the construction of niche products and service offerings to do so (Avenyo et al., 2022). Emerging technologies open new markets through differentiated products and services and new methods for distributing products and services into existing markets, allowing organisations of varying sizes to compete more rigorously (Avenyo et al., 2022). The application of digital technologies is poised to deliver transformation through three core pillars: i) superior customer insights on current and future behaviours, ii) operational efficiencies denoted by data-driven decision making, and iii) a transformation of existing business models through which an organisation delivers value (Avenyo et al., 2022; Tupa et al., 2017).

The long-term implications of adopting digital technologies in the bid to further organisational insights and intelligence are changes in organisational exposures to uncertainty and the evolution of the organisational risk profiles presented by this uncertainty (Prewett et al., 2020; Tamvada et al., 2022; Tupa et al., 2017).

The first pillar for delivering transformation is the acquisition and application of big data and the generated intelligence that has manifested a need for organisations to employ holistic enterprise risk management practices with a view to being a responsible and ethical organisation operating within the fourth industrial revolution (Mpofu & Nicolaides, 2019; Rodríguez-Espíndola et al., 2022; Tupa et al., 2017).

The second pillar for delivering transformation addresses the implications of newfound operational efficiencies, which extend past the incorporation of digital technologies to an organisational environment and speak to the ability of an organisation to automate aspects of production or delivery of products and services to the market (Armstrong & Lee, 2021; Mpofu & Nicolaides, 2019). This

persistent and pervasive advancement of technology generates an increasing exposure to operational risks, which requires a proactive approach to risk management instead of the typical reactive approach denoted by organisational risk management practices. In the South African context, an example may be drawn from rising unemployment and the need for organisations to equip employees with the skills of the future to address market concerns of rising unemployment while also fulfilling the skills gap created by adopting emerging technologies and the widening digital divide.

The third pillar for delivering transformation discussed in this paper is the evolving business model. The literature discusses the disruption of the fourth industrial revolution as superseding globalisation. This view is supported by the prediction that a large proportion of organisation's business models will cease to exist in five years, materially altering how organisations conduct business (Soh & Connolly, 2021). This view may be strongly linked to that of responsible innovation, the need for organisations to employ horizon scanning of emerging technologies, the concept of safety by design, adequate communication related to risks and consideration of risk beyond the traditional scope and into the non-traditional (Linkov et al., 2018). With this understanding of the implications of adopting emerging technologies, the next section reviews literature related to the sources of challenge of emerging technologies.

2.2.3 Sources of challenge associated with emerging technologies

The adoption of emerging technologies by organisations presents an expansion of the sources of challenge. This expansion may be viewed as new sources of challenge and the extension of existing sources of challenge. These sources of challenge, while not exhaustive, are derived from the existing literature and are presented in more detail in Table 2.

Table 2: Sources of challenge associated with emerging technologies

Sources of challenge	Description	Citation
Business model	The ability to create economic value through new products and services	(Birkel et al., 2019; Kapoor & Klueter,

Sources of challenge	Description	Citation
	resulting from the adoption of digital technologies.	2021; Tamvada et al., 2022)
Cyber threats	Unauthorised access, manipulation, or use of sensitive information.	(Birkel et al., 2019; Tamvada et al., 2022; Tupa et al., 2017)
Economic value	The creation/destruction of economic value through investment in emerging technology.	(Birkel et al., 2019; Tamvada et al., 2022)
Ethical and moral factors	The adoption of moral and ethical thinking when employing data-driven decision making in practical scenarios.	(Kuzma et al., 2008; Mpofu & Nicolaides, 2019; Ostrowick, 2021)
Legal and regulatory	Applying legislative and regulatory requirements effectively to an organisation's operating environment.	(Birkel et al., 2019; Herweijer et al., 2018; Ostrowick, 2021)
People	Creating a sustainable future where people are not exploited for organisational gain.	(Birkel et al., 2019; Tamvada et al., 2022)
Technological concerns	The performance of technology against traditional operating techniques, including environmental readiness.	(Birkel et al., 2019; Kapoor & Klueter, 2021; Tamvada et al., 2022)

The sources of challenge referred to in Table 2 are the primary drivers of enterprise-wide challenges faced by organisations. These sources of challenge were assessed through a risk management framework to derive their material impact on specific organisations. The discussion of an appropriate risk management framework is detailed in the following sections of the literature review.

2.3 Theoretical framework

The theoretical framework presentation in the literature begins with a high-level synopsis of available enterprise risk management practices and their evolution from inception. A strong focus was applied to the ISO 31000 risk management framework as the chosen enterprise risk management framework for the

purposes of this study, leading to the concept of risk categorisation and the associated benefits to risk management practices.

2.3.1 Risk theory

In 1995, the first national risk management standard, the Australian-New Zealand risk management standard, was developed to support good management practices (Jankensgård, 2019). This scientific approach to risk management outlined the principles through which Canadian colleagues birthed and enhanced enterprise risk management in the late 1990s (Jankensgård, 2019). With rising concerns about unethical practices, the Committee of Sponsoring Organizations of the Treadway Commission (COSO) began the development of the first COSO ERM framework in 1992, with the publication taking place in 2004, as an extension of its internal audit framework (Jankensgård, 2019; Moeller, 2007). The framework emphasised guidance on principles to support enterprise-wide risk management based on four objectives: compliance, operations, strategy, and reporting (Moeller, 2007). The COSO ERM framework and the ISO 31000 Risk Management framework, developed in 2009 by the International Organization for Standardization (ISO), are the global front runners for enterprise risk management practices.

The ISO 31000 enterprise risk management framework is a generalised and structured framework aimed to serve the needs of an organisation, independent of their chosen specialisation or the industry in which they operate (Jankensgård, 2019; Lalonde & Boiral, 2012). Following the insights provided by the literature above, this study was based on the International Organization for Standardization framework for enterprise risk management (ISO 31000), adopting the principles, framework, and risk management process detailed in Figure 1.

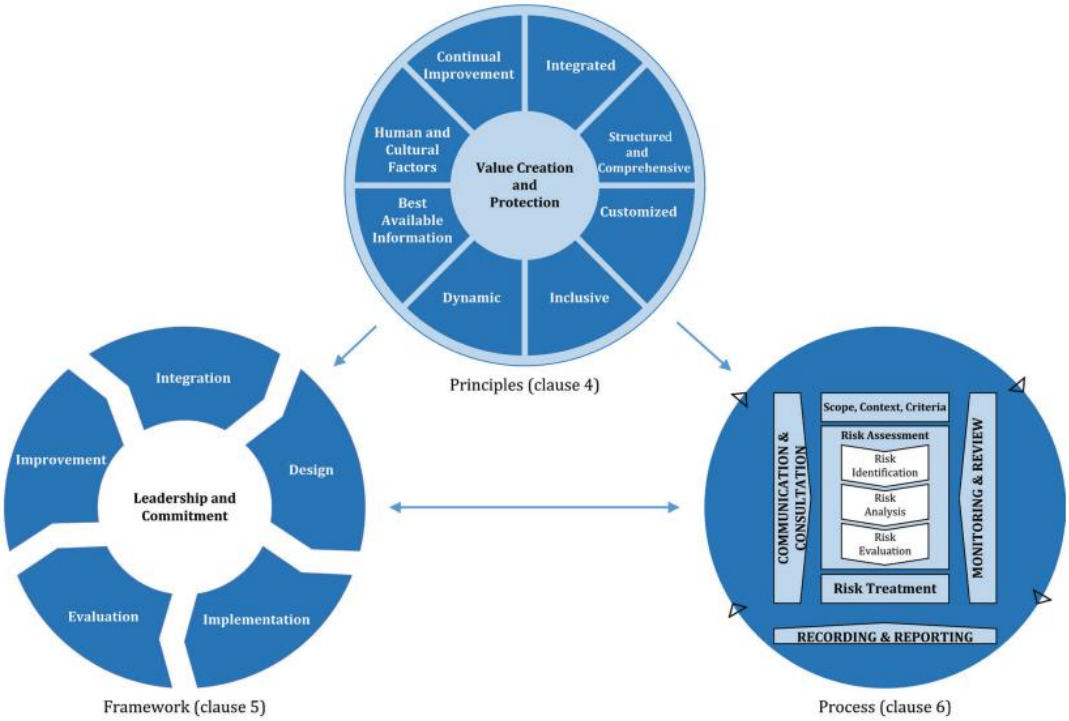


Figure 1: ISO 31000 principles, framework and process (International Organization for Standardization, 2018)

The systematic approach to the enterprise risk management process, defined in Figure 1 (specifically the sphere on the bottom, right-hand side labelled ‘process’), assisted in defining risk, managing the risk, and controlling all related risk activities to generate shareholder value, with the risk assessment being the emphasis of this study (Cormican, 2014; Nocco, 2006). The process of risk assessment is expanded on in accordance with the ISO 31000 enterprise risk management framework:

Risk identification is determining the possible consequences of risk sources and events (International Organization for Standardization, 2009). This risk identification is an essential step in the risk management process within the fourth industrial revolution, allowing a decision maker to systematically conceptualise scenario uncertainties associated with the adoption of emerging technologies for proactive enterprise risk management purposes (Cormican, 2014).

Risk analysis is the process of understanding risk and its nature and estimating the identified risk (International Organization for Standardization, 2009). This constitutes the centre point for enterprise risk management practices, an

estimation of uncertainty in terms of impact and the occurrence likelihood presented by emerging technologies (Cormican, 2014).

Risk evaluation is the process of determining if an identified risk is tolerable to an organisation to inform risk treatment (International Organization for Standardization, 2009). The purpose of risk evaluation is to rank the priority through the perspective of severity for an organisation and the level of influence a risk has on an organisation adopting emerging technologies (Cormican, 2014).

2.3.2 Risk categorisation

The identification of risks affecting an organisation forms the basis from which risk categorisation may take place. The outcome of creating these risk themes or categories in practice is widely known as the organisational risk taxonomy (Birkel et al., 2019; Jankensgård, 2019; Tamvada et al., 2022). Previous studies have evidenced the macro and micro benefits of aggregating pure risks within an organisational environment to promote centralised decision making for risk treatment and an appropriate allocation of economic capital for the purposes of risk treatment (Bratianu et al., 2022; Jankensgård, 2019; Nocco, 2006). The alternative approach to risk categorisation is centred around the treatment of risks in isolation. The practice of managing risks in isolation, by nature, prevents an organisation from establishing connections between the various risks identified, resulting in the selection of a risk treatment which is not representative of the full exposure of an organisation to an uncertain outcome or event (Agrafiotis et al., 2018; Nocco, 2006).

The method for formulating the risk categories elaborated on above is widely debated by existing literature on risk management practices. One such approach is to classify risks into three broad categories: operational, strategic, and market (Birkel et al., 2019). This rudimentary approach to risk classification is considered limiting by design and highly susceptible to the masking of detail associated with nuanced risks faced by an organisation; hence, further studies have incorporated additional risk categories to ascertain a risk profile more reflective of an organisation (Birkel et al., 2019). The aggregation of non-financial risks, typically the practice of enterprise risk management, may be conducted through the

application of content analysis techniques using an impact-oriented approach (Agrafiotis et al., 2018; Barlish et al., 2013; Birkel et al., 2019). The requirements of such an approach would mandate the enumeration and estimation of the pure risks posing the most significant impact on organisational objectives, an approach supported by the risk identification process followed by the ISO 31000 framework (Agrafiotis et al., 2018). The application of content analysis to risk categorisation may be conducted using three approaches, the first being open coding, an inductive method employed by a researcher to openly theme risks. The second is deductive content analysis, which is guided by theory in the risk classification process. The third method is a mixture of inductive and deductive content analysis, which allows for the inclusion of novel risk categories that either support or differ from theory (Agrafiotis et al., 2018). For the purpose of this research, a mixed method of content analysis was adopted, which is supported by previous research conducted on risk taxonomy based on the risk source (Barlish et al., 2013).

While the existing literature does not holistically identify the entire risk universe of emerging technology adoption, be it specific to South Africa or otherwise, there has been evidence of risk categories by organisation, industry, and country (Agrafiotis et al., 2018; Herzfeldt et al., 2012; Tamvada et al., 2022). The commonality of the literature under review and the final consideration of the risk categorisation process is correlation. Estimating the correlation between risks is an imperative element for categorisation and aggregation. This practice is considered closer to that of an art than a science and is typically approached through aggregating identified risks recorded on risk registers (Jankensgård, 2019; Nocco, 2006).

2.4 Conceptual framework

A conceptual framework was constructed based on the theory covered in the literature review, which is the key concept of emerging technologies and risk management practices. For the purposes of this study, this conceptual framework commences with an overview of emerging technology, incapsulating attributes, implications, and sources of challenge, the first research objective. The second research objective began to emerge and ties into the enterprise risk management

pillar, where the ISO 31000 risk management framework is applied. The third research objective became clear through this process and can be mapped back to the sources of challenge presented by emerging technologies.

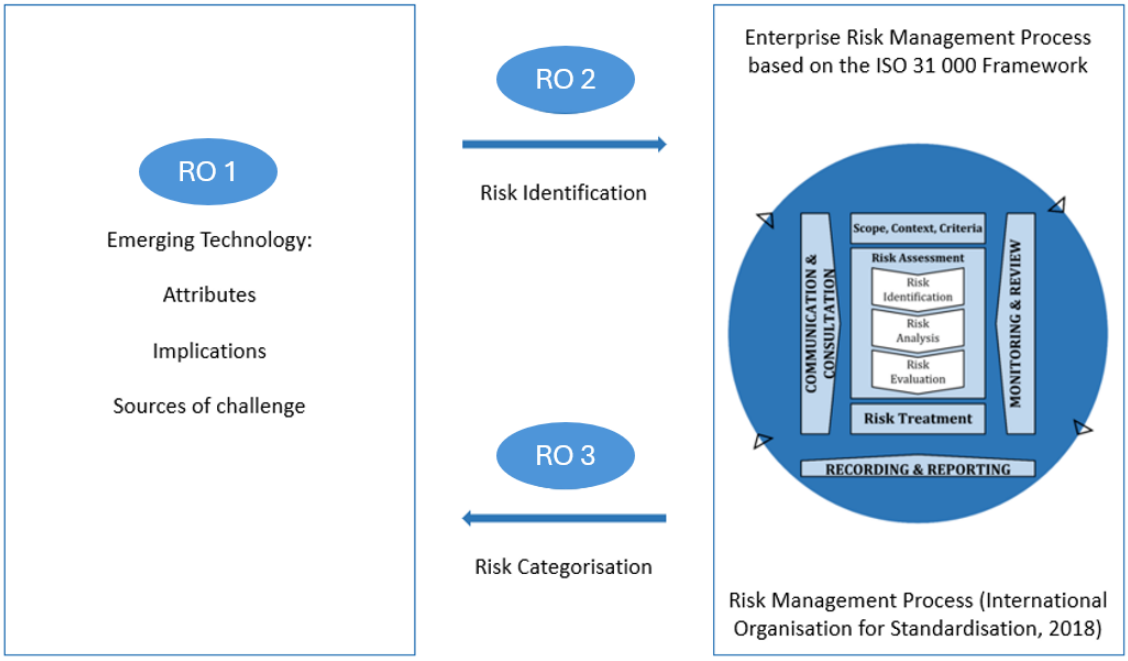


Figure 2: Conceptual framework

Figure 2 provides a structural depiction of the framework employed in linking the sub-objectives for the purposes of this study, concluding with the overall objective of this research paper.

2.5 Conclusion of literature review

The literature review has provided a synopsis of numerous studies to date, discussing emerging technologies and detailing the extent to which organisations are pursuing the adoption of these digital technologies to fundamentally alter how they conduct business and deliver economic value to the environments in which they operate. The chapter has denoted the leading digital technologies which hold the classification of 'emerging technology' and further defined their attributes and contribution to the fourth industrial revolution.

While adopting these emerging technologies is considered a strategic imperative to remain relevant in times of great uncertainty, resultant implications must be addressed by organisations following the path of adopting emerging

technologies. The implications discussed are superior customer insights, operational efficiencies, and business model transformation, all of which have exponential upside and equally catastrophic pitfalls if not implemented in a structured and responsible manner. The associated sources of challenge and their uncertain nature leave organisations exposed to new risks and a rapidly evolving risk profile. While no single piece of research provides a holistic universe of risks faced by organisations adopting emerging technologies, multiple studies have been conducted with strong commonalities.

In order to address these risks and manage the possibility of unfavourable outcomes, organisations are turning to enterprise risk management frameworks to provide a consolidated view of how to deploy economic resources to best address areas of great concern. One such framework is the ISO 31000, adopted worldwide due to the structured methodology designed through overarching principles and guidelines. The chapter further unpacks the concept of risk categorisation, detailing the available methods employed by previous studies and identifying a hybrid method of content analysis as the most desired avenue for the purpose of this study.

Based on the literature, the following propositions were constructed:

- Proposition 1: The exponential opportunities presented by emerging technologies are not without sources of challenge, which are presented in the form of new and evolving risks.
- Proposition 2: The adoption of emerging technologies, typically through a digital transformation strategy, necessitates the application of sound enterprise risk management practices for long-term success in managing the associated risks.
- Proposition 3: Risks associated with adopting emerging technologies may be categorised for the benefit of effectively deploying limited resources to address the uncertainty an organisation faces.

CHAPTER 3: RESEARCH METHODOLOGY

The following chapter presents an overview of the research methodology employed for this study to identify and prioritise the pure and critical risks associated with adopting emerging technologies. Further details are provided regarding the research approach, design, and instrument used for the data collection. The chapter concludes with a discussion on quality assurance, the necessary ethical considerations, and timelines for execution.

3.1 Research approach

This study used a qualitative approach to identify and explore the risks associated with adopting emerging technologies. Following the content of the literature review and owing to the limited research conducted on the risks associated with the adoption of emerging technologies rather than the risks of adopting emerging technology, an exploratory approach was deemed appropriate for the collection of new insights (Creswell, 2009; Saunders & Lewis, 2012).

3.2 Research design

The research has adopted a qualitative approach to better understand organisations' risk insights and experiences when adopting emerging technologies. The approach described above allows for expanding existing literature and adding new perspectives potentially not identified by the existing literature. This unknown is of particular importance as this research paper aims to gain new insight into organisational sources of challenge and resultant risks under the context of the fourth industrial revolution within the South African environment.

3.3 Data collection methods

In an effort to obtain deeper, richer and more specific insights from the perspective of South African organisations, semi-structured interviews were conducted both face-to-face and online with identified senior business leaders (Creswell, 2009). This approach was selected as it allows for a combination of predetermined questions and the flexibility to explore emerging themes in greater

depth, which is particularly valuable in exploratory research such as this (Creswell, 2009).

A senior leader sample set of listed organisations represents their organisations' views, adopting both structured and open-ended questions as part of the interview guideline, aligning with the semi-structured format. This enables consistency across interviews while also allowing participants to elaborate on their perspectives regarding the research topic. These identified business leaders form part of a specified group of individuals through which new insights and perspectives were gathered concerning the research objectives and questions (Saunders & Lewis, 2012).

3.4 Population and sample

The research focuses on skilled and professional individuals exposed to risk management practices within their organisations. These skilled and professional candidates span demographic characteristics such as age group, gender identification and ethnicity. The interviewed candidates are required to be actively employed by a South African-based organisation registered on the Johannesburg Stock Exchange.

3.4.1 Population

The population for the purposes of this study encompasses individuals currently employed by South Africa-based organisations who hold senior management positions within the organisation. These senior leaders either have direct involvement in risk management practices or indirect involvement in risk management activities through organisational management oversight, be this hierarchal structure or management ownership.

3.4.2 Sample and sampling method

The interview candidates have been selected through a purposeful sampling approach with the identification of senior leaders, based on job title, with the following filters then applied: i) employed at a South African organisation, ii) holds five years or more of senior management experience, iii) operates in a strategic

role (Creswell, 2009; Moser & Korstjens, 2018). The results of this list are profiled by industry, matching the eleven registered industries in South Africa. A sample set of 12 participating candidates was identified and they represent five industries and six professional disciplines.

This sample sixe is considered appropriate for qualitative research, particularly when using in-depth interviews to explore complex phenomena such as the risks associated with 4IR technology adoption. According to Moser and Korstjens (2018), qualitative studies typically require between 5 and 25 participants when using purposive sampling with data saturation typically occurring within the first 12 interviews in homogeneous studies.

Research interviews were conducted to collate novel risk insights (Beumer, 2018; Moser & Korstjens, 2018; Saunders & Lewis, 2012). All interviewees were encouraged to openly share their perspectives and experiences of risks associated with the adoption of emerging technologies through responses to the guided interview questions.

3.5 Research instrument

An interview schedule was employed as the research instrument for the semi-structured interviews with the selected candidates. The interview schedule has questions derived from the research objectives identified in Chapter 1 and supported by insights derived from the literature review in Chapter 2. The interview schedule concludes with an opportunity for interviewees to openly discuss the topic at hand with minimal guidance by the interviewer (Saunders & Lewis, 2012).

3.6 Procedure for data collection

Interviewed candidates were contacted via a professional social network platform, LinkedIn, or mobile communication, with supplementary documentation shared via electronic mail upon acceptance of the interview. Where possible, face-to-face meetings were arranged with the selected candidates. Where face-to-face meetings were not possible, virtual interviews were arranged through

Microsoft Teams, with the interview data being captured via video and audio recordings, which were transcribed for thematic coding and analysis.

3.7 Data analysis strategies and interpretation

Purposeful sampling is a research technique employed to identify individuals with a deep, complex understanding of insights relative to the qualities that each individual possesses (Creswell, 2009; Moser & Korstjens, 2018).

Based on the purposeful sampling described above, the interviews were documented through video and audio recordings and subsequently transcribed for analysis. Once all the interviews had been concluded, transcribed and validated by the participants, a thematic analysis following a deductive approach was applied to identify patterns of recurring ideas, namely identified risks, through the coding of quotes by the interview participants in their rich detail (Beumer, 2018; Creswell, 2009). These risk codes then formed the basis through which categories and then themes depicting risk categories are derived and supported by their prevalence in existing literature (Braun & Clarke, 2006). The thematic analysis followed a deductive structured approach, adopting the six-phase framework of thematic analysis proposed by Braun and Clarke (2006), which is widely recognised for its flexibility and rigor in qualitative research being: i) Familiarisation with the data; ii) Generating initial codes; iii) Searching for themes; iv) Reviewing themes; v) Defining and naming themes; vi) Producing the report.

The deductive nature of the analysis meant that the coding process be guided by theoretical constructs and known risk categories from prior studies (Beumer, 2018; Creswell, 2009), while remaining open to the emergence of new and novel insights.

This systematic organisation is faciliatted through computer-assisted qualitative data analysis software (CAQDAS), to deliver new insights and concepts based on the data presented during the interview process. The CAQDAS used for this study is LiGRE Software.

3.8 Possible limitations and challenges of the study

Potential limitations of this study are identified as follows:

- Obtaining the appropriate amount of time with organisational senior leaders to conduct the interviews without constraint is important.
- Due to the nature and sensitivity of the information, organisational confidentiality agreements may prevent a detailed and accurate representation of risk insights.
- Interview candidates may provide false or misleading insights based on personal perceptions or experiences with their organisations or emerging technologies.

3.9 Quality assurance

The trustworthiness of this study depends on the transferability, dependability, credibility, and confirmability, which are outlined in further detail in the following sections. The concepts of transferability and dependability relate to the ability to repeat the study and obtain similar results, while credibility and confirmability relate to the interpretation of the findings, which are true and clearly deduced from the interview candidates' responses (Moser & Korstjens, 2018).

3.9.1 Transferability

The results of this study would be deemed transferrable if they are applicable to comparable environments and the results are validated (Byrne, 2001; Stacey, 2019). Furthermore, for the purpose of this study, the data provided through interviews depicts the experiences of the interview participants (Stacey, 2019). Based on the requirements of the literature above and the study meeting these requirements, transferability was achieved for developing countries with a similar context to that of South Africa. In addition, the interview schedule was consistent for each participant, with a thick description detailing the context of the responses shared by the interview participants for the purposes of this study and enabling transferability of the experiences and findings (Moser & Korstjens, 2018).

3.9.2 Credibility

In order to ensure relevant and credible insights from the interview candidates, the participants were chosen based on bespoke criteria based on the details of this study (Creswell, 2009; Moser & Korstjens, 2018). As a control, to ensure the data collected was a true representation of the interview, the transcripts were shared with the interviewee for verification, and the researcher incorporated any possible corrections and further commentary (Moser & Korstjens, 2018). This process is described as member checking (Creswell, 2015).

3.9.3 Dependability

All undertaken processes for this study have been documented, evidencing that the study can be replicated (Creswell, 2015; Merriam & Tisdell, 2015). The documented processes are supported and supplemented by an audit trail, verifying the data collection and analysis process to accurately depict the subsequent research findings (Creswell, 2009; Moser & Korstjens, 2018).

3.9.4 Confirmability

In order to achieve confirmability for this study, comprehensive records of processes for data gathering, collection, and analysis are available, and access to the steps followed led to the outcomes of this study in accordance with the literature (Byrne, 2001).

3.10 Ethical considerations

Upon acceptance of the invitation to participate as an interview candidate in this research study, the interviewees were provided with a high-level overview of the scope, purpose of data collection, methods of analysis, and outcomes for this study. Signed consent forms were required of all participants to ensure:

i) Their understanding of the details above
ii) Their identity is protected
iii) Their organisation’s identity is protected

All data collected during the interview process was handled with due care for anonymity and confidentiality, which aligns with the intended purpose of its collection. For purposes of data analysis and reporting, all the data, information, and results adhere to strict censorship of any identifiable data.

3.11 Conclusion

The chapter began with an introduction to the research approach, progressed to the research design, and incorporated the data collection methods entailing the target population, participant sample size, and research instrument in the form of an interview schedule. The chapter closed with ethical considerations. This research employed a qualitative approach to conducting face-to-face and online interviews, with the resultant data collated, analysed, and summarised for presentation in the report.

CHAPTER 4: PRESENTATION OF FINDINGS

The following chapter outlines the key qualitative findings pertaining to the study, encompassing the total sample of 12 research participants. The chapter is presented in accordance with the three research propositions.

4.1 Introduction

The purpose of this chapter is to present the key findings of the study. The research paper follows a qualitative approach, focusing on the insights of 12 senior leaders exposed to risk management practices under the fourth industrial revolution through their role or position.

The chapter commences with a breakdown of the participant profile, providing relevance and importance for this qualitative study. The research findings then follow, based on a thematic analysis, and structured into three sections, guided by the research propositions:

- Findings pertaining to Proposition 1: The exponential opportunities presented by emerging technologies are not without sources of challenge, which are presented in the form of new and evolving risks.
- Findings pertaining to Proposition 2: The adoption of emerging technologies, typically through a digital transformation strategy, necessitates the application of sound enterprise risk management practices for long-term success in managing the associated risks.
- Findings pertaining to Proposition 3: Risks associated with the adoption of emerging technologies may be categorised for the benefit of effectively deploying limited resources to address the uncertainty faced by an organisation.

4.1.1 Participant profile

The sample includes 12 participants directly involved in risk management as a practised discipline or indirectly involved in risk management activities through organisational management oversight, be this hierarchal structure or management ownership.

The data points below provide relevant insight into the participants and detailed information such as industry of practice, organisational oversight, professional discipline, and gender identification. The sample represents a wide range of insights from diverse participants across multiple industries.

Table 3: A collective view of represented industries in the South African context

Industry of practice	Number of participants
Consumer Staples	2 participants
Financials	5 participants
Industrials	1 participant
Technology	1 participant
Telecommunications	3 participant

Of the 12 participants, spanning six organisations, half held C-suite positions in their organisation. The remaining 6 participants were denominated as senior leaders, of which all 12 participants were associated with a South African operating entity. These diverse roles provide an important and holistic perspective of the sources of challenge and associated risks with the adoption of emerging technology in South Africa. In terms of the professional disciplines and management oversight of the sample, this presents a diverse perspective of various organisational functions. The data is presented in Table 4.

Table 4: A collective view of the participants' professional disciplines and management oversight

Professional discipline	Number of participants
Commercial	2 participants
Compliance	1 participant
Finance	2 participants
Marketing	1 participant
Operations	2 participants
Risk Management	4 participants

While not an emphasis on participation in the study, the resultant gender distribution across the population sample was recorded at 5 female participants and 7 male participants. This sample emphasises the commitment to ensuring a broad array of insights and perspectives in examining proposed research propositions based on practical knowledge.

Table 5 depicts the technologies adopted by the participant sample. Participant 8 is the only interviewee to recognise a single emerging technology. This mapping of emerging technologies adopted by participants provides importance to the practical insights received in relation to the adoption of emerging technologies.

Table 5: Emerging technologies adopted by interview participants

Interviewee	Emerging technology adopted		
	IoT	Big data	AI
Participant 1	✓	✓	✓
Participant 2	✓	✓	✓
Participant 3	✗	✓	✓
Participant 4	✓	✓	✓
Participant 5	✓	✓	✓
Participant 6	✓	✓	✓
Participant 7	✓	✓	✓
Participant 8	✗	✓	✗
Participant 9	✓	✓	✓
Participant 10	✓	✓	✓
Participant 11	✓	✓	✗
Participant 12	✓	✓	✓

4.2 Findings pertaining to Proposition 1

Proposition 1 reads: The exponential opportunities presented by emerging technologies are not without sources of challenge, which are presented in the form of new and evolving risks.

The study intends to determine whether Proposition 1 can be validated by understanding the impact of emerging technology on the competitive landscape, the depth of emerging technology adoption, and lastly, by identifying the sources of challenge due to adopting these emerging technologies. The identified sources of challenge are in accordance with the following themes: market competition, talent management, data management, business model changes, new and evolving risks, and unknown risks.

An overview of the codes and themes produced during the thematic analysis concerning Proposition 1 is depicted in the table below. Table 6 shows key concepts connecting to themes and are aligned to the research Proposition 1 of the study.

Table 6: Codes and themes related to Proposition 1

Research proposition 1: The exponential opportunities presented by emerging technologies are not without sources of challenge, which are presented in the form of new and evolving risks		
Codes	**Categories**	**Themes**
Value proposition	Competitive advantage	Competitive landscape
Data-led insights		
Operational efficiency	Enhanced operational excellence	
Marketing insights		
Performance data		
Data quality		
Big data	4IR technologies	Emerging technology adoption
Artificial intelligence		
Internet of things		
Adoption trends	Technology adoption	
Market competition	Competition	Sources of challenge
Talent management		
Data management	Organisational evolution	
Business model changes		
New and evolving risks		
Unknown risks		

4.2.1 Competitive landscape

Participants were engaged in the evolution of the competitive landscape at an industry and organisational level with the onset of the fourth industrial revolution. In response, a large majority of participants agreed that the competitive landscape has been impacted by the drivers that make up pockets of opportunity, citing value proposition, data-led insights, operational efficiency, marketing insights, performance data and data quality as the leading drivers of this new competitive landscape.

The first of these pockets of opportunity is a value proposition, with most participants citing the importance to the organisation and their ability to be commercially competitive.

Participant 1 noted that their value proposition went beyond just product as "*People [clients] start to differentiate on other things. So I don't think product always differentiates you anymore, but how you service your clients does, which is almost like an old fashioned thing, how you treat your clients becomes more important*". Participant 1 also believes: "*People still want it [service] to be personal and are less happy with generic output".*

Participant 7 said: "*[The] fourth industrial revolution has obviously increased our organisational intelligence because obviously we can do so much more now*" in terms of value-adding services and further mentioned that the fourth industrial revolution could *"dissolve and/or erode our value proposition as a business to our to our customers and then eventually it could dilute our returns*".

Participant 8 echoed this view regarding the value proposition: *"A lot of opportunities more than competition".*

Participant 11 raised the concept of the internal value proposition and supporting interdependent organisational teams: "*We have all the information and if you want to make your life easier supporting [the organisation]"*. The participant further expanded on the ease of identifying points of value: *"It comes from our reporting tools and into all these dashboards, all this information that that makes my life as a finance controller much easier".*

The second of these pockets of opportunity is data-led insights. Most of the participants highlighted data-led insights as a driver of opportunity. Participant 3 emphasised the depth of available information and data points: "*You know, they're tracking what we do on the website. They're tracking what we do on their app and all this data gets ingested into their customer data platform and all of these insights that are inferred, which requires no human intervention at all"* (Participant 3).

Participant 7 highlighted the data-led insights of the organisation *"Obviously we can get custom identified customer trends*" and added: "*based on trends and based on relationships we have with other telcos, we are able to identify which of our base stations could be a potential next hotspot".*

Participant 11 identified customer targeting as a strong output of data-led insights and an organisational point of focus *"Putting it [data] together and targeting [specific audiences] that is our new change to our strategy".*

Participant 5 highlighted the breadth of data-led insights: *"Big data guys are probably going to be the new cowboys in technology because they're pushing an agenda, based on what they know and the rest of the business [is] saying ok, what do we do?".*

The third of these pockets of opportunity is operational efficiency. In a tie for second, an equal weighting of participants viewed operational efficiency as a driver of the competitive landscape*: "It's exponential, from 2,500 to 40,000 [financial transactions] a month, the company just went eight times faster in a blink of an eye … we eliminate all the manual work",* expanding that *"it's been great for us, just to be able to see what the new digital age can do in terms of customer service, efficiency and speed, and you'll never be able to do that manually. Never"* (Participant 8).

Participant 10 added to the views of Participant 8: *"[The] fourth industrial revolution has enabled us [the organisation] to handle operational efficiencies and has truncated the time frame to do so".*

The insights of Participant 2 centred on acting in real time and expanded on Participant 10's views: *"It could take hours, days to do this extensive research and by the time you are done, it's not relevant anymore. So this is in real time"*, underpinning the emphasis on efficiency in this competitive era of the fourth industrial revolution.

Participant 7 shared the view of Participants 2 and 10: *"They [the organisation] use AI to develop code and debug … what took the guys like three or four days to debug, now they can do it in like 15 minutes. So think about the time saving and the impact"*.

Participant 1 was direct in stating that in the fourth industrial revolution: *"It needs to be efficient and seamless"*, and the participant positioned operational efficiency as a market requirement under the fourth industrial revolution.

Fourth on the list as a pocket of opportunity is marketing insights, with four of the participants mentioning its value in a competitive landscape. Participant 3 said: *"Every broker that I know is doing the same thing. So something like that I think is absolutely how the competitive industry or the competitive landscape is changing. They understand so much more about us as clients. I mean things that we [are] not even saying … they are obviously looking at things that I am currently trading or investing in ... incomes is very focused around what they know would work for me rather than just being this broad pay in spray way of communicating with me".*

Participant 3 elaborated on the depth of personalised marketing communication: *"We use customer segmentation and modelling to determine [a client's] propensity to take up another product, to trade a different market … and to conduct this churn analysis so [that] we can understand who is at risk of churning a month, two months, three months before that even happens".*

Participant 3 went into further detail comparing the differences in marketing communications before the onset of the fourth industrial revolution and thereafter: *"Whereas before, they [would] write, one newsletter and this would go out to 500,000 people. It it's more focused [today] and tailored based on my*

characteristic traits, based on how I interact with them as a business. Which obviously is fantastic for me".

Participant 11 shared views of targeted advertising: *"We started targeting some of our advertising … ensuring that we use this data, seeing what the consumers have [purchased] and moving through where we spend [the marketing budget] … again that's where we need to show and isolate the with the marketing team … you have to try to ensure your marketing people have the information".*

Participant 2 provided an alternative view with regard to marketing insights being a pocket of opportunity, suggesting that marketing elements are a function of emerging technologies by *"[c]reating marketing material, approving marketing material, servicing and onboarding clients".*

Fifth on the list as a pocket of opportunity is performance data and data quality as the leading drivers of this new competitive landscape. Some of the participants who cited performance data described service delivery and product performance metrics as a pocket of opportunity in competitive market conditions.

Participant 9 said: *"Documentation is still something that accompanies shipments, so when you say the internet of things, I can tell you already that airlines have the capability of checking information from the second it leaves the producer's door all the way until it arrives at [the] final consumer delivery destination".*

Participant 11 further said: *"In our case, for us getting [a larger] market share, data is one of the most critical aspects to see how it is going to help us compete against our biggest competitors",* and added*: "So when we decide to evolve we needed to get the right data".*

4.2.2 Emerging technology adoption

Pertinent to the study is the ability to understand the depth of emerging technology adoption amongst South African organisations and the interconnectedness of these three emerging technologies IoT, big data, and AI, as they drive into the fourth industrial revolution.

Big data led the charge, with the large majority of participants claiming that their organisation has employed big data capabilities and is actively seeking to exploit the exponential opportunities presented by the technology as a lever for competitive advantage.

Participant 1 led with big data as a fully adopted technology: *"Big data definitely is one of them"*, and the participant further notes that big data is the most dominant technology employed by the organisation: *"The most dominant, I think we use it [in] everything we do as an organisation".*

Participant 6 echoed and emphasised Participant 1's views: *"Big data is now a household name to make all our decisions, whether we [are] optimising in our [risk] matrix or optimising our [risk] processes".* Further responding and stating that *"Big data and AI are the big movers in our organisation".*

Supporting the insights derived from Participant 1 and Participant 6 was that of Participant 9: *"Definitely big data comes up as first" going further to mention: "that is why big data and how we manage big data is definitely on the cards".*

Participant 3 indicated that big data had been in use by the organisation for a longer period: *"Big data I believe has been around far longer than artificial intelligence. I mean, we have been using big data as an industry and as an organisation".* Participant 3 further elaborated: *"Big data and AI absolutely are the tools that we use. I mean big data we are using in the form of long grammar".*

Participant 10 viewed big data from a volume perspective: "*We collect terabytes and terabytes of data within the hour, within minutes, and the metadata from that, I feel is [the] big data that we need to provide tools to our customers*".

Participant 2 highlighted big data "*[a]s a given. We are a big organisation and to inform these type of tools [within the organisation] we need to be extracting information from various sources of data".*

Participant 7 positioned big data capabilities as a mitigation tactic for large-scale fraud. As an organisation they *"[s]hare these kind of trends and we have actually*

built one database where we use big data … a combination of AI and big data to do the fraudulent accounts checks".

Participant 5 identified big data as a core organisational capability with a strategic imperative: *"A group focus to oversee all big data initiatives across the business"*, and: *"Big data pushes a lot of information back into the business in terms of decision making".*

AI and IoT each earned the majority of participant responses when engaged on which fourth industrial revolution technologies are being employed across the organisation.

Participant 12 elaborated on the application of AI: *"The company has [a custom] ChatGPT. You can check out processes, procedures, policies, how to do something and then you can also check for presentations and it will give you everything associated with the company. It also keeps the company's information private"*.

Participant 3 further noted that as an organisation "*[w]e obviously went on this big AI drive, a lot of it is still being tested but we [are] now at a point where we're having articles that are being published on the website with no [intervention], the only human intervention, rather, is somebody just going in there and being 100% certain that it makes sense".*

"We are working on something in real time as the presenter speaks, we can actually translate that into several other languages as he is speaking" (Participant 3).

Participant 4 pointed out that all three emerging technologies have been adopted in the organisation. The organisation even considered itself the highest industry adaptor of AI. Participant 4 said: *"Of the first two, IoT and big data, we were the highest on adoption of AI. We definitely haven't even scratched the surface in terms of what we can use AI for".*

Participant 9 noted that IoT: *"For us it remains something that is standard application and where there are advances in technology we will always be the*

first to take it on" and went further to state that: "*IoT is something that is industry relative."*

Participant 4 said: *"I will probably go with internet of things as the most dominant in the organisation".*

"It just means that we are as a company, because of [the] internet of things, we are able to play on that interconnectedness element and get the best of what the technologies [Big data and AI] have to offer". (Participant 4)

Participant 4 went on to elaborate around the adoption of IoT: *"We even offer things like trading on your smart watch as well, which did not last very long, but probably had an app on Apple Watch for 20 years. But we were very much in the adopters".*

In reference to Table 5 above, regarding the identification of emerging technologies adopted by interview participants, only Participant 8 noted the adoption of a single emerging technology. Participant 8 said the adoption of this emerging technology *"[f]orced us to like jump light years ahead of where we were based on as you follow the normal evolution".*

In reference to Table 5 above, most participants disclosed that their organisation had adopted all three emerging technologies and pointed out the organisational desire to be a leader in welcoming emerging technologies to the organisation.

Participant 9 supported the view of being an early adopter of emerging technologies: *"The company has always been pioneers. They pride themselves on being pioneers. We are The Pioneers. We will taste it or we will perfect it all".*

"The challenge you have in being a pioneer is you've got to work out all the kinks … competitors will also have the same application[s] and the sooner you can do an implementation of such technology, the more advantage you have, right, because it's all about time" (Participant 9).

Participant 6 noted: *"Embrace innovation ... we have now got a full-on innovation programme, full-on functional".*

"Well, if not the first, one of the first" was the comment made by Participant 4, supporting Participant 9.

Participant 2 focused on the pace of emerging technology development: *"Because things are moving so fast in the technological space, we are moving fast too, but maybe not fast enough".*

Participant 7 and Participant 1 both alluded to emerging technology adoption as a time-based process within the organisation. Participant 7 said: "*I expect it to be more, yeah, quicker, faster. You know, like more pronounced"* and Participant 1 supported the viewpoint: "*It is definitely not an overnight thing, so it is going to have to be while [as] we want the additional computing power".*

4.2.3 Sources of challenge

It is significant to identify and describe the sources of the challenges the participants face as their organisations adopt emerging technologies.

The participants offered the following in response to describing the uncertainty, culminating in the challenges their organisations faced: market competition, talent management, data management, business model changes, new and evolving risks and unknown risks.

Market competition was mentioned by most of the interview participants mentioned, noting disruption in the way business is conducted by existing competitors and the challenges of new market entrants.

Participant 3 noted that from an organisational point of view: "*There's a huge risk that we [are] not moving quick enough".*

Participant 7 furthered the point made by Participant 3 regarding the pace of market changes under the fourth industrial revolution: *"If we have that introduction of that [emerging] technology in our country, you know it might disrupt the way we have been doing business for so long".*

Participant 6 agreed with the view of Participant 3, and explained: *"Basically [market competition] tells us how pervasive it [technology] has been, what has it*

done to our competitive landscape. We have now got the introduction of new competitors … you've got the disruptive ones, you've got the emerging ones, etcetera. The pace at which they evolve is what we consider".

"We have got new competitors. It's one of our key risks now. But I've also got opportunities and then of course these operational efficiencies that I derived from all those" (Participant 6).

Participant 4 shared the view of market competition through the lens of the customer: "*Staying ahead of the competitive landscape, being the choice, the first choice for clients to actually come to use our services because there is end of convenience. There is an element of self-service. There's an element of empowering clients to actually make decisions for themselves".*

Participant 10 believed that organisations can become new market entrants based on access to emerging technology: *"Rapid release of large language modules has fast tracked our ability to compete with large companies. Being in video, we are easily able to leverage our data and push them into LLMs [Large Language Models]. Access to these tools has given us quite a lot of differentiation and competitive advantage. This has changed our product and offering".*

"We were born in 2013, in the fourth industrial revolution, and today we have competitors popping up rather rapidly" (Participant 10).

Participant 2 identified the expansion of new market entrants creating competition: "*Generally market entrants have changed from more traditional competitors such as banks and investment companies to Fintech companies, crypto platforms and peer-to-peer lending platforms".*

Participant 7 raised the threat of existing competitors when considering market competition: "*There is a market disruption list. So, normally if you think about market disruption, you think competitors and you know the kind of risk that potential competitors would bring to us".*

Talent management was discussed by less than half of the participants and then from the perspective of employee education, organisational-wide training and scarce digital skillsets.

Participant 4 noted education around the fourth industrial revolution as a country-wide source of challenge: *"For digital literacy, gaps are going to continue to climb up and up, and adoption of technology and innovation around technology will continue to become an issue, South Africa is massively behind in this one".*

Participant 4 commented: *"Talent will move with technology"*, a source of challenge and concern for organisations: "*will come just generally with educational challenges, inadequate adoption from governments and countries in upscaling people".*

Participant 10 held a view of organisations requiring specific digital knowledge: *"There is a lot of technical risk that we [the organisation] have not managed correctly because we haven't had the competency and the skill sets to do that".*

"There are a lot of people who are welcoming of these technologies, but I do think it is a challenge in a broader sense. It is absolutely going to be a challenge for a lot of people" (Participant 3). This viewpoint of Participant 3 focused on the challenge people faced in learning new digital skills.

Participant 3 added that the openness to emerging technologies could be affected by age: "*I'm still quite welcoming to these new technologies but, I mean, if I were to look at somebody maybe ten, fifteen, twenty years older than me, they might not be as welcoming to these technologies, they might not grasp these concepts as quick as someone like you, or I would maybe do".*

Participant 3 further noted that emerging technologies would negatively impact organisational talent: *"I don't want to be negative, but someone is probably going to lose their job somewhere along the line. Or maybe we will just reduce head count by attrition, but at some point, you won't actually need those people".*

"It [emerging technology] has had a great impact … it is going to affect our staff headcount just because of the nature of what it [emerging technology] is doing. If

you have 10 copywriters but you have an AI that can do it within 10 seconds, you don't need all of them" (Participant 3).

Data management was identified by most of the participants as a source of challenge in their organisation under the context of emerging technology adoption.

Participant 1 viewed data management challenges as a source of challenge relating to transformation: *"We want to move a lot of our data into the cloud, but I know there are a lot of challenge with that [currently]".*

Participant 6 discussed conversation questions raised within the organisation regarding data management practices commencing with relevant questions: "*How do I structure my network? How do I move the data? What are the decisions? You know the risk is too high for me if I do the wrong thing, I'm in trouble"* and concluded with the organisational fear of an incorrect decision.

Participant 7 shared similar concerns to that of Participant 6 pertaining to data governance: *"Data governance obviously also leads to the data security and the privacy issues that normally come with when you're dealing with data, of course".*

Participant 9 clearly confirmed that data management challenges directly affect emerging technology: "*Why big data and how we manage big data".*

"The [organisational] data to get around it, it's big … I mean we can go down to a product sold by a customer [on] which day [at] which time … we will share information to them [the organisation] and it comes extremely fast, but also we can deep dive fast as well … that is where we need to show and isolate the with the marketing team, what the issue is … my job is to make sure it's easy for them and for them to go deep dive into the problems" (Participant 11).

Business model changes were discussed as a source of challenge by Participants 6, 7, and 10.

Participant 6 shared the view of imminent change in relation to business model changes and how organisations operate, detailing: "*The business model is going to change and someone has to say, listen, I'm getting ready to let go of this*

[business model] into this type of thing. I mean, I see it every single day with the existing products in the organisation".

Participant 7 supported Participant 6's viewpint, claiming that the organisation is *"[b]eing collaborative, I'm trying to work together to see how we can use it, to protect what we have, and also to develop new ways of working with the new business models".*

"The potential risk, or the potential disruption, should I rather say, that a new technology could basically bring to our organisation and the impact it could have on the way we do business" (Participant 7).

Participant 10 focused on the commercialisation of emerging technologies by organisations: *"Making money from the product and actually generating revenue is cool. The solution works. It ties to also having processes in place … but turning that product into revenues is difficult because, it is not cheap to use these third-party models. It's quite expensive. So the solution can work, but then it's just not viable commercially"*.

Participant 10 elaborated on the above view: "*One major risk is if the technology gets too good, it just replaces our whole business model. Theoretically the people we've partnered with could just leverage the emerging technologies to replace us".*

Participant 2 alluded to business models having already evolved, supporting the insights of Participant 6: *"Business models have also changed to adapt, moving [away] from traditional methods. For example, traditional personal relationships like having a relationship banker kind of thing to using applications, for example from fixed operating hours to more. That's the flexible work, flexible hours and more digitaly based engagements. Then I guess the obvious answer is also the increase in the development of AI and machine learning".*

The presence of new and evolving risks was noted by most participants in relation to the organisational challenges regarding understanding and keeping pace with new risks.

Participant 7 viewed the need for emerging risks being required for emerging technologies: "*There is a lot more focus on the new type of risk[s] that these technologies bring about … firstly, we had to change our [risk] library, right, like introducing new categories, all those kinds of things, obviously to cater for the new technological risks".*

Participant 5 echoed the insights of Participant 7 by stating that the organisation most likely be *"[r]evamped [the risk universe] again, to see where we are and how much has changed … I think there is about four new degrees that we introduced to that risk universe".*

"Inherently they are new risks themselves that you have to kind of cater for so, there are conversation[s] around how do we mitigate that risk" was cited by Participant 10 in agreement with Participants 7 and 5.

"It's probably more at the execution level of managing that risk that we will probably find the most surprises or the most gaps in our understanding, not that we did not understand the potential risk … so it means that it is very rare to actually have something that you [are] completely taken by surprise by, or that you did not know of, in terms of how well prepared you are on a practical level, to manage that risk is something completely different" (Participant 4).

Participant 1 touched on the evolution of existing sources of challenge under emerging technology adoption in South Africa and mentioned that there is *"[m]ore detail, more levels. I'm not sure we were not looking at any of the general areas before, but the underlying detail is changing."*

Participant 1 explained. "You [are] always challenging the risks that you are measuring and whether those are the most appropriate or whether there's something that's become more important or maybe something [that] is less of a risk".

Participant 6 noted the increased requirement for horizon scanning safeguard organisations through *"[t]he discipline of emerging risk reporting, it was like the sidebar thing that no one used to care about. Now it is the forefront, there is no*

single risk committee that we will come out of and no one is talking about emergent emerging risks".

Facing unknown challenges or risks was discussed by some of the participants who opined that organisations had not adequately identified new sources of challenge.

Participant 8 shared a view on black swan events relating this type of occurrence to the COVID-19 pandemic: *"there is a risk out there that me and you haven't thought about. Hopefully, we don't have to see it, but I'm not so confident that we won't have to see it"*.

"They are still new risks and the thing is, it's unknown … it is like a trial and error with the new tools, and you won't know all the risks" (Participant 12).

Participant 5 identified the need to bring context and relevance to organisational risk frameworks for the purposes of framing unknown challenges: "*One of the clear changes in terms of our [risk] framework, that is definite is, we needed to update it and make it more relevant*" under the umbrella of the fourth industrial revolution.

4.3 Findings pertaining to Proposition 2

Proposition 2 reads: The adoption of emerging technologies, typically through a digital transformation strategy, necessitates the application of sound enterprise risk management practices for long-term success in managing the associated risks.

To explore the risks associated with the adoption of emerging technologies under the fourth industrial revolution, participants were asked to identify the risks they experienced as an organisation following the adoption of emerging technologies. Participants were also asked to identify these risks based on the highest level of impact on the organisation, noting the significance of risks affecting continued technology adoption. The risks identified are as follows: vendor dependencies, change management, people, data management challenges, cyber security,

adverse regulatory challenges, fourth industrial revolution participation, environmental factors, geopolitical threats, and stakeholder management.

An overview of the codes and themes produced during the thematic analysis concerning research Proposition 2 is depicted in Table 7. The table shows key concepts connecting to themes and aligned to the research Proposition 2 of the study.

Table 7: Codes and themes related to Proposition 2

Research proposition 2: The adoption of emerging technologies, typically through a digital transformation strategy, necessitates the application of sound enterprise risk management practices for long-term success in managing the associated risks		
Codes	**Categories**	**Themes**
Third party	External risk dependencies	Vendor dependencies
Model bias		
Fast changing environment	Organisational agility	Change management
Complexity		
Training employees	Workforce capability	People
Employee education		
Human error	Operational risk	
Data security	Information security	Data management challenges
Data volume	Data governance	
Data privacy		
Data accuracy	Data quality	
Cyber security	Cyber	Cyber security
Fraudulent activity		
Regulatory challenges	Compliance and regulation	Adverse regulatory challenges
Ethical practices	Governance and ethics	
Lack of participation	Digital divide	4IR participation
Risk culture		
ESG	Sustainability	Environmental factors
Acts of God		

Research proposition 2: The adoption of emerging technologies, typically through a digital transformation strategy, necessitates the application of sound enterprise risk management practices for long-term success in managing the associated risks		
Codes	**Categories**	**Themes**
External threats	Political and economic instability	Geopolitical threats
Customer demand	Market expectations	Stakeholder management
Reputation	Public perception	
Influencers		

4.3.1 Vendor dependencies

Third-party reliance risk was raised by a large majority of participants, which could also be presented as vendor dependencies.

Participant 8 discussed the matter of outsourcing services to third parties and specifically that of crucial capabilities: "*That [service] is done by an outsource service provider, so we are highly dependent on [the vendor] that keeps our records as this can go back a whole number of years, can show you all the contributions paid including, all the returns on your fund".*

Participant 8 noted key vendor dependencies as issues of system integration and reliability in communication: *"We had to talk to Home Affairs and you need to make sure that those details, what you sent me tied up with Home Affairs. Then what you sent me, tied up with the bank … SARS said to me [the organisation], you can pay Brett and this is how much tax you must deduct".*

"The Home Affairs platforms is a bit unstable … that was probably the weak link" (Participant 8).

Participant 6 viewed vendor dependency from the perspective of resilience: "*[Emerging] technology has become prominent, more permanent, resilience has become more prominent in fourth industrial revolution because a global outage is really what scares us around the things of technology".*

Participant 6 further explained that the organisation *"[w]ould partner a lot, but responsibility is still going to say to us, when you are partnering with someone,*

are they employing these types of [resilience practice] things? So no, I don't think that South African technology risk is given enough prominence".

Participant 9 offered similar insights to Participant 6: *"Integration with custom systems enables us to execute at the highest level and it's similar across integrators"*, following up with the statement: *"broader risks for where you are based for the supply of just production items, that you need to provide the service, which is also something you have to consider. So the risks are not only consumer based but also supplier based".*

Participant 4 provided a detailed description of a third-party dependency, supporting the insights of Participants 9 and 6*: "Because you are looking to get the best technologies from different sources, which means that you there isn't an end of risk from third party providers as well, over and above you being a target"* (Participant 4).

Participant 4 expanded on the insights shared above, relating to challenges linked to vendor dependency that *"Corporations that we are all connected to, like Microsoft or Salesforce [for example], you know, we always knew that the day would come, where we would actually lose internet [connection] but, when it actually happens, that is when your BCP, your business continuity plans are actually tested or your redundancy lines are actually tested".*

"A recent one you will remember when on the West Coast of Africa, fibre [network] cables were actually cut. Then that's when you're like, oh, I actually did not know that this third party had all their connectivity linked on one side of the coast. And, you know, even though they talked about redundancies on the eastern side of the coast, they don't work as well, or there's too much traffic, or there's too much latency … if we had quizzed them a lot more to actually understand how robust are their secondary channels were, we would have actually known" (Participant 4).

Participant 10, similar to Participant 4, described a similar scenario linked to the organisation and a provider of crucial technology services: "*We are leveraging ChatGPT, the 4.0 model … a big risk from my perspective is that we don't have*

complete control" Participant 10 also said: "*we leverage a lot of the AI tools in our development processes".*

"If AWS goes offline, we are offline, like it doesn't really happen [often], but it has happened. So that is a huge kind of risk, how do you mitigate that? How do you have redundancies, a failsafe, failovers, where does your failovers read through?" (Participant 10).

Participant 2 added: *"Credential stuffing, it was a big incident we had, it was a third party's data that was vulnerable".*

Participant 5 noted challenges posed by third-party vendors and their multiplicity: "*Now more than ever the governance questions that we used to ask is like do we have a vendor agreement with you? Do we have a third-party agreement with you? Have you been on-boarded? Those things are becoming [important], in the past you used to take it for granted because it's the same vendor, now it is all these new people coming through the front door and you have to hold hands and get them on board, get the paperwork sorted out, get the scope of work in place".*

Participant 12 identified the need for multiple vendors, claiming that as an organisation: "*You need to have a backup bank completely. If something were to go wrong, you need to be able to make payments. It should not affect your payments, so the internal control would be you need to have like a minimum of three banks loaded".*

Participants 6 and 10 provided alternative views on the dependencies placed on third-party vendors from the perspective of inheriting vendor bias or challenges.

"You don't want models that are culturally insensitive, models that are not considered of the particular local markets" (Participant 6).

Participant 10 identified the validation of AI models: *"Benchmarking of these AI models is actually a risk because we're dealing with life-or-death situations, like threats of fires. If you miss it, it has severe consequences".*

4.3.2 Change management

Change management was cited by most participants: this was driven by the pace of change experienced in fast-evolving environments and the complexity associated with organisational change.

Participant 12 shared insights on change management, noting learnings from their organisation: "*You [the organisation] should not be implementing 2 tools within the same stream like streamlined process, because if one breaks and the other is fine, you don't even know which is not working".*

"It is the hardest thing to get a payment out of out of the company, because there's probably about like five to six systems you need to go through and the verification processes as well" (Participant 12).

Participant 8 elaborated on delays in technology adoption: "*The IT project never gets delivered on time and on budget. You know, that has been my experience".*

Participant 2 noted: "*Operational concerns around legacy systems and systems, not speaking to each"*, echoing further adoption and change management challenges.

Participant 10 added regarding change management of emerging technologies and specifically in relation to the pace at which change occurs: *"AI at the moment is moving too quickly. It's like you probably have to update your standards every week".*

Participant 4 identified the pace required by change management within the organisation: "*I think maybe that is a risk of itself. The fact that we have not fully adopted that technology [AI] at all, it is a massive sort of commercial or competition sort of risk because competitors are adopting stuff and a much quicker pace than us".*

Participant 6 supported and framed the insights of Participant 4: "*The pace of the world is ridiculously crazy".*

Participant 9 held a view of complexity with regard to change management at both an industry and organisational level*: "So what you would see is a multiplicity of needs being fed by a single supply"* (Participant 9).

Participant 9 further explained the complexity of change management: "*To adjust the way they approach the industry and manage diverse streams of production, but at the same time being able to deliver on a level of service that you commit to … Outside of our comfort zone of what we traditionally do".*

"Traditional freight forwarding companies who act as an intermediary between yourself and the airline, trade boarding companies have created online platforms that allow you as a consumer to directly book it, will integrate directly into airline systems" (Participant 9).

4.3.3 People

Risks concerning people were presented in the form of knowledge gaps among employees and human error. Most participants shared people's challenges regarding the adoption of emerging technology.

Participant 1 held a view derived from the educational aspect of people challenges: *"There are a lot of people in the organisation who do not know how these [emerging] technologies work"*, expanding this insight to include that *"for employees to keep abreast of what new stuff is available, is quite a challenge".*

Participant 7 was clear: *"The lower levels probably still have to get their heads around it [emerging technology], think about what they do and how it could impact them".*

"Even if they can use it [AI] just to write an e-mail properly. I know there is a lot of resistance that we face in the organisation … One of the uncertainties that people on the lower level think when they think about AI are the insecurities about job losses and those kind of things. And I think that kind of thinking holds people back. So they don't want to really learn how to use it," further stating that *"people pushed against it [AI] a lot, but I think people have come to see the value of it [AI], so we use it [AI] across the business"* (Participant 7).

Participant 2 supported Participant 7 and added about the organisation: "*We have had lots of awareness around it [AI] because there is obvious concerns with employees around the use of AI. Some are legitimate concerns, thumbs up, some are not really legitimate concerns".*

Participant 6 expanded on people challenges from an upskilling perspective: "*It lives in terms of trying to upskill our employees and some things are becoming mandatory that everyone has to do, so really build a full on digital skills programme, even in so much as saying that we are now trying to tap directly to universities because in some areas, particularly big data and AI, skills are very scarce. I mean we can't generate the data scientists fast enough".*

Participant 11 explained the organisational need to bridge the knowledge gap: "*A whole website of e-learning modules are available, that we have to follow, we have to sign and acknowledge".*

Participant 8 shared a similar view to Participant 11 regarding a need to bridge the knowledge gap of employees: *"We are trying to make it easy for them … We had people to help them, but once they got to use it, it's not that complex … there are some guys it is a bit difficult for but we got everyone over the line".*

Encompassed in people challenges was human error and Participant 2 said: *"One human error risk that you do have in the digitised world carries more weight than ordinarily what would happen in the manual world".*

Participant 12 supported this view: "*When someone is completing the configuration mapping for new processes and something is incorrectly mapped or streamlined, everything breaks".*

"For us it is with automation comes system error as well as human error" (Participant 12).

Participant 12 added that system errors can occur due to human error, and these system errors are passed on, compounding the human error. Participant 12 believed: *"[y]ou can still have human error with the implementation of new tools. You have to still be that person who validates what this tool is doing. You cannot*

wholeheartedly trust what is being given what is being implemented because, it [technology] can also still make an error behind the scenes, the mapping of the system [is susceptible to human error]".

4.3.4 Data management challenges

Most sample participants noted data management challenges, citing data volume, data security, data accuracy, and data privacy as the risk drivers.

Participant 1 noted: *"Information flows much faster now", going further to state that as an organisation: "You need to be able to handle volume".*

"We are running into challenges with computing power and having to schedule when things [big data scripts] run. They have to run after each other because you don't have enough computing power for all of it anymore" (Participant 1).

Participant 9 shared the concerns of volume in relation to data management challenges and stated that as an organisation "*[w]e have over 140 systems that manage what we do every single day … [this] exponentially increases the amount of data, information that you have to manage, which then back in the information systems means that we need to enhance how we process data, how fast we can execute and whether or not it takes us outside of the norm".*

Participant 11 noted that there is *"[t]oo much [big data]. Sometimes you don't know, where is the focus? You have really got to summarise data that is going make your life easier and data you do not want to see".*

Participant 10 shared data challenges pertaining to data security: "*A big risk is that we have got so much data, that if somebody hacked into our system, we have got access to a lot of data".*

Participant 9 ratified the challenges of data security: *"I think we are one of the companies in the world that get the most cyber-attacks a day. So, hyping up your online security, your firewalls is a constant. You don't even have a choice".*

Participant 9 also stated: "*The sharing of customer data is something that is protected by the jurisdictions in all countries that we operate in, we subscribe to*

a number of international organisations on compliance. So there is significant amount of protection built into the systems in which consumer data is managed".

"The data governance obviously also leads to the data security and the privacy issues that normally come with when you're dealing with data, of course" (Participant 7).

Participants 7 and 8 agreed from the perspective of ensuring the correct level of data accuracy. Participant 7 said: "*We need to make sure that our data that we are using to develop these algorithms or whatever we are doing with them, is accurate and reliable".*

Participant 8 added: *"When you have lots of data, you can get some nonsense information … we have third party validation of data, that is very important".*

Participant 12 mentioned challenges of sensitive information regarding data management: *"Data privacy, I would say it is becoming bigger than what we thought because we are more aware of what data privacy is now, because before we actually were not aware of what data privacy was and what it entails".*

"Last year, they implemented data privacy and it was like pushed down everybody's throat for a reason. And I get and I understand why … it's about actually having your employees understand the seriousness of just sharing information" (Participant 12).

Participant 1 shared similar views to that of Participant 12 on the concept of data management challenges and specifically privacy concerns when adopting emerging technologies: "*Of course the privacy side, but even once you've sorted that out, I think data in the cloud is managed differently".*

"Data privacy is a big detail in terms of our own data and client data. And then also, you know what people can do with that data if they get hold of it" (Participant 1).

Participant 9 said regarding organisational privacy challenges: "*Making sure that the data you collect and information you use to execute services is protected",*

and further commented: "*So in actual fact, is your data really confidential? Because it's all managed within the chain".*

Participant 11 supported the notion of sensitive organisational performance data: *"Now there's more information and the audience unfortunately will also become a bit wider. And that's the risk of data privacy or for confidential information like gross margins and other stuff that should not be shared".*

4.3.5 Cyber security

Cyber security risk was discussed by most of the participant sample, identifying the presence of cyber threats and fraudulent activity from malicious actors. Participant 9 said: *"Terrorist organisations can find their way onto your network. I mean, those risks are evident and unfortunately it is only sometimes when those occur, do we actually heighten our protective mechanisms to make sure that we avoid it in future".*

Participant 8 added to Participant 9 viewpoint regarding cyber-attacks by malicious actors: *"The biggest risk that we face today is cybercrime. I mean, it is terrifying what could happen to an organisation? You know, that could happen. They take your data"*.

"When it comes to cyber risk, I don't think anyone's got that covered" (Participant 8).

Participant 12 had the view that there are multiple cyber threat actors:: *"A lot of people are targeting you, fraudsters, hackers. They're always after huge corporation data because, what they do is they take it and they sell it".*

Participant 1 mentioned the volume, breadth, and evolution in relation to cyber activity: "*Cyber risks have probably increased quite a lot over the last while. Not that they weren't there before, but I just think it is sort of skyrocketing"* going further to state: *"The technology for hacking into something I think has improved too. So your protection and stuff needs to sort of ramp up with that … cyber risks, ransom attacks and all that are always big on our agenda and I think we do a*

huge amount of work to try and prevent that. And I think the risks are changing all the time, you know, the types of attacks".

Participant 3 had similar insights to that of Participant 1, linking cyber activity to criminal activity: *"Financial crime is going to evolve as fast as the technology. So as fast as the good technologies are going to evolve. I mean criminals are opportunistic. So as an organisation, the way we identify, oh, we could use this for good within our organisation matters".*

"Criminal organisations are going to do the exact same thing you know, and look for those opportunistic technologies to help them do better" (Participant 3).

4.3.6 Adverse regulatory challenges

Most of the participants cited challenges regarding South African regulation, more specifically trailing regulation, and ethical practices regarding emerging technology.

Participant 7 observed: *"New technologies around AI in a lot of the African markets we [the organisation] operate in, they don't have any regulation at all on the use of AI".*

Participant 6 observed matters of data governance as they relate to data sovereignty and the resultant pressure from regulators: *"As AI continues to evolve, I think one of the things we really have to be thinking about is data sovereignty. It's going to come. We can't avoid it … we're going to say we want to use data to make decisions and build models. Someone's going to say, but my data can't leave my country".* Participant 6 expanded on this insight: *"A regulator or a country, a government can say to me, switch off or, you know, switch off your network. So I have to tread lightly when I make decisions"*.

"The EU has been leading in formalising legislation for AI, but even for all these [emerging technology] things that we were talking about right before the destination, whereas Africa is not, you know, you got to put up the guardrails. I want some guardrails and some certainty" (Participant 6).

Participant 4 discussed the lack of pace experienced by regulators: *"Takes 12 years for regulators to actually catch up and actually, you know, build a regulatory environment for those type of [emerging technology] products. So it just means for the longest of times, that particular technology is not regulated … the uncertainty becomes a lot more and sometimes, you don't even know if the regulators will actually decline something when you have been invested in and/or created a new business completely, only to be told five years down the line that we don't want this product in our country".*

Participant 5 described regulatory challenges from the perspective of emerging technology adoption: *"There are new legislation and new changes that we have to consider".*

"We need to level or we need to carve out some kind of framework or white paper … we actually try to engage with them and formulate their opinion and not just allow the regulator to form their own opinion. I think we would have been in a much better position than where we have been, would we have co-formulated the legislation" (Participant 5).

Participant 5 observed that organisations *"[n]eed to run ahead and when the legislation eventually catches up, then you [the organisation] have to pull, stand still and go and retrofit again".*

Participant 2 shared the insights of Participant 5: "*The challenges that we face in the compliance world has also increased and changed, and our regulators focus has also changed or started to lean towards digital asset regulation"*, and continued: *"changing regulation requirements may be difficult to implement".*

Participant 7 cited ethical practices within organisations in relation to adverse regulatory pressures: *"Data governance is always an issue, and while we here have become more strict in terms of how we and what we use our data for, and how we manage it, sometimes the people we partner with might have different data governance".*

Participant 7 also highlighted that as an organisation "*[w]e had to write in some guidelines in terms of what can be done or what cannot be done with AI".*

Participant 5 identified material questions asked by the organisation when considering ethical practices of emerging technology: *"When we do these things are we being ethical? Are we being moral about it? So there is the legislation, part of it. I think the governance and legislation part of it is the second biggest challenge that we're facing at the moment".*

Participant 3 shared an external event which has raised ethical concerns within the country regarding a competitor's application of emerging technology in an unethical manner: *"There is a broker that has recently been called up by the Financial Services Conduct Authority [local regulator], where they were using AI and deepfakes … absolutely a threat to the industry where you have these bad actors going out there using AI for nefarious reasons"* expanding on the required pace of regulation regarding emerging technology.

4.3.7 Fourth industrial revolution participation

Lack of participation is a challenge within the fourth industrial revolution and embracing emerging technology was cited by more than half of the participants. In relation to emerging technologies, Participant 7 stated: "*People are scared to embrace it because of all the uncertainties"* further observing that: "*when you speak to people on the ground, you still hear the uncertainty".*

Participant 3 shared a view on the lack of adoption at an organisational level: *"Whether it is them [employees] being risk averse or not understanding the technology, I am not 100% certain of that, or it may actually just be a combination of both. They don't understand the technology and therefore they don't understand the risks associated with it".*

Participant 9 noted the lack of adoption in South Africa as a developing economy, in comparison to that of developed economies: *"It is not yet adopted by those countries who really can't afford it right".*

Participant 12 held a view on the willingness of people to participate in the adoption of emerging technology from the perspective of incurring additional administrative responsibilities: *"What I've come across is some people want to*

learn the new tool being adopted and other people are just like, no, I don't want to learn this new tool, like this is going to add more work".

Participant 7 spoke about risk culture as a driver for the lack of participation in the fourth industrial revolution: *"Informed risk taking"* as necessary, and further stated*: "We have introduced scenario planning into our framework".*

Participant 2 noted risk culture resulting in organisational risk aversion when adopting emerging technology: *" Always try to scan for horizon issues or horizon regulation … Compared to other companies that have worked for that, the company definitely has a culture of wanting to do the correct thing and wanting to prepare adequately. Prepare adequately for any emerging issues, and there is a culture embedded that people want to do the correct thing".*

4.3.8 Environmental factors

Environmental, societal, and governance (ESG) risks were raised by most of the participants, who were largely focused on environmental impacts of organisations adopting emerging technology.

Participant 1 highlighted: *"ESG risks and some of those [specific ESG risks] are harder to pin down in terms of the impact. We are not unaware of them. [It] is more just being somewhat uncertain as to how they might affect you".*

Participant 1 provided deeper insight regarding ESG risks: *"You know that we are obviously doing the social development kind of stuff, we have for a while, in terms of the actual emissions and that side, I say we are less up to date".*

Participant 3 directly mentioned the environmental impacts of emerging technologies: "*AI blindly is not good for the environment. You know you have these massive data centres running through copious amounts of electricity, taking up a hell of a lot of space. So I suppose from that perspective, it's not that great".*

Participant 6 echoed the views of Participant 3: *"Data centres are towing so much energy it is becoming crazy".*

Participant 6 emphasised the disregard for ESG impacts by organisations: *"There are some things that have you know definitely come out to the top and become you know even way more important, particularly issues of governance, social impact in the environment, but I do want to emphasise that what most people don't think about when you talk about fourth industrial revolution or any of these technologies is that [ESG]".*

Participant 9 identified ESG risks similarly to that of Participants 3 and 6 in terms of organisational impacts from expanded operations under the fourth industrial revolution: *"All of our aircrafts use jet fuel. Nothing has been designed to take hydrogen base or electric base. There is nothing even possible that can power those engines and ultimately, 98% of all airline operators, all of our emissions, our CO2 emissions are coming from our aircrafts".*

"I think there are risks industry wide, which are not being clearly identified moving forward. I'm talking [about] a broader application of environmental impacts. I don't think people are taking it seriously" (Participant 9).

4.3.9 Geopolitical threats

Two participants discussed geopolitical risks in relation to the adoption of emerging technologies within the context of the fourth industrial revolution.

Participant 1 stated: "*I think geopolitical stuff is always happening, but you know there can always be something new that you do not expect, I suppose knowing whether something is going to escalate out of control, you are never really sure about that".*

Participant 9 discussed geopolitical concerns with insights relating to the impact on an organisation's business operations: *"War and geopolitical issues in certain regions … that will impact our ability to deliver services, and those are risks scoring activities which continue, we manage those within our ability".*

4.3.10 Stakeholder management

Stakeholder management was cited by four participants from the perspective of customer demand, influencer activity, and general reputational consequences on stakeholder perception.

Participant 11 shared insights on an organisation's management of specific stakeholder groups for brand advocacy, namely that of influencers: *"Where we get a lot of influences selling the products on our behalf, that is when Social e-commerce comes through. So there is a lot of risk in that aspect of trying to ensure we get the people that are the right people for the brand and ensuring that when they sell the products on as well, they are also getting their commission and their funds, for the posts that we require them to make".*

"What you post on Instagram, what you post on Facebook, TikTok, and the like, all these things are clearly evident of how you represent the company" (Participant 11).

Participant 9 focused on stakeholder management from the perspective of customer demand as a result of emerging technology in driving consumerism: *"The challenge that exists is now the prediction on the [customer] volumes, the prediction on available [organisational] capacity, and therefore ultimately the prediction on the plus".*

"I would say one our existing risk profile remains, but two is evolving based on the buying pattern of consumers" (Participant 9).

Participant 10 discussed reputation from a reliability point of view, holding an insight of always being connected and available to customers: *"If we are offline and our clients, customers are offline and then their businesses go pear shape, that is brand and reputational damage which will burn us".*

4.4 Findings pertaining to Proposition 3

Proposition 3 reads: Risks associated with the adoption of emerging technologies may be categorised for the benefit of effectively deploying limited resources to address the uncertainty faced by an organisation.

To understand the risk categories faced by organisations adopting emerging technologies and the determination of these risk categories, participants were asked to identify the risk categories currently faced by the organisation and provide insight into the practical formulation of these risk categories. The identified risk categories are as follows: business model risks, operational and conduct risks, technology and cyber risks, regulatory risks, societal and environmental risks, and geopolitical risks.

An overview of the codes and themes produced during the thematic analysis concerning Proposition 3 is depicted in Table 8. The table shows key concepts connecting to themes and aligned to the research Proposition 3 of the study. Based on participants ' insights, these themes have been prioritised in order of importance and materiality.

Table 8: Codes and themes related to Proposition 3

Research proposition 3: Risks associated with adopting emerging technologies may be categorised for the benefit of effectively deploying limited resources to address the uncertainty an organisation faces			
Codes	**Categories**	**Themes**	**Prioritisation**
Change management	Organisational agility	Business model risks	1
Stakeholder management			
Strategic implications	Transformation		
Vendor dependencies	Third party reliance	Operational & conduct risks	2
People	Internal vulnerabilities		
Operational risk			
Cyber security	Information governance	Technology & cyber risks	3
Data management challenges			
4IR participation	Organisational readiness		
Adverse regulatory pressures	Compliance & legal constraints	Regulatory risks	4
Environmental factors	ESG considerations	Societal & environmental risks	5
Ethical practices			
Geopolitical threats	Political & economic instability	Geopolitical risks	6

4.4.1 Business model risks

Most participants cited the business model risk category, identifying two significant contributors in this regard, notably strategic implications, and stakeholder management risk. Participants also noted that third-party vendors, people management, and crucial government service providers are included under business model risks.

Participant 6 cited business model risks from the perspective of an organisation's chosen strategic direction, centring on emerging technologies as a pillar for growth under the fourth industrial revolution: "*What are the big things that move our organisation forward, they would define the impacts … Strategy, we just come out of doing that. What we did is elected [leaders in] the organisation"* from the perspective that: "*there are some things [strategic pillars] that matter to you, the inverse of those things are risks. Then you formulate for this to develop a risk universe".*

"It is marrying exactly what the shareholders are expecting from us. It is marrying exactly what the investors expect from us, it is a world that makes sense, it is not a theoretical thing" (Participant 6).

Participant 4 positioned strategic and commercial direction as a business model risk in the adoption of emerging technology: *"Everything is there, but it was geared around our strategic objectives, our values and then of course the thing that really mattered to us … the adoption of new technologies, if you don't adopt quickly, you will commercially just walk behind".*

Participant 10 viewed business model risk as a category based on emerging technology evolution and the fear of being disrupted: "*Our biggest risk is just these AI models are getting so good that our business model could be completely flipped on its head".*

Participant 1 supported the insights of Participant 10, viewing business model risks as the risks of the practical running of the business.

Based on the sample, most participants highlighted stakeholder management as a sub-risk to the business model risk category and an area of concern for organisations adopting emerging technology in South Africa.

Participant 6 identified stakeholder management from the perspective of third-party vendors and their ability to deliver on crucial business operations, citing the need for reliable power supply and sustainable power solutions: "*If South Africa does not resolve their energy crisis, guess what, all my base stations run on diesel".*

Participant 8 raised business model risks from a people perspective, specifically the need to manage organisational talent when adapting to business models associated with emerging technologies: *"When those skills are not there, then you have got some serious issues",* and also: *"These skills, they're not always readily available".*

"We have a lot of component parts, a lot of law involved, very specialised areas of the law so people need to get on top of it and once a person understands it and is good at it, then they are quite a prized individual" (Participant 8).

Participant 10's insights on business model risks included employees' decision-making ability and the employees' aptitude to make decisions, which speaks to the fourth industrial revolution: *"People inherently do not like making risk decisions. So they do not necessarily do it correctly".*

Participant 4 shared the insights of Participant 8. Under the context of business model risk, Participant 4 shared that talent management is material to business model risks in so far as having the right people to guide the commercial development of fourth industrial revolution business models: *"Which goes to the people elements. You might not get information officers or an information officer could not take the role because they know that your environment is not strong enough and they are kind of taking the risk on themselves. Instead of the organisation, it is interconnected".*

4.4.2 Operational and conduct risk

Operational risk is a risk category within the organisation under the fourth industrial revolution, which was mentioned by five of the participants. Participant insights positioned operational efficiency and human error as intertwined factors which can be presented as operational and conduct risks.

Participant 1 cited operational risk as an organisational failure from the viewpoint of emerging technologies multiplying human failures, based on the interconnected nature of man and machine in business best practice under the fourth industrial revolution: *"AI is possibly going to further impact the operational conduct result".*

"Operational conduct risk is diverse and all sorts of things can happen in that space and you are trying to monitor a lot of stuff which, I think the human mind has some issues with, whereas AI does not at all. It can be looking at a lot of things at the same time. The challenge for us is to know how to employ the AI, I think that's a big challenge. You've got to ask the right questions" (Participant 1).

Participant 3 offered an opposing perspective to emerging technologies' involvement in operational risk, from the perspective of underperforming emerging technologies: *"When AI is [negatively] impacting operations, we would put it as an operational risk".*

Participant 11 observed operational risk as a risk category when considering vendor management and supply chain operations in a commercial landscape filled with partnerships. The insights of Participant 11 hinged on the plethora of processes managed within the supply chain operations, further compounded by the need for multiple vendors to support emerging technology adoption.

4.4.3 Technology and cyber risks

Cyber security risks were observed by five of the participants, emphasising the necessity to safeguard the organisation's technology assets and infrastructure from malicious threats.

Participant 9 noted the importance of *"[s]ystem protection, as I mentioned earlier that we [as a company] are constantly under attack".*

Participant 9 expanded on technology and cyber concerns from the perspective of emerging technology supporting cyber actors with malicious intent: *"I do believe that people who would like to get into our system are constantly getting more and more sophisticated and with the use of AI, I think it [AI] can be used against us. I don't think we are prepared for that".*

Participant 10 observed the need for building an understanding across the organisation of the importance of cyber security during the fourth industrial revolution, where emerging technologies are used as our defence but also as an aid to cyber threat actors: *"We are trying to really speak about the [cyber] risks. There is also a lot of, security required".*

Participant 5 shared Participant 10's viewpoint, the prominence of cyber risks in relation to emerging technology adoption: *"I will look at the ones that are fairly technology driven, like cyber is the big one"* (Participant 5).

Participant 5 also shared the view that cyber risks are a constant in the risk universe. Participant 5 viewed cyber risks as only increasing and persistent: *"To try and quantify or contextualise that cyber threat is always going to be there".*

Participant 4 noted the volume of cyber-attacks their organisation faced as a digital platform business and the severity of these events at an organisational level: "*We have had a fair share of cyber-attacks. Cyber-attacks not in their threat, but featuring an actual and active threat. Just in the past three years, we have had two major incidents where, we were targeted. One was a denial of service attack"* (Participant 4).

Participant 4 also noted cyber risks from the perspective of concerned stakeholder, namely customers and regulators and the connected nature of these concerns: *"There is a couple of risks that are present … such as client risk, if clients don't feel like the data that they have with you is protected, they can leave"* and the participant added: *"if my cyber security environment is not robust enough or does not meet regulatory standards, that is an issue".*

Participant 6 identified cyber-attacks in the form of fishing attacks as a risk category for concern: *"The one that presents the biggest risk for us is that fishing intelligence, cyber goes without say".*

Participant 7 identified emerging technologies as the driver to expanding the cyber threat: *"New technologies, bring new vulnerability issues and data privacy issues, so probably cyber".*

4.4.4 Regulatory risks

Regulation and legislative challenges as a risk category for concern was identified by most of the participants, relating to pressures of compliance from regulatory bodies, and new and pending legislation.

Participant 4 noted the fear of exclusion by the regulator when adopting emerging technologies that are not yet regulated: *"You have got regulatory risk like you know, you do have the potential of your business being closed".*

Participant 10 shared concerns of being non-complaint with regulation, citing the need for better indicators for measuring the level of compliance in organisations adopting emerging technologies in South Africa*: "Compliance is another big one, there are no benchmarks or metrics for organisations"* (Participant 10).

Participant 6 noted commercial strategy dependency on regulation and legislation, and the challenges faced by organisations in managing the balance when considering the adoption of emerging technologies: *"I am dependent on legislation of considerance … It is the legislation again which makes my world insane".*

Participant 11 identified regulatory risk from the perspective of new regulation and specifically publicly topical regulation that affect emerging technology and the manner in which it is used: "*The data privacy risk with all these new laws and changing laws that we have, it is a priority which is run by our legal department".*

Participant 6 discussed the impact of regulatory decisions regarding data sovereignty and the impact that would have on organisational infrastructure development and the cost to deliver on pending regulation*: "I was at an African*

conference a few weeks ago and they are talking about the number of data centres that we need. If government says they want all their data in South Africa, okay, data sovereignty, we have to build that. I don't know how many [data centres]" (Participant 6).q

4.4.5 Societal and environmental risks

ESG-related risk was noted by some of the participants as a key risk category. Participants observed an understating of the societal and environmental risks associated with the adoption of emerging technology and the impacts these technologies have on the planet.

Participant 7 identified the rise of ESG-related risks : "*ESG used to be under the governance risk, but then it has become so pronounced in terms of our carbon emissions and all those kind of things that now it is a category on its own".*

Participant 9 echoed the insights of Participant 7, from the perspective of placing enough prominence as an organisation on the effects operations related to emerging technologies has on the environment: *"I would definitely say we have not placed enough emphasis on environmental impacts, putting some solar panels in and recycling in offices is generally not enough … We say a lot of customers are window shopping, but no one's prepared to buy and that is the problem when it comes to environmentally friendly practises within organisation".*

Participant 4 described ESG-related risks to be centred around social disparities: "*Social, economic inequalities and exclusion of different populations"*. The participant further noted a resistance by organisations in adopting responsibility of ESG impacts: "*How much are we impacting the environment by using cloud computing, how much are we further exacerbating the need for data engineers and to a large degree not supporting the development of data engineers".*

"We have talked about resistance to adoption and you know, I think there is that element still, that we feel like it is not ours, rather the government that can deal with the labour aspect, you know, deal with the employment and labour market risks" (Participant 4).

Participant 11 observed reputational risk from the social perspective and the engagements of organisations in that realm which affect people connected to a specific organisation*: "So obviously reputational risk is number 1"* (Participant 11). The participant added: *"Influencers and the marketing things that we do on social media … You know, we watch what people say, what people post, is where it should be" (Participant 11).*

4.4.6 Geopolitical risks

Geopolitical concerns were noted by two of the participants, who identified the driver of this risk category to be trade wars and potential and existing conflict wars.

Participant 9 noted the American government's stance in regard to trade with the rest of the world and the consequential impact on South Africa as a trade partner*: "The second element of that is just really geopolitical issues. We are not at the forefront of managing what will happen in the industry … With Donald Trump's speech, he specifically mentioned the taxation of international foreign countries and companies were doing business with Americans, and that is something that will have a massive impact on first, Fashion e-commerce companies, which will have a ripple effect on all air freight related activities. I do not think they will be the first country to do that because whatever the United States of America does, there are quite a few others [countries] that follow. Ultimately, I think that is a risk that we have not really clearly identified ... I have 15 triple seven aircrafts arriving between June and December this year, so it is a huge influx of capacity with potentially lower demand"* (Participant 9).

Participant 5 insights pointed to commercial relationships being impacted by geopolitical issues detailing: "*The embargo with Huawei in the United States of America and, because Huawei is a big supplier to our technologies, access to the network, so it is also technology driven".*

4.5 Conclusion

Chapter 4 presented insights from 12 senior leaders with direct and indirect exposure to enterprise risk management practices within their respective

organisations. The findings were presented in accordance with the three research propositions and contextualised for a deeper understanding of the insights shared by the research participants. Codes and themes were identified and included in support of the three research propositions.

Proposition 1 focused on the exponential opportunities of emerging technologies identified as competitive landscape, emerging technology adoption and sources of challenge. The first area of focus was the competitive landscape, participants agreed that the competitive landscape has been impacted by pockets of opportunity citing value proposition, data-led insights, operational efficiency, marketing insights, performance data, and data quality as the leading drivers of this new competitive landscape. This was followed by insights into the depth of emerging technology adoption amongst South African organisations, observing the interconnectedness of emerging technologies namely big data, AI, and IoT. The last component of Proposition 1 was the sources of challenge as a result of adopting emerging technologies presented as market competition, talent management, data management, business model changes, new and evolving risks, and unknown risks.

Proposition 2 focused on the adoption of emerging technology and identifying the risks associated with adoption. Proposition 2 is driven by the diverse sources of challenge identified in Proposition 1. The risks articulated by a thematic analysis were presented as the following: vendor dependencies, change management, people, data management challenges, cyber security, adverse regulatory challenges, fourth industrial revolution participation, environmental factors, geopolitical threats, and stakeholder management. The findings evidenced the need for a sound application of responsible risk management practices in identify nuanced risks that were presented by emerging technology.

Proposition 3 aimed to categorise and prioritise these identified risks for purposes of developing a risk taxonomy that supports emerging technology adoption. The findings revealed six risk categories: business model risks, operational and conduct risks, technology and cyber risks, regulatory risks, societal and environmental risks, and geopolitical risks. The insights provided in regard to Proposition 3 shed light on two important factors: collaboration amongst senior

leaders and the value of risk aggregation in organisations looking to effectively deploy limited resources to mitigate the identified risks.

CHAPTER 5: DISCUSSION OF THE FINDINGS

5.1 Introduction

The following chapter presents a discussion of the research findings pertaining to this study to identify and prioritise the crucial risks associated with the adoption of emerging technologies. Further details are provided regarding deeper insights into the identified risks. The chapter concludes with a discussion about and the subsequent categorisation of the material risks.

5.1.1 Participant profile

Following the participant profile Chapter 4 presents, provides a foundational lens through which the findings of the study can be analysed. The diversity in industry representation, professional disciplines, and organisational roles across the 12 participants offers a multifaced and rich understanding of the risks associated with the adoption of 4IR technology in South Africa.

Participants represented five key industries being Financials, Consumer Staples, Telecommunications, Industrials, and Technology. The Financials being the most represented by 5 of 12 participants, while participants from the traditional sectors ensure that the findings of this study reflect a broad spectrum of insights. From the perspective of organizational roles and risk oversight, half of the participants hold C-Suite positions with the remaining being senior leaders with strategic oversight. This is a crucial distribution which ensures that the insights gathered are all grounded in both executive decision making an tactical risk management.

The participants professional background spanned 6 disciplines, including Risk Management, Finance, Operations, Commercial, Compliance and Marketing. This diversity supports a holistic view of risk, encompassing financial, operational, regulatory, and reputational dimensions. The strong representation from risk related functions, validates the relevance of the insights while, the inclusion of non-risk functions highlights how emerging technologies impact broader organizational domains.

Although gender was not a primary focus, the distribution depicted 5 females and 7 male participants, providing a relatively balanced distribution which contributes to the inclusivity of perspectives across genders. Lastly, the evidence of technology adoption confirms the practical relevance of the study, and ensures that the risks discussed are grounded in real world implementation experiences with the variation in technology adoption allowing for comparative insights across different technological contexts.

5.2 Discussion pertaining to Proposition 1: The exponential opportunities presented by emerging technologies are not without sources of challenge, which are presented in the form of new and evolving risks

The first proposition of this study discusses the evolving landscape faced by organisations in South Africa, the depth of emerging technology adoption, and the resultant sources of challenge. The evolving landscape, depth of emerging technology adoption, and the resultant sources of challenge provide the scope and context for effective risk identification in accordance with enterprise risk management practices (International Organization for Standardization, 2009). The section concludes with a broad discussion of these sources of challenge as risk drivers in organisations operating under the fourth industrial revolution in South Africa. The sources of challenge are as follows: market competition, talent management, data management, business model changes, new and evolving risks, and unknown risks (Avenyo et al., 2022; Tupa et al., 2017).

5.2.1 Competitive landscape

This competitive landscape component of the study revealed that organisations have experienced a significant shift in market conditions towards a highly competitive environment where traditional and non-traditional competitors explore the pockets of opportunity presented by the adoption of emerging technology through a radically heightened sense of organisational intelligence.

The findings align with Litvinski's view that radical changes are supported by digital technologies (2018).

All the participants conveyed a sense of dramatic change in market conditions and an elevated level of competition across the board, citing drivers of this change as increased value proposition, data-led insights, operational efficiency, marketing insights, performance data, and data quality. This sense of a dramatic change supports the view that organisations adopting emerging technologies are presented with exponential opportunities to create and deliver economic value (Armstrong & Lee, 2021; Avenyo et al., 2022).

As drivers of change in this fourth industrial revolution, value proposition ranked at the top of participants' insights, with most of the participants denoting the drive for reliably informed value-added services, followed by data-led insights, recognising the increased level of curated and custom offerings presented by organisations in this new digital age. Operational efficiency came in second. The participants noted the shift from manual-intensive processes to highly efficient automation of business activities required to deal with the increased organisational activity volume. Automation improved the delivery of economic value to both internal stakeholders and the customer, confirming the views of researchers Avenyo et al. (2022) and Tupa et al. (2017) regarding the articulation of the three core pillars of transformation when adopting emerging technology.

The remaining identified drivers, marketing insights, performance data, and data quality spoke to organisational efforts to acquire meaningful market share in a highly competitive landscape, as noted by less than half of the participants.

5.2.2 Emerging technology adoption

In relation to the adoption of emerging technologies, the participants expressed organisational desires to be pioneers of emerging technology in the sense of being early adopters of technology, or a close second, to embrace innovation within the organisation, emphasising the importance of the pace at which emerging technologies are progressing. There is an organisational requirement to be on the forward periphery of these leaps in technology to be an organisation driving sustainable economic value and strongly positioned in the fight for a

greater share of the market (Avenyo et al., 2022). A study by Linkov (2018) linked responsible innovation by organisations to horizon scanning and the concept of safety by design, supporting the findings above.

Within the participant sample, the majority asserted the adoption of all the emerging technologies, with big data leading in adoption, followed by AI and IoT. These insights into emerging technology adoption reveal the depth of organisational desires, efforts, and strategic investment to be technology-forward innovators and industry leaders in a rapidly evolving and competitive landscape (Armstrong & Lee, 2021). This viewpoint follows the realisation that to reap the long-term benefits of emerging technology, organisations should be purposeful in the implementation and integration of these emerging technologies (Piccarozzi et al., 2018; Prewett et al., 2020; Tamvada et al., 2022; Tupa et al., 2017)

Under no illusion of the developments in emerging technologies and the associated capabilities, the majority of participants claimed to be immersed in AI, with a clear sense of understanding that the current application of AI in organisations was felt to be just scratching the surface of what can be realised with a greater focus and intent to foster radical change in the way business is conducted at the strategic, tactical, and operational levels.

5.2.3 Sources of challenge

In terms of the after-adoption uncertainty of emerging technology adoption and the resultant sources of the challenge faced by organisations, the key aspects for consideration were: market competition, data management, talent management, business model changes, new and evolving risks, and unknown risks (Avenyo et al., 2022; Tupa et al., 2017).

Most interviewed participants mentioned market competition, noting a steady and tangible disruption to how existing competitors and new market entrants conduct business. Notably identified by participants was the challenge on existing, established market competitors by non-traditional new market entrants with the ability to disrupt how business is conducted in the traditional sense through the delivery of emerging technologies' capabilities and economic value at a previously unprecedented pace (Avenyo et al., 2022).

A significant number of participants who discussed talent management noted the need to upskill the internal talent pool, including attracting new aptitude from both competitors and the formal education sector, mainly tertiary. Talent management as a source of challenge continues to evolve with the pace of technology, requiring constant efforts from both the employer and employee to ensure relevant skills and a sustainable future of employment within the organisation (Birkel et al., 2019; Tamvada et al., 2022).

Data management in relation to the adoption of emerging technology was raised by most of the participants, who illustrated the importance of data management strategies, the consequential impacts of data strategy on organisational capabilities, and the rate at which the organisational data can be consumed, not forgetting the ever prominent aspect of data security (Correani et al., 2020).

A some of the participants discussed business model changes as a source of challenge. The insights provided discussed the need for an open-minded, collaborative and flexible approach as these new business models reveal themselves to the industry (Avenyo et al., 2022; Tupa et al., 2017). Alternatively, organisations run the risk of disrupting the existing way of business, impacting their ability to profit from these pockets of opportunity (Bailey et al., 2019).

While many organisations experienced new sources of challenge in their journey of emerging technology adoption, there is a perception that these sources of challenge were simply an evolution of previous sources of challenge, with a large majority of the participants noting similar perspectives. There lies the inherent need to expand the risk universe in catering for the broadened landscape organisations under the fourth industrial revolution (Prewett et al., 2020; Tamvada et al., 2022; Tupa et al., 2017). There is an opposing view that certain sources of challenge only reveal themselves in the execution leg of emerging technology adoption, requiring further flexibility and methodical implementation of responsible and ethical enterprise risk management practices (Mpofu & Nicolaides, 2019; Rodríguez-Espíndola et al., 2022; Tupa et al., 2017).

5.3 Discussion pertaining to Proposition 2: The adoption of emerging technologies, typically through a digital transformation strategy,

necessitates the application of sound enterprise risk management practices for long-term success in managing the associated risks

The second proposition of this study revealed, in greater detail, that the adoption of emerging technologies results in risks to the organisations. These identified risks are led by the multiple challenges South African organisations face operating within the context of the fourth industrial revolution.

The identified risks below consist of new and evolving risks formed from a rapidly changing and competitive landscape that has driven organisations to pursue pockets of practical opportunity in an expanding risk universe.

The risks identified in Table 8 were prioritised in terms of materiality, with importance derived from the frequency of discussion by participants.

5.3.1 Vendor dependencies

Vendor dependencies were cited by a large majority of the participants, revealing that under emerging technologies, strategic partnerships with competent partners are a key risk when considering crucial business operations being outsourced. The identified risk is further exacerbated by diminished oversight of external operations, governance practices and values-based decision making. Elements of third-party dependency, reliability, and resilience of operations weigh heavily on the organisation's ability to maintain and escalate operational competencies that are core to service delivery. These challenges are evident in the literature, where technology concerns are raised from the perspective of emerging technology performance and environmental readiness (Birkel et al., 2019; Kapoor & Klueter, 2021; Tamvada et al., 2022). While the central focus of participants was a dependency on these third parties, the literature further depicts a need for organisations to identify competent third-party providers who complement the organisation's attributes.

5.3.2 Change management

The majority of the participants discussed the risk of change management as a materially significant factor in the adoption of emerging technologies. The need

for an agile mindset and the adoption of relevant methodologies is crucial to enabling efficient and effective transformation within organisations to combat the pace and complexity at which emerging technologies are evolving. Similar views were held by Bailey et al. (2019), noting that the increase in emerging technology intelligence presents a significant opportunity for organisations to alter traditional operation practices by dealing with uncertainty and complexity, as Tamvada et al. (2022) noted.

The literature and the study findings centre on the sources of challenge organisations face when adopting emerging technology. Supporting literature from this study depicts emerging technology as pervasive and persistent, further articulating the need for a clear transformation strategy when adopting emerging technologies (Armstrong & Lee, 2021). A thoughtful and tactful approach is imperative while managing the transitional period of technology adoption into core competencies (Bailey et al., 2019).

5.3.3 People

The people risk was noted by most participants as a necessary point of concern when considering the level of competence required to navigate the deployment and implementation of emerging technologies. The need to upskill the workforce becomes ever demanding and apparent in the face of emerging technology adoption. This upskill need is compounded by the organisational need to consume emerging technologies while remaining cognisant of the potential displacement effects on the existing workforce. In order to secure a sustainable future, the digital divide must be addressed with urgency in the form of talent management of both employees and employers.

The crossing of paths exists where the literature presented by the study makes relevant the need for a sustainable future, one where employees are not exploited for organisational gain but rather a sharing in the opportunistic value presented by emerging technology adoption (Birkel et al., 2019; Tamvada et al., 2022). While the findings of this study align with the narrative of people risk, the literature was inclusive, presenting people as those with internal and external and direct and indirect ties to an organisation. Therefore, people risk is presented as part of

the industry and country context (Tamvada et al., 2022). There is materiality to the identified risk, suggesting that the findings depict a developing economy context and it may take time to understand the broader impact on people under more inclusive parameters.

5.3.4 Data management challenges

As a risk to organisations adopting emerging technologies, the findings reveal that data challenges are: data volume, data security, data accuracy, and data privacy. The complexity of data management in regard to emerging technologies requires a holistic approach to responsible enterprise risk management practices, encompassing skilled ethical and regulatory-compliant practices that match the requirements of the organisations' operational environments.

The literature presented in this study discusses technology infrastructure challenges and the organisation’s ability to safeguard strategic assets through adept practices, supporting the materiality of emerging technology infrastructure risks to organisations (Birkel et al., 2019; Herweijer et al., 2018; Ostrowick, 2021).

Where the findings of this study diverge is the emphasis on data management as a key risk to organisations and not a sub-risk under wider emerging technology risks. The study highlights the prominence of big data operations and illustrates the need to elevate this risk as a material concern for organisations operating in the South African context.

5.3.5 Cyber security

Most participants noted the risk of cyber threats and related fraudulent activity stemming from internal and external malicious actors in an organisation. The study participants shared a common understanding of the sheer magnitude of targeted cyber activity and cyber-related crimes in this digital age. The findings show that the exponential rise of cyber threats raises concerns for organisations regarding the security of both the organisation and its customers. The study findings provided insight into the volume and severity of successful cyber activity, describing its paralysing nature for organisational operations.

This paralysing result of cyber activity for organisations is noted in the literature, which provides an expansive risk taxonomy with regard to cyber harm and cyber threats, further detailing its propagation in the connected world (Agrafiotis et al., 2018). Concern about cyber threats is compounded by the availability of emerging technology to malicious actors as a technological weapon to further their capabilities. The prominence of the cyber threat is supported by literature noting that where sensitive information is accessed, manipulated, and stolen by unauthorised actors there lies a credible threat to assets held by the organisation (Birkel et al., 2019; Tamvada et al., 2022; Tupa et al., 2017). The study findings suggest that the growing significance of cyber-related risks is related to the advancements in emerging technology, creating additional exposure to cyber threats as organisations operate at the forefront of emerging technology.

5.3.6 Adverse regulatory challenges

Most participants raised the risk of regulation and ethical practices, focusing on the importance of regulatory bodies playing a key role in supporting the sustainable adoption of emerging technologies. Participants revealed a desire for proactive regulation in South Africa, further sharing the organisational challenges of the existing regulatory environment. Findings identified a lagging approach to policy formulation as an inhibitor of the practical application of emerging technology under the fear of being reprimanded for early adoption. Participants suggested that in many instances, under and over-regulation are highly restrictive on responsible organisations while not harsh enough on organisations engaged in unethical practices.

In section 2.2.3 table 2, of the literature review, the risk of regulation and ethical practices was presented as a source of challenge from the perspective of an organisation being effective in the application of regulation within their operational environment (Birkel et al., 2019; Herweijer et al., 2018; Ostrowick, 2021). However, the study identifies the risk of regulation and ethical practices as an inhibitor of progress through the lens of lagging regulation and policy rather than compliance with regulatory policy. Hence, while the source of the challenge is still relevant to organisations, the context through which the source is viewed defines the risk of South African organisations adopting ethical thinking to emerging

technology decision making (Kuzma et al., 2008; Mpofu & Nicolaides, 2019; Ostrowick, 2021).

5.3.7 Fourth industrial revolution participation

Most of the participants described the risk of fourth industrial revolution participation as the lack of purposeful involvement in emerging technology adoption by organisational stakeholders, namely, employees, customers, and industry firms. Deduced from the findings of the study, drivers of this risk point are the uncomfortable uncertainty held by organisational stakeholders.

The prominence of the fourth industrial revolution participation is supported by literature, notably Herzfeldt et al.'s (2012) construct of a risk taxonomy for IT firms. Uncomfortable uncertainty limits emerging technology adoption and key stakeholders require convincing of the longer-term opportunities. Literature supports the view from a customer and employee perspective, and denotes that a sustainable view on people is imperative in the long term with the fourth industrial revolution (Birkel et al., 2019; Tamvada et al., 2022). The findings expanded this view, promoting the intent of collective adoption of emerging technology amongst industry competitors to propel the capabilities of emerging technologies within the sectors in which they operate.

5.3.8 Environmental factors

Environmental risk was raised by most of the participants. The findings revealed a common understanding that emerging technology requires a significant amount of high-performing physical infrastructure, most of which depends on a stable energy supply. While organisations vigorously adopt emerging technology, their impact on the environment multiplies, with the point of inflexion being the risk of being unable to accurately determine the extent to which an organisation's operations are detrimental to the environment in which it operates.

The study further explained the lack of prominence of ESG risks given by organisations regarding emerging technologies' impact on emissions, with a tendency to focus on smaller aspects such as waste management. The literature supports the study's views on the low prominence of ESG risks as an

organisational concern under the fourth industrial revolution (Tamvada et al., 2022).

The ESG risk determinant, is providing deeper insights into the unknown as organisations develop an understanding among internal stakeholders and key decision-makers as to where a greater impact can be achieved.

5.3.9 Geopolitical threats

Geopolitical threats were noted by a small portion of the participants, identifying that while external to an organisation, business operations are severely impacted by unexpected escalations of trade wars, sanctions, and war. Organisations depend on scenario planning and the fortification of internal control environments to manage this risk. The existing literature presented by this study does not elevate geopolitical risks as a material source of challenge. However, in the context of South Africa, which is a developing economy heavily reliant on global trade and support, it is relevant for local organisations dealing with the ripple effects of geopolitical events.

Where the literature does provide an intersection is the understanding that the adoption of emerging technology may result in the rise of new risks for organisations operating in the South African context (Tupa et al., 2017).

5.3.10 Stakeholder management

Stakeholder management was cited by less than half of the participants, identifying customers and strategic partnerships as the key contributors to reputational perception. An organisation's image extends beyond the actions of internal stakeholders and towards the wider actions of stakeholders associated with the organisation's brand. The literature aligns customer demand as a sub-category of business risk. At the same time, stakeholder management is seen as a cross-cutting risk impacting other identified risks such as regulatory risk, vendor dependency risk and the risk of ESG (Tamvada et al., 2022). Considering the importance of the role of regulatory bodies and vendors in business operations supporting emerging technology adoption, maintaining relations is a notable concern for organisations. Furthermore, the literature observes that emerging

technologies may be employed as a multi-stakeholder risk strategy to actively manage associated risks, such as strategic partnerships (Birkel et al., 2019; Linkov et al., 2018).

5.4 Discussion pertaining to Proposition 3: Risks associated with adopting emerging technologies may be categorised for the benefit of effectively deploying limited resources to address the uncertainty an organisation faces

The third proposition of this study explores the practice of risk categorisation, identifying several categories for further discussion and exploration. These identified risk categories result from risks raised by participants currently employed by organisations in South Africa.

The content below follows the themes presented in Table 8, identifies inclusive risk categories ranked according to the research findings. These categories represent the material risks faced by organisations adopting emerging technologies under the fourth industrial revolution in the South African context. These identified risk categories further provide the ability to better analyse and evaluate risks for the purpose of risk treatment within an organisation in accordance with enterprise risk management principles of practice (International Organization for Standardization, 2009).

5.4.1 Business model risks

The business model risks ranked first and has three sub-risks: strategic implications, stakeholder management, and change management. These sub-risks are derived from participant insights referenced in Tables 7 and 8 and suggest the need for an evolving strategy developed on organisational purpose, objectives, and values. This purposeful organisational intention is integral in navigating a rapidly changing competitive landscape faced by organisations under the fourth industrial revolution.

The first sub-risk is the need for a strategic approach and is supported by literature that discusses the disruption of the fourth industrial revolution as

superseding globalisation and predicting that most business models will be non-existent in five years (Soh & Connolly, 2021).

The second sub-risk is stakeholder management that is central to organisational strategy for managing the multitude of stakeholders impacted by an organisation's business operations and, specifically, the stakeholders affected by an organisation's ambition to adopt and drive the application of emerging technologies. The prominence of business risks as a category is supported by literature and is noted as a core requirement of organisations: the need to create economic value from the adoption of emerging technologies through the delivery of new products and services to the market (Birkel et al., 2019; Kapoor & Klueter, 2021; Tamvada et al., 2022).

The third sub-risk is change management, as the magnitude of business model risks stems from the organisational strategy, with the potential inverse of core strategic objectives becoming the risks faced by organisations. The opposite is also relevant: organisational risks then inform business strategy – underscoring the intertwined nature of business strategy and enterprise-wide risk management practices (Cormican, 2014).

5.4.2 Operational and conduct risks

The operational and conduct risks ranked second, is an aggregation of non-financial risks concerning potentially negative outcomes of organisational events resulting from process and control environment failure. These safety and control failures highlight the need for responsible innovation and adoption of safety by design principles in business practices (Linkov et al., 2018). The sub-risks represented in this category are vendor dependencies (from an external view), operational risk (from an internal view) and people (internal conduct). The interconnectedness of these risks portrayed by the participants is determined using an impact-orientated approach to the pure risks identified by participants. This approach is supported by the views of current literature (Agrafiotis et al., 2018; Barlish et al., 2013; Birkel et al., 2019). The priority of operational and conduct risk is further supported by literature, defined as operational and

managerial risk, and emphasises the importance of organisational leadership in relation to this risk category (Barlish et al., 2013).

5.4.3 Technology and cyber risks

Following business model risk, operational and conduct risk, technology and cyber risks ranked third. The technology and cyber risk category is a construct of cyber security, data management practices, and participation in the fourth industrial revolution. The prevalence of technology and cyber risks is drawn from the digital transformation journey of organisations adopting emerging technologies and the pervasive and perpetual expansion of the digital environment owned by organisations (Agrafiotis et al., 2018; Armstrong & Lee, 2021).

Literature supports the technology concerns, noting that environmental readiness is required from both an internal and an external perspective (Birkel et al., 2019; Kapoor & Klueter, 2021; Tamvada et al., 2022). The literature supports the categorisation and prioritisation of technology and cyber risks, arguing that organisations can experience the materiality of these risks as two separate categories: technology risk and cyber risk (Tamvada et al., 2022).

5.4.4 Regulatory risks

Regulatory risks were ranked fourth, with fear of non-compliance to existing and future regulations that would lead to adverse regulatory pressures. While participants viewed regulatory bodies as necessary to the sustainable development of industries and a safeguard to both industry participants and customers, the lagging pace of regulation in addressing emerging technologies within South Africa presents a hurdle to the adoption of these technologies and stifles the speed at which organisations can deliver value.

Participants further concluded that communication and collaboration with key regulatory regimes has typically been minimal or absent in the South African context. Literature has consistently identified regulatory and legislative challenges to organisations, including highly prioritising the impacts of not effectively implementing regulatory requirements across business operations

(Birkel et al., 2019; Herweijer et al., 2018; Ostrowick, 2021). The findings of this study in relation to regulatory risks coincide with the literature to the extent that regulatory requirements are presented across operating environments and pose a significant risk if not managed with due care and consideration (Birkel et al., 2019).

5.4.5 Societal and environmental risks

Societal and environmental risks were ranked fifth, with sub-risks identified by participants as environmental factors and ethical practices, representing an aggregate view of these non-financial risks. Societal and environmental risks encapsulate the impact of an organisation's operations on the planet and the communities in which it operates, focusing on the potential for harm if not addressed responsibly. Participants' insights unveiled a deep understanding of the negative effects of emerging technologies in terms of the requirement for vast amounts of energy to fuel operations. In further analysis, it is clear that organisations are not fully cognisant of their contribution to planetary challenges such as climate change, global warming, and carbon footprint (Birkel et al., 2019).

Electronic waste was identified as the most understood and practised environmental challenge addressed. However, the findings suggest that this is not enough to correct the impact of organisations from a South African and global context. While the literature agrees with elevating this risk into a material risk category, the view is expanded by the more inclusive use of ESG (Tamvada et al., 2022). Based on the study findings and the presented literature, there is an evident lack of acknowledgement by organisations of their contributions to ESG risks and the severity of this risk category for a sustainable future.

5.4.6 Geopolitical risks

Geopolitical risks ranked sixth and last as a category for consideration. Only two participants described the impact of global political tensions as having a cascading reach beyond geographical borders. The literature also rarely discusses geographical risk, possibly due to the external nature of the risk. Organisations must explore the wider implications of geopolitical risks based on

their organisational context, centred on the view of the interconnectedness of emerging technologies under the fourth industrial revolution (Armstrong & Lee, 2021; Beumer, 2018).

5.5 Conclusion

The chapter commenced with a thematic analysis and discussion relevant to Proposition 1: exponential opportunities presented by the emerging technologies of the fourth industrial revolution and the resultant sources of competitive challenges faced by organisations operating in South Africa. The discussion supported Proposition 1, concluding that the exponential opportunities presented by emerging technologies are not without sources of challenge, which are presented in the form of new and evolving risks.

Thereafter, the chapter presented the discussion relating to Proposition 2: adoption of emerging technologies The adoption of emerging technologies necessitates the identification of risk through digital transformation strategy development and the application of sound enterprise risk management practices for long-term success. The literature review findings supported the identification of risks as a result of the various sources of the challenges faced by South African organisations, evidencing the value of sound enterprise risk management practices by organisations adopting emerging technologies.

The chapter concluded with Proposition 3: risk categorisation and prioritisation. Risks associated with adopting emerging technologies may be categorised for the benefit of effectively deploying limited resources to address the uncertainty an organisation faces. This discussion component culminated in identifying and prioritising six inclusive risk categories, following an impact-orientated approach to risk aggregation. Five of the six risk categories were widely available in the supporting literature as current risks, with the geopolitical risks category depicted as an emerging risk.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This study aimed to identify, catergorise, and prioritise the risks associated with adopting emerging technologies in South African organisations in accordance with sound enterprise risk management practices. This chapter presents academically grounded conclusions regarding the research objectives stated in Section 1.4, providing depth of understanding to the risks associated with adopting emerging technology in a developing economy context.

Research Proposition 1 identifies the exponential opportunities of emerging technologies and the associated sources of challenge associated with emerging technology adoption. The opportunities act as risk drivers in the formulation of risks identified in Proposition 2, which are linked to Research Objective 1. Research Proposition 3 is linked to Research Objective 2, which categorises and prioritises the identified risks associated with emerging technologies. Based on the conclusions of Research Objectives 1 and 2, the chapter provides recommendations, highlighting the empirical contribution of the study and concluding with suggestions for consideration in further research.

6.2 Conclusions regarding Research Objective 1

> Research Objective 1 of this study was to identify the sources of challenge associated with the adoption of emerging technologies.

The adoption of emerging technology is identified as a strategic imperative of South African organisations, aiming to maximise the potential capabilities of emerging technology and harness these capabilities to deliver economic value and exponential growth in the form of superior customer insights, operational efficiencies, and business model transformation. The study observed that organisations actively adopting emerging technology and operating in South Africa under the fourth industrial revolution face multiple challenges posed by the rapidly evolving and competitive business landscape.

The organisation identifies sources of challenge, based on the context of their operations and the interconnected nature of conducting business in a digitally connected world. This study reinforces that such challenges are not isolated but are deeply embedded within a broader ecosystem of technological, regulatory, operational, and societal dynamics. Further, the study depicts that the sources of challenge present a unique lens through with risks may be identified, specific to an organisation relevant to the breadth of operations.

These conclusions, namely the identified sources of challenge and associated risks, supported the intentions of Proposition 1: exponential opportunities presented by emerging technologies are not without sources of challenge, which are presented in the form of new and evolving risks.

6.3 Conclusions regarding Research Objective 2

Research Objective 2 of this study was to identify the risks associated with the adoption of emerging technologies.

The organisation identifies sources of challenge, mapped to the breadth of the organisation's operations and provides the platform through which risks associated with emerging technologies are identified and contextualised for the benefit of managing the concept of uncertainty. The study further depicted the need for a structured and responsible approach to enterprise risk management practices to translate the multiple sources of challenge into key risks that have a material impact on an organisation's strategy.

The inherent risk posed to organisations adopting emerging technologies is further expanded in the form of new and evolving risks, nuanced to the emerging technologies chosen for adoption under the context of the fourth industrial revolution, evidenced by the findings of this study. Through discussion of the findings, the study articulated key risks based on the sources of the challenges faced by organisations: vendor dependencies, data management challenges, change management, people, cyber security, adverse regulatory pressures, fourth industrial revolution participation, environmental factors, stakeholder management, and geopolitical threats.

The study further noted that these identified risks are plagued by complexity and rapid evolution, driven by the persistence and pervasiveness of emerging technologies in a digitally forward business landscape. In comparison to the presented literature, clear commonalities can be derived from the context of developing economies adopting emerging technology with regard to the risks faced by organisations.

These conclusions, namely the identified risks, supported the intentions of Proposition 2: adoption of emerging technologies that result in risk identification typically through a digital transformation strategy. The identified risks point to the necessity for sound enterprise risk management practices for long-term success in managing the associated risks.

6.4 Conclusions regarding Research Objective 3

> Research Objective 3: Categorise and prioritise the risks associated with the adoption of emerging technologies.

The study demonstrated a broad array of key and material risks, spanning various pillars and stakeholders within the organisational ambit of operations, all of which had a single connecting factor: the adoption of emerging technology. Given the volume and diverse nature of the identified risks, the study illustrated, through the findings and discussions, a clear need to appropriately and comprehensively categorise and prioritise the identified risks to allow for the effective use of available resources in the implementation of mitigating actions.

Through discussion of findings, following an impact-oriented approach, the following risk categories were identified and listed in order of priority: business model risks, operational and conduct risks, technology and cyber risks, regulatory risks, societal and environmental risks and geopolitical risks. The prevalence of these risk categories has been supported by the available literature across multiple studies with similar commonalities as areas of concern for organisations adopting emerging technologies within the fourth industrial revolution.

Furthermore, the study depicted categorisation as a tool for mapping risks faced by organisations across the strategic, tactical, and operational levels, painting a

comprehensive picture for stakeholders to better understand the nature, depth and complexity of the identified risks. The categorisation of identified risks and the resultant formation of risk categories, referred to in the literature as a risk taxonomy, can be further enhanced by the prioritisation of these risk categories, beginning with the most impactful and concluding with the least impactful. The study further pointed to an understanding that the categorisation and prioritisation of these identified risks provide a line of sight that cuts across organisational divisions and departments, emphasising value in the strategic allocation of limited resources for the purposes of risk mitigation.

In conclusion, the insights provided by the study, cross-referenced with the available literature, supported the intentions of research Proposition 3: risks categorisation and prioritisation, which is required as the risks associated with the adoption of emerging technologies may be categorised and prioritised for the benefit of effectively deploying limited resources to address the uncertainty faced by an organisation.

6.5 Contribution of the research

This study contributes empirically to academic research and the practical application of enterprise risk management practices in identifying, categorising, and prioritising risks associated with emerging technologies in a developing economy context. The resultant risk taxonomy guides organisations embracing emerging technologies in South Africa, seeking to understand the potential risks of emerging technology adoption. The study offers insight into the sources of challenge faced by organisations under the fourth industrial revolution and the resultant risks experienced by organisations actively deploying AI, big data, and the IoT.

The study further highlights the complex and matrix nature of enterprise risk management practices in organisations adopting a responsible approach to managing the inherent risk of emerging technologies. These findings contribute to the articulation of an organisation's risk profile for managing common risks of emerging technology adoption in a rapidly evolving and highly competitive business landscape.

6.6 Recommendations

In view of the discoveries of this study, the following recommendations are provided to both risk management professionals and senior management directly and indirectly involved in risk management practices to achieve long-term success in adopting emerging technology in the South African landscape.

Firstly, enterprise risk management is an organisational capability still largely perceived by stakeholders as an ad hoc service to the core business. It is for this reason that the onus lies with risk management professionals to package and communicate the value of their organisation-focused risk methodology clearly and succinctly. For the long term success of organisational objectives, the focus must be placed on the interconnectedness of risk management practices and the resultant identified risks to strategy development. This interconnectedness, between the cyclical nature of risk management practices and the digital transformation journey presents great value in the iterative development of an organisational strategy prepared to navigate the fourth industrial revolution.

Secondly, based on the discoveries of this study, it is further noted that enterprise risk management professionals have a duty to organisational stakeholders, which requires them to develop and implement a thoughtful, structured and responsible risk management programme. The programme must be focused and provide a methodology for business leaders across the organisation to identify risks in deep granularity from the operational level to the tactical level and then, further, the methodology must include the strategic level. Through risk professionals providing these various layers of risk insights, may senior leaders be equipped to make informed risk-based decisions.

Thirdly, enterprise risk management practices serve as a methodology for identifying, categorising, and prioritising risks within an organisation. Therefore, the need to identify risk places a significant responsibility in the hands of senior leaders to adopt these enterprise risk management practices. Senior leaders must work with risk management professionals to understand the big picture in relation to the risks associated with emerging technology adoption in their unique operating environment and the wider impact these risks play to the organisation.

Finally, based on the discoveries of this study, it is noted that both senior leaders and risk professionals have an onus to actively engage critical business stakeholders, with emphasis on regulatory and legislative bodies with the ability to radically shaped the operating landscape. This active approach to governing bodies provides a platform for cross collaboration between stakeholders seeking mutually beneficial outcomes towards an aligned and collective objective.

These recommendations aim to draw together risk management professionals, the outputs of their efforts and the responsibility and skill of senior leaders to effectively address the challenges faced by digitally forward organisations operating at the forefront of the fourth industrial revolution and committed to driving sustainable change through the adoption of emerging technologies.

6.7 Suggestions for further research

The study highlighted and identified the risks associated with the adoption of emerging technologies for organisations operating in the South African context and the opportunity to categorise and prioritise the identified risks into risk categories, presented in the form of a risk taxonomy, nuanced to an organisation.

In order to effectively capture the risks associated with emerging technologies in better detail, the adopted definition of emerging technologies was limited to the virtuous triangle, namely AI, big data, and IoT based on their interconnectedness. Further studies may wish to extend the definition of emerging technologies beyond AI, big data, and IoT, becoming more inclusive of the several technologies presented by the fourth industrial revolution.

In addition, it is suggested that the research can be extended to understand the risks associated with early adoption of emerging technologies and the consequential impact on the risk taxonomy.

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APPENDIX A: PARTICIPANT INFORMATION SHEET

Dear Sir / Madam

My name is Brett Williams. I am a Master of Management student in the field of Digital Business at the University of the Witwatersrand, Johannesburg. My supervisor is Dr Manessah Alagbaoso. I am conducting a research study about risks faced by South African listed organisations, who are employing emerging technologies and navigating uncertainty in this regard. The study title is, 'Risks associated with the adoption of emerging technologies under fourth industrial revolution: a South African study.'

I am inviting you to take part in an interview. If you decide to take part, your participation in this research study will last about one hour. The interview will take place in person or on Microsoft Teams, at a time convenient to you. With your permission, I would like to video record the interview. This data will be stored on a secure drive for the period of the study and deleted at conclusion of the study, the term of the study being not longer than two years. Only I will have access to the data.

The interview will be confidential and anonymous. When I share the results of the research study, I will not include your name or anything else that could identify you. If you decide to take part in the research study, it should be because you want to volunteer. You do not have to take part. You can stop being in the study at any time. You do not have to answer any questions if you do not want to. You will not get any direct benefits if you choose to join the research study, nor will you be paid for participating in this study. You will not lose any services, benefits, or rights you would normally have, if you decide not to participate.

This research study will be written up as a research report. The report will be available on the university library website. If you would like to receive a summary of this report, I will be happy to send it to you. If you have any questions during or afterwards about this research study, feel free to contact me using the details listed below. If you have any concerns or complaints about the ethical procedures of this research study, you are welcome to contact the University Human

Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za.

Yours sincerely,

Brett Williams

Researcher:

Brett Williams, 1719751@students.wits.co.za

Supervisor:

Manessah Alagbaoso, Obinali.Alagbaoso@wits.ac.za

APPENDIX B: PARTICIPANT CONSENT FORM

Title of project: Risks associated with the adoption of emerging technologies under fourth industrial revolution: a South African study.

Name of researcher: Brett Williams.

I, ……., agree to participate in this research project.

I agree to the following (Please circle the relevant options below):

The research study was explained to me. I understand what this study is about	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that the interview may be audio recorded	YES	NO
I agree that direct quotations from my interview may be used by the researcher in their research report	YES	NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report)	YES	NO

……(signature) …… (name of participant) …….. (date)

……(signature) …… (name of researcher) …….. (date)

APPENDIX C: CONSISTENCY TABLE: RESEARCH QUESTIONS, PROPOSITIONS, DATA COLLECTION AND DATA ANALYSIS

RQ #	Research Objective	Proposition #	Research proposition	Data collection detail	Data analysis method
1	Identify the sources of challenge associated with the adoption of emerging technologies.	1	The exponential opportunities presented by emerging technologies are not without sources of challenge, which are presented in the form of new and evolving risks.	Interview guide questions: 1,2,3,4,5	Qualitative: Thematic analysis.
2	Identify the risks associated with the adoption of emerging technologies.	2	The adoption of emerging technologies, typically through a digital transformation strategy, necessitates the application of sound enterprise risk management practices for long-term success in managing the associated risks.	Interview guide questions: 6,7,8,9	Qualitative: Thematic analysis.

RQ #	Research Objective	Proposition #	Research proposition	Data collection detail	Data analysis method
3	Categorise and prioritize the risks associated with the adoption of emerging technologies.	3	Risks associated with the adoption of emerging technologies may be categorised for the benefit of effectively deploying limited resources to address the uncertainty faced by an organisation.	Interview guide questions: 10,11,12,13, 14	Qualitative: Thematic analysis.

APPENDIX D: INTERVIEW SCHEDULE

Introduction:

Hi (name),

Firstly, thank you for making the time to participate in this research study as an interview participant. As per our initial engagements, my name is Brett Williams. I am conducting research for the completion of my Master of management in the field of digital business. My research topic is, ‘Risks associated with the adoption of emerging technologies under fourth industrial revolution: a South African study.’

Your participation in this interview is voluntary and as such, shall you feel uncomfortable and wish to stop at any time, you have the right to do so.

I would like to remind you that your participation in this study is confidential and all identifiable information pertaining to both you and your organisation will be removed. This interview will be audio and video recorded, as per your signed consent, lasting approximately an hour. Are you comfortable that I commence with the recording of this interview?

I would appreciate if you could provide me with as much detail as possible when answering the interview questions. Where you are not clear on the requirements of the question, please do not hesitate to ask any clarifying questions.

Before we commence, do you have any questions for myself, with respect to this interview and any of the details I have covered thus far?

Proposition 1: The exponential opportunities presented by emerging technologies are not without sources of challenge, which are presented in the form of new and evolving risks.

1. How has the competitive landscape in your industry changed with the onset of the fourth industrial revolution? Please elaborate on your reasons.

- **Probe:** i) Increased organisational intelligence (beyond their human counterparts), ii) Intelligence gathering in the form of big data and, iii) New market disruptions and innovation.

2. In your understanding, what action has your organisation taken to navigate the fourth industrial revolution and what impact has that had on the organisation?
3. Which fourth industrial revolution technologies has your organisation already employed?

- **Probe:** Robotics and RPA, the internet of things, big data, cybersecurity, biotechnology: neurotech, cloud computing, artificial intelligence, virtual and augmented reality, blockchain, additive manufacturing.

4. Based on your selection above, which emerging technologies are most dominant in your organisation and what uncertainty have these emerging technologies presented?
5. What sources of challenge are being faced by your organisation as a result of the adoption of emerging technologies?

- **Probe:** Business model, cyber threats, economic value, ethical and moral factors, legal and regulatory, people and technological concerns.

Proposition 2: The adoption of emerging technologies, typically through a digital transformation strategy, necessitates the application of sound enterprise risk management practices for long-term success in managing the associated risks.

6. What effect has the adoption of emerging technologies had on your organisations risk universe? In the sense of new or evolving risks identified by the organisation.
7. What are the top risks currently affecting your organisation, related to the adoption of emerging technologies?
8. How effective has the current enterprise risk management process been in identifying risks faced by the organisation? Please support your answer with reasons.

9. In your opinion, what potential risks to you see, which are currently not being adequately recognised by either your organisation, the industry in which you operate or the country?

Proposition 3: Risks associated with the adoption of emerging technologies may be categorised for the benefit of effectively deploying limited resources to address the uncertainty faced by an organisation.

10. How does your organisation categorise risks for the purposes of enterprise risk management?

- **Probe:** Triple bottom line, risk source, existing categories.

11. Do you see value in the use of risk categories for your organisation and if so, what has been the impact of employing risk categories in your organisation?
12. What are the current risk categories identified by your organisation and of these risk categories, which do you believe are most influenced by the challenges of the fourth industrial revolution?
13. Which of the above-mentioned risk categories, do you see as the most influential in determining the organisational risk profile and why?
14. Do you believe your organisation to be missing any relevant risk categories and if so, what are these categories?

APPENDIX E: ETHICS APPROVAL

Graduate School of Business Administration
University of the Witwatersrand, Johannesburg

Wits Business School

Wits Business School Ethics Committee
Constituted under the University Human Research Ethics Committee (Non-Medical)

Ethics Clearance Certificate

Ethics protocol number: WBS/DB1719751/348
This certificate is only valid with a legitimate ethics protocol number and signed by the Researcher (below).

Project title	Risks associated with the adoption of 4IR technologies in South Africa
Investigator / Researcher	Mr Brett Williams
Nature of Project	MM (Digital Business)
Decision of the Committee	Approved, provided stakeholders and participants are guaranteed confidentialty.
Issue Date of Certificate	8/29/2023
Expiry date	Date of submission of the project / research report
Chairperson	Dr Pius Oba +27 11 717 3976 +27 82 733 6587 pius.oba@wits.ac.za

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Declaration by Researcher

One copy must be signed by the Researcher and returned to the Chairperson of the Wits Business School Ethics Committee.

I fully understand the conditions under which I am 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 undertake to resubmit the protocol to the Committee.

Signature

8th Jan 2024
Date: