The Fourth Industrial Revolution and the South African Platinum Mining Industry.

Traditional Research

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Thesis presented in partial fulfilment for the degree of Master of Business Administration to the Faculty of Commerce, Law, and Management, University of the Witwatersrand

26 November 2021

DECLARATION

I, Tshepo Timothy, declare that this research report entitled The Fourth Industrial Revolution and the South African Platinum Mining Industry is my own unaided work. I have acknowledged, attributed, and referenced all ideas sourced elsewhere. I am hereby submitting it in partial fulfilment of the requirements of the degree of Master of Business Administration at the University of the Witwatersrand, Johannesburg. I have not submitted this report before for any other degree or examination to any other institution.

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Signed at Johannesburg on 26th November 2021

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ABSTRACT

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Thesis title: The Fourth Industrial Revolution and the South African Platinum Mining Industry.

Johannesburg, November 2021

Most mining organisations have warmed up to adopting the latest technologies in recent times, as they have the potential to give them an edge in a highly competitive industry. In South Africa, Platinum Group Metals (PGM) are extensive on the African continent of which South Africa holds about 80% of the world's reserves. It was estimated that the industry exported approximately USD 4.4 billion worth of platinum during 2015, and the industry is a major contributor to the South African economy (Conradie, 2016). Due to dwindling commodity prices and productivity, coupled with safety concerns, the industry is finding itself in a challenging position to be sustainable. It is against this backdrop that a quantitative research approach using quantitative surveys was used to glean/collect data and determine the gaps as informed by the existing profiles vis a vis the required skills and educational profiles of the people in the mining value chain. Mining officials from Sibanye Stillwater mining company, related mining companies and mining students in their personal capacity within the mining industry value chain in South Africa were engaged as study participants. The findings of the study revealed that stakeholder engagement and organisational readiness are linked. The link between stakeholder engagement, Radio-Frequency Identification (RFID), and artificial intelligence (AI) was highlighted. The research also discovered a link between organisational culture and the skills required, as well as the technology relevant to the fourth industrial revolution.

Key Words: Stakeholder Engagement, Skills Requirements, Fourth Industrial Revolution Technologies, Platinum Industry, South Africa

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ACKNOWLEDGEMENTS

I would like to praise and give glory to the Almighty for giving me the gift of life and the strength that was needed to undertake this project.

A massive sacrifice was made by my partner, Lerato Tau, for being understanding . A project like this takes time and commitment and the fact that I spent most of my time busy with my studies and she was understanding at all times means a lot to me. To my daughter, Ntokozo, my mother and my siblings, thank you for being my strength. There were times when I wanted to give up, but just the thought of you made me persevere.

I would also like to thank my supervisor, Thandiwe Chidzungu, for her support and understanding. Without you, I would have been lost. This project would also not have been possible without the participation of all of the study's participants.

I would like to extend my gratitude to my friends, colleagues and extended family for supporting me through the challenging times of the COVID-19 pandemic.

Lastly, I would like to thank the Wits Business School family and my current employer for providing me with the opportunity to study for an MBA degree.

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DEFINITION OF KEY TERMS AND CONCEPTS (ABBREVIATIONS)

IT	Information Technology
UNDAF	United Nations Development Assistance Framework
USD	United States Dollar
BN	Billion
ICT	Information and Communications Technology
IoT	Internet of Things
RDO	Rock Drill Operator
DMRE	Department of Mineral Resources and Energy
AI	Artificial Intelligence
R&D and I	Research and Development and Innovation
CMSI	Centre of Sustainable Mining Industries
CMMS	Centre for Mechanised Mining Systems
WMI	Wits Mining Institute
PGM	Platinum Group Metals
MRRC	Mining Resilience Research Centre
CoE	Centre of Excellence on Occupational Health and Safety
RIA	Mining Research Impact Area
SPSS	Statistical Product and Service Solutions
RFID	Radio-Frequency Identification

1 INTRODUCTION TO THE RESEARCH

1.1. Background and Context

The mining sector has experienced several technological advancements. These technological advancements have been fueled by a variety of issues, including safety concerns, decreased productivity, high production costs and the desire to boost production efficiency and effectively develop previously economically unappealing mining projects (Bertayeva et al., 2019). Safety is a major concern in the mining industry and the platinum sector has seen a spate of serious injuries as well as fatal injuries in recent times. Whenever there are any stoppages due to safety reasons, there is normally a decline in productivity which affects the overall performance of the affected mining companies.

There are also significant production costs due to the continued use of inefficient old machinery in the mining industry. To solve these issues, Oshokoya & Tetteh (2018) argue that the industry should be knowledge-driven through a database model that transmits and receives information (environmental, mining production, and mineral processing) to enable proactive choices to be taken from both operational and control room perspectives. The future mine will, therefore, be reliant on a highly skilled skeleton labour force capable of performing a variety of activities, including automated and remote-controlled operations and monitoring.

Considering the above-mentioned issues, the introduction of innovative technology is critical; yet, it necessitates the acquisition of new, modern and relevant skills, as well as an appropriate educational curriculum. As a result, the study seeks to determine how the Fourth Industrial Revolution in the Platinum Mining Industry can be established. Furthermore, contributes to labour and an educational policy by providing a suitable framework for implementation.

1.1.1. South African Platinum Mining Industry

According to Conradie (2016), the South African platinum mining sector is one of the largest in terms of employment and export revenues in the country's mining industry. Platinum mining in South Africa, or mining for Platinum Group Metals (PGM), is expected to be substantial across the African continent, with South Africa holding around 80% of the world's deposits. It is projected that the sector exported around USD 4.4 billion in platinum in 2015, and it is a significant contribution to the South African economy (Conradie, 2016). Due to falling commodity prices, less productivity as well as safety issues, the sector is in a difficult position to remain sustainable. Certain skills are required to drive such plans ahead for the sector to remain viable and relevant in the future. The industry's task is to determine which skills and knowledge are required to be compatible with the anticipated technologies that will be prominent in the future. Thereafter, it will use these skills and knowledge to improve productivity and safety in mines.

1.1.2. Readiness of the Fourth Industrial Revolution in the South African Platinum Mining Industry

The platinum mining industry is changing in response to current global economic and technological trends. It is worth noting that the fourth industrial revolution differed from earlier revolutions in that it was characterised by technologies with a combination of physical, digital, and biological characteristics that could affect all disciplines, economies and sectors (Whysall, et al., 2019). The major premise underlying this notion, so far as the fourth industrial revolution is concerned, is the vast deployment of information technology (IT) and information and communications technology (ICT) advances into production processes (Brodny, 2018).

Since mining is typically a cost-sensitive business, it is usually hesitant to adopt new technologies. However, in recent years, most mining companies have warmed up to adopting cutting-edge technology because it has the potential to give them a competitive advantage in this highly competitive business. It does, however, come with a desire for increased educational and skill requirements that will be compatible with the new technology.

1.1.3. Educational and Skills needs in the South African Platinum Mining Industry

According to Mining Weekly (2016) Frik Fourie (Former Anglo American Platinum Head of Mining) stated that conventional mining was no longer a profitable way to operate mines in South Africa and that this was due to low commodity prices. The website further mentioned that the industry needed collective action between the mines, government and educational institutions to mechanise the mines, as it (mechanisation) stood to play a significant role in ensuring safety for mineworkers.

Mechanisation, through the fourth industrial revolution, will need certain education and skills to realise the vision of the future. As it stands currently, the industry lacks certain skills and knowledge in order to be ready for the mines of the future.

According to Humphreys (2019), in 2016, the trade journal Mining Magazine conducted an extensive survey on the specific technologies that mining companies believed would have an impact on the industry, concerning profitability, productivity and safety in the future. The following results were obtained. See *Table 1-1* below.

Table 1-1: Mining technologies 'which will have the most impact in 5–10-years

Rank	Technology	% Responding
1	HP satellite/drones/laser survey/imaging	97.4
2	Big data/predictive analytics	95.7
3	High powered computing/cloud	92.2
4	Internet of Things/connectivity	69.8
5	Operating technologies-IT integration	53.4
6	High precision guidance/control	53.4
7	Remote/teleremote control	50.0
8	Automation/robotics	35.3
9	Ore sorting/pre-concentration	28.4
10	Gaming type visualisation/software	25.0

Source: Mining Magazine 2016

In the next 5–10 years, technologies that are expected to have a major impact on the industry include those related to improvements in remote geological surveying utilising satellites and drones (with improved imaging) (Humphreys, 2019). In terms of enhanced productivity, the application of high-powered computing and big data were identified as key technologies that could generate real-time information that had the ability to reduce downtime, save energy, increase safety and boost output (Humphreys, 2019).

Humphreys (2019), also indicated that the internet of things and operating technology-information technology (OT-IT) integration are focused on linking all aspects of the business together into a seamless whole, or collaborative IT, as it is sometimes called. In contrast to factories, conditions in mines are shaped by nature and are continually changing, necessitating the adaptation of information and management systems. By improving maintenance, mine planning and asset utilisation, better integrated, real-time systems are considered to have the potential to yield significant productivity improvements.

1.2. Research Conceptualisation

1.2.1. The Research Problem statement

The platinum mining industry in South Africa has historically been prolific, contributing greatly to the creation of jobs for both local and migrant workers in the country, as well as neighbouring countries. It is important to note that the platinum sector has recently experienced a decrease in production as well as an increase in safety concerns. This is due to a number of issues, including the poor skills base and inadequate education of workers who are directly involved in the industry's productivity. Furthermore, mining is a cost-sensitive business in general, and mining companies must optimise in order to stay competitive and efficient in the current economic climate. As part of embracing the Fourth Industrial Revolution, they can incorporate digitisation, the internet of things (IoT), robotics, and data mining as means of remaining competitive.

However, for the above to be realised, the workforce must have the right skillset and education. The reality is that most mining companies continue to face professional and frontline skills shortages that make it impossible for the day-to-day running of these operations. Lanel et al. (2015) state that while there has been progress in the past in terms of training programmes to address these issues, the scarcity of skills in frontline positions among artisans and supervisors persists. Having noticed this, a critical skills gap study is needed which aims to assess the skills and educational needs that will be recommended to various stakeholders.

1.2.2. The Research Purpose (Aim and Objectives)

The research aims at assessing the skills and educational requirements for the Fourth Industrial Revolution in the South African platinum mining industry. The study has the following objectives:

i. To explore the possible Fourth Industrial Revolution technologies that will be of benefit to the platinum mining industry in the future.
ii. To determine the skills and educational requirements that will empower current and future employees to be relevant when the Fourth Industrial Revolution is implemented.
iii. To identify the factors that will affect organisational cultures and employee productivity when these skills and knowledge are introduced in the South African Platinum Industry.

1.3. Research Questions

R_1: Is stakeholder engagement needed in terms of organisational readiness when implementing Fourth Industrial Revolution technologies?

H_o: “When implementing the Fourth Industrial Revolution technologies, there is a strong relationship between stakeholder engagement and organisational readiness”

H_a: “Organisational readiness when implementing the Fourth Industrial Revolution technologies, does not need stakeholder engagement”

R_2: Are skills requirements affected by job security and organisational culture (strategy) in the implementation of the fourth industrial revolution technologies?

H_o: "When implementing the Fourth Industrial Revolution technologies, there is a strong relationship between skills requirements, organisational culture, and job security"

H_a: "Skills requirements is not affected by job security and organisational culture when implementing the Fourth Industrial Revolution Technologies"

R_3: What factors affect organisational culture when new skills and knowledge are introduced in the South African mining industry when the fourth industrial revolution is introduced?

H_o: "Productivity due to new skills and knowledge will influence organisational culture in the platinum mining industry in the implementation of fourth industrial revolution technologies".

H_a: "Productivity due to new skills and knowledge will not influence organisational culture in the platinum mining industry, in the implementation of fourth industrial revolution technologies".

1.4. Delimitations and assumptions of the study

The study is about the envisaged skills and educational requirements pertaining to the fourth industrial revolution in the South African platinum mines. It was confined to a sample population of Sibanye Stillwater and other platinum mining corporations, as well as academics in the mining industries in their individual capacities.

A bigger sample population could have been gathered from various commodities mining firms, such as gold mining companies, coal mining companies, diamond mining companies, iron ore and manganese mining companies, for the study to be complete. This was , however, not feasible due to the time constraints.

Even though a mixed technique approach was intended during the research proposal phase, a quantitative strategy was adopted. This was owing to a snag in the ethics clearance process and the challenges that the COVID-19 pandemic imposed on work, interaction and travelling. As a result, there was limited time at the researcher’s disposal to gather both qualitative and quantitative data in order for the fourth industrial revolution to benefit the platinum mining industry. There are certain issues that will have an impact on the implementation of the fourth industrial revolution and these include:

- the availability of technology that will be of benefit to the industry.
- the availability of educational and skills requirements which will benefit the platinum mining industry before and during the implementation of the fourth industrial revolution.
- the impact that the organisational culture will have when the fourth industrial revolution is implemented.

The scope of the study as it points to research objectives was therefore, focused on these pertinent issues.

1.5. Significance of the Research Study

The study's findings stood to benefit the platinum mining sector as well as major educational institutions in developing the curriculum that is required for mining professionals when the Fourth Industrial Revolution will be implemented. Furthermore, the research aimed to raise awareness about various cutting-edge technologies that might help mining corporations remain competitive in the face of falling commodity prices as well as how they can address worker safety issues. The outcomes of this study aimed to considerably aid the Department of Mineral Resources and Energy (DMRE) by assisting them in altering their legislation to be more relevant to the fourth industrial revolution needs. For the researchers, the study will aid them in identifying critical areas in the skills development and educational requirements for the Fourth Industrial Revolution that many researchers have been unable to investigate, potentially leading to the development of a new theory of technological education. Most mining firms can benefit from understanding how technological change affects organisational culture and how to incorporate people when new technologies are adopted.

1.6. Preface to the Research Report

Following this introductory Chapter 1, Chapter 2 provides a literature review covering the problem, past studies, the explanatory framework and the conceptual framework. Chapter 3 discusses the research strategy, design, procedures, reliability, and validity measures as well as limitations. Chapter 4 provided the presentation of research results covering descriptive statistics of the respondents, reliability tests that were done, regressions on the organisational readiness and stakeholder engagement. This chapter also focused on the regressions on skills requirements, job security, and organisational culture. Following the previous chapter, chapter 5 details the summary, conclusions, limitations, and recommendations of the study. Chapter 6 looks at the possible future research to be done pertaining to this study.

2 LITERATURE REVIEW

2.1. Introduction

The content of this literature review entails the fourth industrial revolution technologies that will be beneficial to the platinum mining industry, but it must be mentioned that it is not, by all means, a representation of all the literature that encompasses the subject matter content. To get a grasp of all the themes within those research questions, the literature was examined and analysed in accordance with the research questions and hypotheses in Chapter 1. The first portion of the assessment examines the issues that the platinum mining sector faces in the context of the fourth industrial revolution. The emphasis was on future technologies that will benefit the industry, as well as the skills and educational requirements associated with these technologies, organisational culture in the new era, and the level of engagement required by all relevant stakeholders to develop the curriculum required for the fourth industrial revolution. The last section of the literature review deals with knowledge gap analysis, qualitative and/or quantitative factors that are important to the study, a framework for interpreting the research findings, and the review's summary and conclusion.

2.2. Research problem

2.2.1. Theory of Change – What to expect in Industry 4.0?

According to United Nations Development Assistance Framework (2017), a theory of change is an approach that utilises a casual analysis based on existing evidence to explain how a given intervention, or collection of treatments, is likely to lead to a specified development change. It must be guided by sound analyses, consultation with key stakeholders and learning from the experiences of the UN and its partners about what works and what does not work in various contexts.

2.2.2. Why the theory of change?

The United Nations Development Assistance Framework (2017), documents that a theory of change assists in identifying solutions to effectively address the causes of problems that hinder progress and guides decisions on which approach should be taken. Noble (2019) mentions that the output from a theory of change process describes how we believe our activities will lead to the outcomes and impacts what we want to achieve. It is essential that the concepts of the theory of change be examined and implemented in the platinum industry to make the fourth industrial revolution a success. According to the United Nations Development Assistance Framework (2017), development changes are complex and are typically produced by many factors and layers that are embedded deeply in the way society functions. For example, introducing the fourth industrial revolution technologies into the mining industry may not necessarily lead to high profit margins for organisations in this industry, unless:

i. human capital is empowered by science, technology, engineering and mathematics (STEM) education,
ii. emphasis is on increased human potential,
iii. adoption of lifelong learning models,
iv. automation of schools,
v. future employees' global mind-set and
vi. changes in higher education.

The United Nations Development Assistance Framework (2017), also noted that a theory of change makes provision for learning both within and between programming cycles. The theory of change assists in the correction of the selected approach when it is deemed to not be working or if anticipated risks materialise. Lastly, the theory of change can furthermore be used as a means of developing and managing partnerships and partnership strategies. This is evident when the fourth industrial revolution technologies need to be implemented in the platinum industry, which is predominantly a mass-production industry, and in order for it to be a success, collaboration between the state, corporate citizens, the community and educational institutions is needed (United Nations Development Assistance Framework, 2017).

2.2.1.2. Key Principles for Developing a Theory of Change

According to Valters (2015), there are four (4) main principles that seek to ground Theory of Change approaches in this emergent knowledge and are rooted in a concern with persistently damaging problems within the industry and these are:

i. **Focus on the process:** In the past, conventional programme management tools used to ignore the "process elements", approaching projects as "closed, controllable and unchanging systems". In order to change the status quo a theory of change approach can be utilised, where regular engagement with underlying assumptions is essential. Critical thinking can be sparked by project timelines or program diaries, which feeds into broader strategy testing.

ii. **Priority learning:** For change to have a long-lasting effect, the theory of change phenomenon proposes a paradigm shift from a monitoring and evaluation concept to learning and adaptation. It must be noted that, having accountability for learning could lead to desirable outcomes. e.g., in the past most programmes could not be held accountable for how much has been learnt over time, the adaptation to new information and why this adaptation was important for development outcomes.

iii. **Be locally led:** It must be noted that one of the dangers with a Theory of Change approach is that it remains a top-down process where a small group at the top of an organisation imposes their strategies without input from the 'beneficiaries' i.e., lower ranked employees and other stakeholders. It is advisable to include local organisations and all stakeholders in order to reap the full benefits of the envisaged results.

iv. **Think compass, not map:** This process entails the development of a "roadmap" to get you from one point to another. The downfall of this approach is that it tends to confine people to assumptions and linearity. The advantage of using the Theory of Change is that a process should be like a "compass," helping us to navigate through complex systems and discovering a path as we go along. Acknowledgement of these complexities does not necessarily mean discarding the planning process altogether, but rather taking note that plans that reflect the best guesses about the future will likely shift over time, meaning that one has to be adaptable to move forward.

As seen above, the Theory of Change helps in strategising new concepts and, in this study, the implementation of the fourth industrial revolution in the South African Platinum Mines.

2.2.3. What is the Fourth Industrial Revolution?

The fourth industrial revolution refers to the rising revolution in artificial intelligence, reality technologies, cloud computing, three-dimensional printing and robotics that is taking place in the physical, biological, and digital worlds (MYEDU, 2020). On the one hand, the fourth industrial revolution denotes a fascinating and intense worldwide transformation, while on the other hand, it denotes a disruptive change in the past cheap industry and life standards (MYEDU, 2020).

According to Get Smarter, (2021), the fourth industrial revolution offers the opportunity for transformation, growth, and improvement for governments, organisations, and professionals. According to MYEDU (2020), the fourth industrial revolution will have the following effects on society and education, as social revolution and education are inextricably linked:

i. The fourth industrial revolution is expected to fight poverty and inequality.
ii. The fourth industrial revolution is set to reinvent labour, skills, and production in many industries in the future.
iii. It aims to increase financial services and investment.
iv. Modernisation of agriculture and the agro-industry
v. The improvement of health care and human capital

In addition to the foregoing, Lights On Data (2020) listed the following benefits of the fourth industrial revolution:

Advantages

i. **Higher productivity:** It is estimated that productivity will increase by 5-8% in the next 5–10 years. This is due to increased automation in most industries.
ii. **Improved quality of life:** Technology has facilitated the enablement of new products and services that increase the efficiency and pleasure of our personal lives.
iii. **New markets:** The mixture of technology in physical, digital and biological entities stands to create new markets and growth opportunities.
iv. **Lower barrier to entrepreneurship:** New technologies such as three-dimensional (3D) printing for prototyping is currently reducing the barriers between investors and their proposed markets. Modern entrepreneurs will have the ability to establish their companies and test their various products with lower start-up costs without the traditional time and cost constraints often present in traditional prototyping methods. This in turn lowers the barrier to entry in most industries.

2.2.4. Future Fourth Industrial Revolution technologies that will benefit the platinum mining industry in the near future

The platinum mining industry is one of the oldest industries in South Africa and traditionally, just like most mining companies, was reluctant to implement new technologies. Substantiating this argument is Marwala (2018), who argues that the "mining industry was still stuck in the first and second industrial revolutions." This has been attributed to the industry being cost-sensitive and lacking the necessary skills and education needed to operate these technologies. (Michaud, 2019) views the digitization of the mining sector and the broader economy as an opportunity to re-skill and re-direct workers into higher-value technology-driven jobs such as data mining and data analytics.

The fourth industrial revolution is a new technological revolution wave recommended at the World Economic Forum in 2016 in fast developing communications, robotics, information storage and processing technologies (Jan & Topal, 2020). The digitization of the economy and society, which is still in its infancy, lies at the heart of this change (Mahnkopf, 2019). Durrant-Whyte, Gerqahty, Pujol, & Sellschop (2015) make a similar point, stating that there has been a movement in the mining sector to focus on boosting productivity and performance, which has been fuelled by digital and technological developments. They go on to say that technical and digital innovation have the potential to transform crucial parts of mining.

Nevertheless, Marwala (2018) argues that the reason why the mining sector was reluctant to integrate the advancements of the fourth industrial revolution was due to its political economy. While Durrant-Whyte et al. (2015) feel that the mining sector is at a tipping point, there is a case to be made that digital technologies have the potential to open new ways of reducing unpredictability and increasing production. However, a wide range of rare skills must still be learned, and the platinum industry must examine the fourth industrial revolution's educational and skill needs.

2.2.5. Skills and educational requirements that will empower current and future employees to be relevant when the Fourth Industrial Revolution is implemented

Technological progress or innovation necessitates a shift in the educational qualifications and skill sets of potential employees if they are to remain relevant as the Fourth Industrial Revolution begins. (Durrant-Whyte et al., 2015) identifies four major groups of technologies that will be required for adoption, each of which will necessitate the development of a new skill set among potential employees:

i. **Analytics and intelligence:** Improvements in analytics - from machine learning to improved statistical techniques for integrating data - are assisting in turning vast data sets into insights about the probability of future events.

ii. **Data, computational power, and connectivity**: These are concerned with the vast numbers of sensors in physical objects that give out large amounts of data for analysis and enable communication among machines.
iii. **Analytics and intelligence:** Improvements in analytics, from machine learning to improved statistical techniques for integrating data are assisting in turning vast data sets into insights about the probability of future events.
iv. **Human-machine interaction:** This refers to how people interact with machines as well as how they interact with others.

- **Digital-to-physical conversion:** This deals with advanced robotics and artificial intelligence and has made it possible for improved production.

All of these varied types of technology will necessitate skills development, which will be fuelled by a curriculum designed for the Fourth Industrial Revolution. According to Webber-Youngman (2017), the following 10 abilities are crucial for students to learn to cope in a new environment (with special reference to the development of associated skills):

i. Complex problem solving
ii. Critical thinking
iii. Creativity
iv. People management
v. Coordinating with others (group work activities)
vi. Emotional intelligence
vii. Judgement and decision-making
viii. Service orientation
ix. Negotiating
x. Cognitive flexibility

Webber-Youngman (2017) states that in 2017, the following skills were proposed as activities that machines would not be able to do in the future.

He also stated that the number in brackets indicated the importance of the skills mentioned (source: PwC):

i. Creativity and innovation (4)
ii. Leadership (3)
iii. Emotional intelligence (5)
iv. Adaptability (2)
v. Problem-solving (1)

According to Webber-Youngman (2017), when considering the skills mentioned above, it was no surprise that complex problem-solving was ranked above all of them. It was imperative that educational institutions think differently about the way they educate and teach the next generation of mining practitioners, as it was recognised that whatever students are taught now will be obsolete in the next 5–10 years. He also articulates that independent learning will be a skill that must be acquired so as to be able to deal with the complexities associated with the mining industry.

2.2.6. Organisational Culture in the New Era

"*Organisational culture or corporate culture is the pattern of values, norms, beliefs, attitudes and assumptions that, while not stated, impact how people in an organisation behave and get things done. Values refer to what is believed to be important about how people and organisations behave. Norms are the unwritten rules of behaviour*" (Mohelska & Sokolova, 2018. P2228). Recruit Gyan (2019) mentioned that organisational culture is essential for the success of any company. Beehive Strategic Communication (2019), also added to this point by mentioning that workplace culture impacts how employees experience work attendance every day and establishes the norms for how they interact with one another and their supervisors. A new, modern workplace culture is replacing the traditional culture of the workplace, which is frequently anchored in hierarchy, authoritative communication style and stringent restrictions (e.g., set working hours, formal dress code, inflexible work arrangements) (Beehive Strategic Communication, 2019).

As stated above, organisational culture is closely related to behaviour in the workplace or, in some cases, in individual performance. Sokolova and Mohelska (2018, p. 2229) also mentioned that there are three (3) types of organisational culture that were observed in their study, namely:

a) **Bureaucratic culture:** These are hierarchical and fragmented (compartmentalised) in nature and there are clear lines for responsibility and authority of each staff organisation.
b) **Innovative culture:** This encourages creativity, is results-oriented, and prioritizes a challenge in the workplace,
c) **Supportive culture:** That promotes teamwork, humanity orientation, friendship, hope, and trust in the work environment.

*Table 2-1***,** below, shows the characterization of culture mentioned above as well as culture types/dimensions.

Table 2-1: Characterisation of K. Cameron, R. Quinn, and E. Wallach organisational culture types/dimensions

Organisational culture types by K. Cameron and R. Quinn	Organisational culture dimensions by E. Wallach	Core values of the organisational culture (HRM environment)	Individual motivation for development of human resource potential (McClelland, 1967)
Hierarchy (similar to market but characterised with a stronger market orientation	Bureaucratic	Efficiency, result orientation, control, loyalty, and competition	Power
Adhocracy	Innovative	Personal creative freedom, orientation towards change, innovation, and risk	Achievement
Clan (family type culture)	Supportive	Unity (“we” consciousness),	Affiliation

		team, loyalty, and mutual respect	

Source: Sokolova & Mohelska, (2018)

It is evident from the literature above, that for mining organisations to be future-ready, they need to embrace innovative and supportive cultures. According to Beehive Strategic Communication (2019), a modern workplace culture will be collaborative, independent, inventive, and strategic. For the Fourth Industrial Revolution to be implemented successfully, there are factors that will drive change in the workplace culture. According to Beehive Strategic Communication (2019), these three (3) factors below drive this shift towards a modern workplace culture:

a. **Rising expectations that employees have of their employers** are mostly driven by the millennial generation. The millennial generation, which is now the biggest in the workplace, differs from prior generations in that they demand of senior leadership to actively seek out and consider their thoughts and ideas, and they also expect to find purpose and meaning in their job. Working for organisations whose ideas align with their own, particularly environmental and social justice causes, is an important component of discovering this generation's purpose and meaning. It should be noted that most organisations' executive teams are now aware of these escalating expectations.
b. **Technology** is the second major element influencing the transition to a modern workplace culture. Digital communications platforms such as emails, instant messaging, sophisticated conference and video call systems and mobile devices, provide for more flexible work arrangements by allowing workers to work from practically anywhere. Since there are people who operate in the hybrid model, the COVID-19 epidemic has worsened this situation in the mining business (remote and in the office).
c. **Expectation of transparency:** This is the third most important aspect in the transition to a modern workplace culture, and it is also impacted by technology. Organisations cannot hide information from their

employees in the present day when everything is chronicled online and on social media. Modern employees want openness and authenticity, and if there is a lack of either, they are ready to point it out.

On the point of expectation of transparency and environmental and social justice, Mpofu & Nicolaides (2019) noted that while technology has much to offer positively, it must thus not be at the expense of employees and infringe on their labour and other human rights. In the mining industry, digital technologies may improve volume, improve profitability, and support sustainability (Noble, 2019), but this could well be at the expense of thousands of miners as huge layoffs are likely to happen as miners are increasingly investing in autonomous vehicles and equipment (Mpofu & Nicolaides, 2019). The disruptions that are going to be brought about by the fourth industrial revolution technologies will have some positive and negative effects. Mining houses must guard against the class divide that is envisaged to grow in that the rich will get richer and the poor will get poorer. It must be noted that a greater gender equilibrium will manifest (Mpofu & Nocolaides, 2019). Mpofu and Nicolaides (2019) also mentioned that sectors such as mining that involve manual labour or monotonous administrative tasks are there for the taking by robotic automation, whether in a mechanical or software domain or a combination of both. This phenomenon is bound to increase unemployment, predominantly for males who are involved in the manual labour sector. Female-dominated industries, on the other hand, such as call centres, retail, and administration, are set to grow.

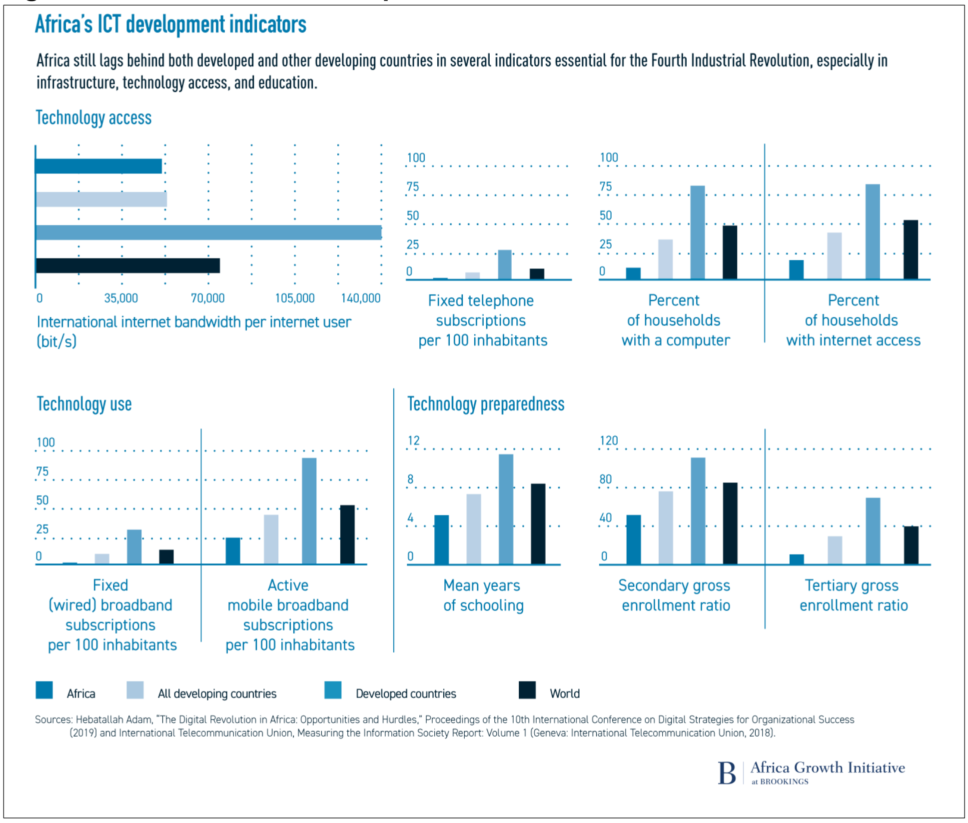
Based on the literature above, we can see that it will make sense for the platinum industry and the mining industry in general to create strategies and organisational cultures that will be more inclusive regardless of gender and economic class. This will enable the industry to still be at the forefront of job creation as it is traditionally one of the industries that absorbs a lot of human capital. For this to be realised, a high level of engagement is required between academic institutions, mining companies and the government to ensure the sustainability of the industry.

2.2.7. Developing the curriculum needed for the Fourth Industrial Revolution

As mentioned before, the Fourth Industrial Revolution is characterised by the fusion of digital, biological and physical worlds as well as the growing utilisation of new technologies such as artificial intelligence, cloud computing, robotics, 3D printing, the Internet of Things, and advanced wireless technologies, to name a few. According to Brookings (2020), these technologies have ushered in a new era of economic disruption with uncertain socio-economic consequences for Africa. However, he mentions that Africa has been left behind during the past industrial revolutions and asks if it will be different this time.

To date, Africa has not yet claimed the 21st century due to its lagging behind in many indicators essential for a successful digital revolution (see *Figure 2-1* below).

Figure 2-1: Africa's ICT development Indicators



(Source: Brookings, 2020)

Mitra et al. (2018) make mention of the "smart factory", which is a system where a cyber-physical system monitors the physical processes in a factory and makes decentralised decisions. Lamprini & Bröchler (2018) explain that in this new challenging era, experts are calling for leaders and citizens to stand together and shape a future that works for all by putting people first, empowering them, and constantly reminding ourselves that all of these new technologies are first and foremost tools made by people for people. Mpofu & Nicolaides (2019) argued that while artificial intelligence is used in various industries, there is little legislation to manage the likely effects, and this poses a problem for these industries.

From these arguments, it is clear that all stakeholders in the mining industry must work together to address the looming problem of job losses when the Fourth Industrial Revolution is fully implemented. Mpofu and Nicolaies (2019) argues that as companies seek out skilled labour, it give rise to an increasingly segregated job market, as poorly skilled employees will be substituted by computers and digitisation to the lack of the necessary skills, it is unlikely that employees who possess greater skills are unlikely to be replaced soon and they will still continue to receive generous salaries. Mpofu & Nicolaides (2019), further state that the labour lansdcape is increasingly going to become challenging for the majority of workers in South Africa as they will most likely be replaced by robots, mechanical systems and modern technologies.

More jobs are set to be lost and this might lead to labour unrests and agitation. In the same breath, new jobs are likely to be created due to the skills demand that will become prevalent. This is where the public and private sectors need to collaborate and play meaningful roles in supporting education initiatives (Mpofu and Nicolaides, 2019).

There seems to be a glimmer of hope considering the competitive nature of the world markets. For mining companies to stay competitive and ensure the safety of their employees, they need to adopt new technologies. Lamprini & Bröchler (2018) further argue that in order to gain a common and shared view, humanity first needs to adapt to the changes in technology in order to shape a society with competitive economies and highly-skilled individuals that can face these challenges head on. Lamprini & Bröchler (2018), also emphasise the need to promote innovation and new knowledge generation, along with dynamic and effective collaboration and communication. It is clear that this necessitates collaboration between industry, educational institutions and government in order to develop new methods of developing knowledge and expertise that will propel this agenda forward.

2.3. Research Knowledge Gap Analysis

2.3.1. Investment on Research & Development and Innovation

The South African Mining R&D space is very fragmented compared to other countries (Singh, 2017). There is a need to reposition South Africa as the world leader in mining Research & Development and Innovation by developing human resources skills, capabilities and capacities. This should cut across academia, industry and the science councils to ensure its sustainability. To support this claim of fragmentation in the mining RD&I environment, Singh (2017), also note that presently, there are several mining-related collaborative initiatives such as:

a. The University of the Witwatersrand's Centre for Sustainable Mining Industries (CMSI)
b. Centre for Mechanised Mining Systems (CMMS) - University of the Witwatersrand
c. Wits Mining Institute (WMI) - University of the Witwatersrand
d. Mining Resilience Research Centre (MRRC) – University of Pretoria
e. Centre of Excellence on Occupational Health and Safety (CoE) -Mine Health and Safety Council
f. Mining Research Impact Area (RIA) – CSIR

It must be noted that even though these institutions exist, funding to these institutions has led to insufficient critical mass in any one field, resulting in limited research capabilities and capacities. The South African mining industry is in dire need of a strong capacitated, vibrant and adequately resourced local mining RD&I community which will provide quality solutions to the industry to address socio-economic as well as technical challenges.

Due to limited funding, there is an erosion of research capability and capacity currently. This has resulted in a loss of confidence in the ability to develop new solutions that can benefit the industry. Resultantly, the RD&I plays a critical role in identifying what change management and leadership, re-skilling, training requirements, work planning, mine operation as well as relationships with supporting industries are needed when the fourth industrial systems are implemented.

2.3.2. Legacy of the past

The South African mining industry, unfortunately, has a dark history in terms of inequalities. For the implementation of the Fourth Industrial Revolution to be successful, a proper reconciliation with the past is needed. Mondi (2017) posits that despite the mining industry’s potential to transform the future of the economy, its dark history of injustice towards black workers cannot be overlooked. He also mentions that the industry failed to develop its own empowerment charters even though other sectors voluntarily initiated their own. The author also indicated that despite the commitment by the current democratic government to equity and redress, the patterns of accumulation and social relations in the mining industry have not changed substantially for most of the mineworkers.

For the successful implementation of the systems that will be prevalent in the Fourth Industrial Revolution, there should be inclusivity among all stakeholders to avoid a similar incident such as the horror of 2012 at Marikana, where employees were fighting for better wages and living conditions, but due to conflict, unfortunately lives were lost. The research will attempt to find solutions for the proper implementation of new technologies, allowing for better co-operation and harmony in the industry which stands to benefit the overall socio-economy of the country. This, in turn, will stimulate the economy and create more job opportunities.

2.4. Qualitative attributes or quantitative variables key to the research

Western Sydney University (2020, p1) defines research as "the creation of new knowledge and/or the use of existing knowledge in a new and creative way so as to generate new concepts, methodologies, and understandings." Tunnell (1977) expands this definition by describing the dimensions that are involved in research, and these are natural behaviour, natural setting, and natural treatment. Tunnell (1977) also mentions that "certain research problems preclude incorporating all three (3) dimensions in a single study, but investigations that have included all three (3) dimensions have accrued the three (3) benefits mentioned below:

a) novel empirical laws have been discovered,
b) the research has been made more credible to participants, thereby increasing internal validity, and lastly,
c) the research has gained greater external validity, which is a valuable asset in a discipline ostensibly concerned with real-world events."

Morgan, Gliner, and Harmon (1999, p. 217) suggest that "a research must be conducted and reported so that its logical argument can be carefully examined. It does not depend on surface plausibility or eloquence, status, or authority of its author; error is avoided; evidential testing and verification are valued; the dispassionate search for truth is valued over ideology." Every piece of research or evaluation, whether naturalistic, experimental, survey, or historical, must meet these standards to be considered disciplined ".

Research involves inductive and deductive methods. On the other hand, inductive research methods are used to analyse an observed event. On the other hand, deductive methods are used to verify the observed event. Inductive approaches are associated with qualitative research, and deductive approaches are more commonly used in quantitative research.

For the purpose of this research on assessing the pre-fourth industrial revolution educational and skills needs in the South African Platinum Mining Industry, quantitative research approaches will be employed.

In our research, the reason a quantitative method was utilised was to emphasise quantification in the collection and analysis of data that was collected via survey questions. Various contracts were made in terms of the variables that were going to be in our survey questions.

2.5. Framework(s) for interpreting research findings

The research dealt with the inevitable changes that are bound to happen soon in the platinum mining industry in terms of technology. This change will require the acquisition of a new set of skills and a change in the educational curriculum to produce workers and graduates that are fit for purpose. This will mean a radical change from the system of production that workers and industry have been accustomed to. Against this backdrop of radical change, the Theory of Change was used as the main framework for interpreting the research findings. Connell & Kubisch (1998) elucidate the theory of change as the theory of how and why an initiative works. They also elaborate that the theory of change is a systematic and cumulative study of the links between activities, outcomes, and context of the initiative.

The reason this theory was selected is because of the disruptive nature of technology that the Fourth Industrial Revolution will bring. From the literature review, it was mentioned that the Fourth Industrial Revolution is a new technology in rapidly evolving communications, robotics, and information storage and processing technologies. We saw that the mining industry is slow to react to advancements in technology because of the political economy the industry is hiding behind.

The research followed a quantitative methodology where numerical data was collected and analysed to describe, explain, predict, or control variables and phenomena of interest. (SAGE, 2016, p.108) state that "from a quantitative point of view, conclusions are drawn about the world and its phenomena cannot be considered meaningful unless they can be verified through direct observations and measurements".

The concept that facts and feelings can be separated and that the universe exists as a single reality made up of facts acquired through observations and other measures, was common among quantitative researchers ((SAGE, 2016). The aim of quantitative research studies is vastly different from the qualitative goal of gaining a better understanding of a situation or event (SAGE, 2016). Researchers use quantitative research studies to describe present circumstances, identify links between variables, and occasionally attempt to explain casual interactions between variables (SAGE, 2016).

The targeted participants were Sibanye Stillwater officials, educational institutions (University of the Witwatersrand, University of Johannesburg, and University of Pretoria School of Mines' students in their personnel capacity as academics). The data was analysed using the Statistical Product and Service Solutions (SPSS) analytic package, as well as Microsoft Excel in some instances, in order to produce statistical and graphical information. After the analysis and interpretation of data, conceptualisation and the theoretical work will be done. This may include refining research questions or if there is a need, further data collection will be done. A final report will then be generated. From the quantitative method perspective, immediately after the selection of the target audience, the collection of data as well as the administrative of research instruments are going to be done. The data will be processed and analysed thereafter. Findings and conclusions will be made in order to complete the study.

2.6. Summary and Conclusion

2.6.1. Summary of literature reviewed

The Fourth Industrial Revolution is a new technological revolution in the fast-growing field of digital technologies. While the platinum mining industry and most mining companies have been reluctant to implement these new technologies due to the industry being cost-sensitive and lacking the necessary skills and education needed to operate these technologies, safety concerns and low productivity in recent times are fuelling technological changes.

When implemented, the internet of things (IoT) in underground mines can provide effective communication and data collection technology to enable quick decision-making in the mining industry at various levels, both underground and on the surface. New skills development among workers and students is imperative for the Fourth Industrial Revolution. Moreover, an innovative culture is needed to stimulate creativity, which leads to employees being result-oriented.

The Fourth Industrial Revolution appeared to be the last significant evolutionary step industry would take with human operators, and that the complete development of artificial intelligence (AI) would revamp all attributes of life on earth. Furthermore, the South African mining R & D space is very fragmented compared to other countries. The literature shows that there is a need to reposition South Africa as the world leader in mining RD & I by developing human resources skills, capabilities and capacities across academia, industry, and the science councils to ensure its sustainability.

2.7. Research strategy, design, procedure and methods arising from the literature reviewed

Table 2-2: Proposed Research Strategy, design, procedure and methods arising from the literature reviewed

Phase/Stage	Description
Research Design	**Quantitative methods** was employed. **Cross-sectional** design was employed. Online survey technique was used to gather data and was relatively inexpensive and not very time consuming.
Data analysis	Data was analysed using SPSS computer package; this will also provide the statistical results.
	Primary results and findings as described in the introduction and method section of the study.

Results and discussions	I verified whether the results are consistent with the literature
	I verified whether the results are not consistent with the literature and this might indicate that there is some new information pertaining to the knowledge. In addition, a comparison of what I planned to do versus what other researchers did will be done and will also attest if this objective is achieved.
Discussion and conclusion	Recommendations were done for future work as well as guidance of what research could be done in future that conjoins with the gap analysis.

Source: (Bryman & Bell. 2011)

3 RESEARCH STRATEGY, DESIGN, PROCEDURE AND METHODS

3.1. Introduction

This chapter provides a detailed view of the research approach that was undertaken in the study. This chapter entails the procedures and methods, the respondent sample and their subsequent selection criteria, the ethical consideration for collecting data, as well as the information collection and processing phase. This chapter ends with the research strengths and weaknesses that had an impact on this research study.

3.2. Research Strategy

The study followed a quantitative research strategy approach, where the aim was to test the pre-determined hypotheses and produce general results. Data was collected and analysed using statistical methods, the results of which either confirmed or refuted the hypotheses of the relationship among the variables under study.

A research strategy introduces the main components of the research project as the research topic area and focus, the research perspective, research design, and research methods (Bryman & Bell, 2011). It refers to how one proposes to answer the research questions set and how the methodology will be implemented. The main strategy employed in this research was a phenomenological method. The reason the phenomenological method was employed was to attempt to describe any of the participant's experiences in this research in terms of perception and awareness in terms of the Fourth Industrial Revolution in the platinum mining industry. This method was mainly concerned with surveys to gather both quantitative and qualitative data.

3.2.1. Quantitative Survey

The core aim of conducting survey research is to describe the characteristics of a group or population (SAGE, 2016). The ability of online sites is to allow for the widespread and low-cost distribution of surveys as well as the organisation of responses. It needed to be appealing to the participants, which was achieved. Questions were not too long and were understandable for the targeted participants. These questions also need to accurately measure the issue under investigation. The opinions of the respondents assisted in getting a meaningful insight into the subject matter, and the data collected from the respondents as well as the analysis of the data assisted in ascertaining the patterns that helped in making better predictions.

The quantitative research methods used in this research assisted in the objective measurement and statistical, mathematical, and/or numerical analysis of data collected through questionnaires and surveys. The researcher focused on the gathering of numerical data and generalising it across groups of people to explain phenomena unearthed during the analysis of this research. The goal of conducting this type of research study method was to determine the relationship between the independent variable and dependent variables within the population of the researcher's study. A descriptive study design was used to establish the associations between variables.

The study dealt with numbers, logic and an objective stance. The data was gathered using structured research instruments and the results were based on sample sizes that were representative of the population.

3.3. Research Design

The research design was cross-sectional in nature. In a cross-sectional study, the researchers measured the outcome and the exposures of the study participants at the same time (National Centre for Biotechnology Information, 2016). This type of research study is often used in developmental psychology but can also be used in social science and educational studies. Although cross-sectional research does not involve conducting experiments, researchers often use it to understand outcomes in the physical and social sciences and many business industries.

3.3.1. Characteristics of cross-sectional studies

Bryman & Bell (2011) listed various characteristics of cross-sectional research design which are as follows:

a. **More than one case:** - researchers using a cross-sectional design are interested in the variation that only occurs when more than one (1) case is being investigated. Normally, researchers will choose more than two (2) cases as they are more likely to find variation in all the variables, they are all interested, finer distinctions can be made between cases, and proper sampling procedures require larger numbers.
b. **At a single point in time:** - data on the variables is collected more or less simultaneously.
c. **Quantitative or quantifiable data: -** in order to establish variation between cases and then to examine associations between the variables, it is essential to have a systematic and standardised method for gauging variation.
d. **Patterns and association: -** with cross-sectional design, it is only possible to examine relationships between variables, not causality, because the researcher cannot manipulate any of the variables. This normally causes issues with establishing the direction of causal influence. If the researcher discovers a relationship between two variables, he or she cannot be certain whether this indicates a causal relationship because the features of an experimental design are not present.

The data collected in a cross-sectional study includes participants that are similar in all variables except the one that is under review. The cross-sectional study was conducted to understand how people from the mines, e.g., employees, executives, managers, organised labour, academics and the communities around the mines, respond to the imminent change of the Fourth Industrial Revolution.

3.3.2. Benefits of cross-sectional design method to the research:

a. It was relatively quick to conduct and due to the time constraints, that I have experienced, there was not enough time to collect data. This will therefore be great for my research.
b. It allowed me to collect all variables at once through questionnaires.

3.4. Research procedure and methods

This section documents the actual procedure and the methods employed in this research to collect, collate, process, and analyse empirical evidence. Broadly explained, to detail the data and information collection instruments (Section 3.3.1), the target population and sampling of respondents (Section 3.3.2), the ethical considerations during the research process (Section 3.3.3), the data and information collection process and storage (Section 3.3.4), data and information processing and analysis (Section 3.3.5), as well as research strengths, reliability and validity measures applied (Section 3.3.6).

3.5. Research data and information collection instrument(s)

Research data and information collection is an important step in a research process. Based on the literature review, the research instruments that were used were questionnaires and surveys. The research data collection started with self-completion questionnaires. Bryman et al. (2011) mentioned that there is a distinction between self-completion questionnaires and structured interviews. As a result, self-completion questionnaires as compared to structured interviews tend to:

- have fewer open questions since closed questions are easier to answer.
- have easy-to-follow designs to minimise the risk that the respondent will fail to follow filter questions or will inadvertently leave out a question.
- be shorter, to reduce the risk or ‘respondent fatigue ’and the questionnaire end up in a waste paper bin.

There are advantages and disadvantages to self-completion questionnaires, and they will be listed in *Table 3-1*, below:

Table 3-1: Advantages and disadvantages of self-completion questionnaires

Advantages	Disadvantages
a. Cheaper to administer	b. Cannot prompt
c. Quicker to administer	d. Cannot probe
e. Absence of interviewer effects	f. Difficulty of asking other kinds of questions
g. No interviewer variability	h. Do-not-know who answers
i. Convenience for respondents	j. Difficult to ask a lot of questions
	k. Not appropriate for some kinds of respondent
	l. Greater risk of missing data
	m. Lower response rates

Source: Bryman et al. (2011).

3.6. Research target population and selection of respondents

3.6.1. Research Target Population

The target population is "the entire aggregation of respondents that meet the designated set of criteria" (Unisa, 1997, p. 31). A sample is a group of people who take part in the investigation. The target population of the research was mining officials at Sibanye Stillwater and academics from the school of mining at Wits University, in their personal capacity.

a. **Inclusion Criteria**: according to Unisa (1997, p.32), inclusion criteria are "the characteristics we want those in our sample to possess." The respondents chosen were all adult participants working at various platinum mines across the country who are well versed in English, the language the researcher is well conversant with. The respondents were chosen due to their being at supervisory level as well as having a minimum mining qualification to be able to understand and appreciate the types of questions asked in the questionnaire.

b. **Exclusion Criteria:** Unisa (1997, p.32) defines exclusion criteria as "characteristics that a participant may possess that could adversely affect the accuracy of the results." In this research, participants in lower job categories and those who did not possess any formal trade or tertiary education were excluded because the researcher felt that due to their background, they would not have been able to answer all the questions, or they might have distorted the response the researcher needed in order to do a proper analysis of the results.

3.6.2. Sampling or Selecting Respondents from the target population

For the purpose of research, a sample is a group of people, objects, or items that are taken from a larger population for measurement. The sample should be representative of the population to ensure that the researcher can generalise the findings from the research sample to the population. The type of sampling that was used is both purposive and snowball sampling. Purposive sampling is defined by Tongco (2007), as a non-random technique that involves the deliberate selection of a key informant due to the expertise on the issue under study that the informant possesses. These were identified through the researcher`s existing contacts at Sibanye Stillwater and the University of the Witwatersrand, the University of Johannesburg and the University of Pretoria. Snowball or chain referral sampling were informants and previous respondents refer a researcher to their social circle which has other potential respondents (Berg, 1988).

According to Alchemer (2018), **purposive sampling**, which is also referred to as judgemental sampling, selective or subjective sampling, is a type of non-probability sampling in which researchers rely on their own judgement when choosing members of the population to participate in their study. I have prior knowledge of the South African platinum mines and also work for Sibanye Stillwater, and this makes it easy for me to properly choose and approach eligible participants in my study. The eligible participants were people at the supervisory level and higher. The reason why this sampling method was chosen is that the study aimed to interview industry experts and students in the platinum mining industry. The method that I used when conducting the sampling involved rejecting individuals that did not fit the set profile when creating the sample. The technique that was used was the maximum variation technique, because it allowed me to examine a diverse range of cases that were relevant to my study of the Fourth Industrial Revolution.

Glenn (2015) defined **snowball sampling** as a phenomenon where research participants recruit other participants for a test or study. Key informants in the platinum mining industry were engaged to recommend other individuals that fit the profile needed for the study. This type of sampling assisted in finding other participants that were rather difficult to reach. Snowballing also assisted in discovering characteristics about the participants that were deemed not to exist. This assisted me in determining the level of knowledge the participants had with regards to the skills that are needed for the Fourth Industrial Revolution. The only negative aspect of this sampling method is that it did not allow me to determine the sampling error or make inferences about the population based on the gathered sample.

3.7. Ethical considerations when collecting research data

According to the World Health Organisation (2021), research ethics governs the standard of conduct for scientific researchers. To protect the dignity, rights, and welfare of research participants, it is critical to follow ethical principles. As such, all research involving human beings should be reviewed by an ethics committee to ensure that the appropriate ethical standards are being upheld (World Health Organisation, 2021).
The researcher conducted the research as a partial fulfilment for the degree of Master of Business Administration with the Faculty of Commerce, Law, and Management at the University of Witwatersrand.

For survey questionnaires, agreeing to complete the survey was a proof of consent and that was included in the survey instructions. Participants were formally informed of the aim of the study without any deception. They were also assured that their identities were going to be protected as they would remain anonymous. This was ensured through the use of general titles like respondent 1, and even avoiding using their designated titles like CEO, which could be traced back to the person. This also helped to ensure confidentiality. They were also informed that they were allowed not to respond to questions that they did not feel comfortable responding to. All the information was stored, saved, and accessed through a password known only to the researcher.

3.8. Research data and information collection process and storage

The method used to collect data was through a structured online survey questionnaire. The main reason for using this method was to understand the general characteristics or opinions of the respondents for the purpose of this study. Sukamolson (2007) describes survey questionnaire research as the one (1) that uses scientific, sampling, and questionnaire design to measure characteristics of the population with statistical precision. This survey research assisted me in making comparisons between the variables in this study and applying the results to the entire population with some degree of certainty. The key respondents were purposively sampled and the referrals were snowball sampled. The respondents used self-administered questionnaires where they completed the questionnaires by themselves, and these questionnaires were distributed via *Qualtrics XM* online survey software. This was done to get information from an array of people who were working in the platinum mines regarding their perceptions how they felt about the Fourth Industrial Revolution. The other reason these models were chosen is as follows:

3.8.1. Logistics:

- **Costs:** the cost involved in conducting interviews with Sibanye Stillwater employees and experts was minimal due to me being an employee. In terms of online surveys, I used the Qualtics XM application. The reason for this is me having access to a computer and the internet and that it is free to register and set up the online questionnaires

- **Time available:** although there was limited time to conduct this research, in terms of the research design everything was in order. The permission of participants in this research was not an issue as they were interviewed in their personal capacity and gave consent to take part in this research.
- **Staffing:** the work was primarily done by the researcher.
- **Access to participant:** most people that were part of this research were accessible, as they were contacted via email and various multimedia applications. However, their response was very poor.

3.8.2. Sampling

Convenience sampling was used, which is "sampling that is simply available to the researcher by virtue of its accessibility" (Bryman et al, 2011, p.178). Even though convenience sampling was employed, probability sampling was used as a guide for sample size calculation. According to the probability sampling formula, to find the appropriate sample size, the confidence level was adopted to be 95% (Z), the sampling error was to be no greater than 5% (E), and a 90% chance of success was estimated (P). The sample size for this study was predicted to be 100, but due to slow responses and little time available for data collection, only 30 people responded. The population under consideration will be from Sibanye Stillwater as well as current and recently graduated mining students. During the data analysis, bootstrapping was done in order to replicate the sample size by 1000 times.

3.8.3. Self-completing questionnaire

A self-completing questionnaire is a research method where participants answer questions by completing the questionnaire by themselves, without the presence of the interviewer in asking these questions (Bryman & Bell, 2011) this method was chosen because:

i. Questionnaires can be distributed to a large audience within a short period of time.
ii. Respondents do not feel pressured to complete the answers, and if they do not take part in the research, they will not be penalised.

iii. It must be noted that this method also has its downfalls, which include the interviewer having a challenge in probing the respondent, and the questionnaire must not have many questions; otherwise, the respondents will be agitated and will not take part in the research.

iv. The study was conducted by the researcher during the period of March 15, 2021, and April 15, 2021 (30 days). The questionnaire was sent to 100 participants, however, only 30 responded. Three (3) responses were disqualified as it did not have enough data for it to be used in the research. Therefore, 27 responses were accepted and analyzed for the purpose of this research.

3.8.4. Questionnaire Design

The questionnaire was designed to collect primary data to evaluate current employees and university students' understanding, awareness, and perception of the Fourth Industrial Revolution (See Apendix1). The questionnaire intends to answer the proposed research questions with a total of 15 closed questions, which were based on the literature review in chapter 2.

The questionnaire has four (4) sections. The detailed description and the purpose of the questions with the concept used to design the questionnaire are displayed in *Table 3-2* below.

Table 3-2: Survey Questionnaire Concept and Purpose

Section A: Demographics			
No.	**Concept**	**Question**	**Purpose**
1	Demographic Information	What is your gender?	To describe the demographic characteristics of the sample population
2		Which age category do you fall under?	
3		What job category do you fall under	
4		What is your highest level of education?	

5		What organisation do you belong to?	
6		If the answer was "other" in question 5, please specify	
Section B: Organisational Information			
No.	**Concept**	**Question**	**Purpose**
7	Organisational Fourth Industrial Revolution Technology Readiness	How many people work in your organisation? (Including both full-time and part-time but excluding contactors)	To ascertain the size of the organisation, which will help in evaluating the time it will take to implement the Fourth Industrial Revolution technologies.
8		At what technological stage is your organisation currently?	To find out if employees and students are conversant with different industrial revolutions.
9		What Fourth Industrial Revolution technologies are currently used and will be available in future for the platinum mining industry	To identify respondents' level of understanding with regard to different Fourth Industrial Revolution technologies that are currently available.
Section C: Respondents Attitude/satisfaction and Insecurities			
Stakeholder Engagement			
No	**Concept**	**Question**	**Purpose**
10	Level of engagement needed by academics, mining corporates and government in order to develop the curriculum needed for Fourth	What level of engagement is required by educational institutions, the mining corporates, and the government in order to develop the curriculum needed for the Fourth Industrial Revolution (4IR Technology)?	To assess stakeholder engagement for the implementation of the fourth industrial revolution in the South African mining Industry

No	Concept	Question	Purpose
	Industrial Revolution in the South African Platinum Industry		
Skills and Educational Requirements (Likert Scale)			
No	**Concept**	**Question**	**Purpose**
11	Skills and educational requirements that will empower current and future employees for the Fourth Industrial Revolution technologies	IT Infrastructure	To measure the relationship between various technologies with regard to skills and educational requirements.
		Automation technology	
		Data analytics	
		Data security/Communication security	
		Development of applications of assistance systems	
		Collaborative software	
		Non-technical skills such as systems thinking and process understanding	
AI software/application in the organisation (Likert Scale)			
No	**Concept**	**Question**	**Purpose**
12	Fourth Industrial Revolution Technologies in the Organisation	Using AI/Software/Application in my organisation is a good idea	To measure respondents' attitude towards the Fourth Industrial Revolution technologies
		Using AI/Software/Application in my department is beneficial to the organisation	
		Using AI/Software/Application in my department is always enjoyable	
Implementation of AI/Software/Applications (Likert Scale)			
No	**Concept**	**Question**	**Purpose**
13	Job Security when Fourth Industrial Revolution Technologies are implemented.	I am confident that I will be able to keep my job despite the implementation of AI/Software/Applications	To measure respondents' opinions and feelings towards the implementation of AI/Software/Applications by the organisation.
		I think that I will be able to continue working in the	

		organisation despite increase in the use of AI/Software/Application	
		I fear that I will be redundant due to the increase in the use of AI/Software/Applications	
		I worry about the continuation of my career due to the use of AI/Software/Application	
Section D: Strategic Intention/Alignment of the Organisation/Innovative Culture			
Organisational Culture on Employee Productivity when Fourth Industrial Revolution Technological Skills and Knowledge are implemented. (Likert Scale)			
No	**Concept**	**Question**	**Purpose**
14	Skills and knowledge of Fourth Industrial Revolution Technologies	Learning to operate AI/Software/Applications would be easy for employees	To measure respondents' attitude towards organisational culture on productivity when Fourth Industrial Revolution technologies are introduced in the organisation.
		Employee interaction with AI/Software/Applications would be clear and understandable	
		Employees will find AI/Software/Applications easy to use	
Innovation (Linkert Scale)			
No	**Concept**	**Question**	**Purpose**
15	Stimulation of new ideas and innovation in the organisation	The application of AI Software help employees to come up with new ideas	To measure innovative culture of the organisation through employees and students

Source: *Sasivongpakdi & Wang (2014)*

3.9. Research Data and Information Processing and Analysis

3.9.1. Types of Variables

A quantitative survey was conducted for data collection. SPSS software was used as the main tool for data analysis. The questions in the questionnaire were pre-coded and represented different variables for the study. According to (Bryman & Bell (2011) there are five (5) main types of variables that are generated during research.

a. **Dichotomous variables:** these contain data that has only two (2) categories (Bryman & Bell, 2011, p.313). Among the survey questions, question 1 (gender) is a form of dichotomous variable. It must be noted that gender can also be a nominal variable.
b. **Nominal variables:** these are also known as categorical variables and "comprises categories that cannot be rank-ordered" (Bryman et al., 2011, p.313). The survey questions 3 to 6, questions 8 and 9 about age, job category, level of education, organisation, technological stage of the organisation, as well as Fourth Industrial Revolution technologies, belong to the category of nominal variables.
c. **Ordinal variables**: these "contain that which can be ranked ordered, based on some order of magnitude, but distances between categories are not equal" (Bryman & Bell, 2011, p.313). In the questionnaire, questions 2 and 7 about the number of people employed in an organisation and question 10 about the level of engagement required by various stakeholders within the mining industry with respect to the curriculum needed for the Fourth Industrial Revolution, fall into the category of ordinary categories.
d. **Interval/ratio variables:** these have "identical distances between the categories" (Bryman & Bell, 2011, p.313). Many scholars argue that these variables can be treated like interval or ratio variables, because of the relatively large number of categories they generate (Bryman & Bell, 2011, p.313). In the questionnaire, questions 11 to 15, which were designed with Likert scales, are considered interval/ratio variables for data analysis.

3.10. Research Data and Information Analysis

For this study, narrative and discourse analysis were used. The research followed a mixed approach where interviews and online surveys were used. Opinions shared by people that are working in or involved in the platinum mining industry helped me to find the answers to the research questions. For discourse analysis, the study attempted to determine the mood and feelings of people working in the mines with respect to the implementation of modern technology in the mining industry. The study sought to find out the perceptions people have with regards to job security as well as upskilling when these technologies are implemented.

3.11. Data Analysis in Quantitative Research

a. Univariate Analysis

Univariate analysis refers to the analysis of one variable at a time (Bryman & Bell, 2011, p.313). Frequency tables are commonly used in univariate analysis because they "provide the count and the percentage belonging to each of the categories for any type of variable" (Bryman & Bell, 2011, p.313). Frequency tables were used to analyse ordinal variables in this thesis. In addition, diagrams like "bar charts, pie charts, and histograms are frequently used to display quantitative data because they are easy to interpret and understand" (Bryman & Bell, 2011, p.313). For nominal and ordinal variables, pie charts as well as bar charts were used when displaying the results. For interval and ratio variables, histograms were employed. In data analysis, SPSS software was used to conduct univariate analysis in order to produce descriptive statistics measuring central tendency, i.e., the arithmetic mean, the median, and the mode. Univariate analysis was used to analyse questions 1 to 10 of the questionnaire.

b. Bivariate Analysis and Multivariate Analysis

Bivariate analysis is concerned with "analysing two (2) variables at a time in order to uncover whether or not they are related" (Bryman et al., 2011, p.320). This group of statistical techniques is called correlation analysis and simple regression analysis, which can be used with interval and ordinal level variables

(Sasivongpakdi & Wang, 2014, p.16). The use of the correct technique depends on the nature of the two (2) variables being analysed by Byron et al. (2011). These are:

a. **Pearson's correlation coefficient (r)** is used to analyse the relationship between two (2) interval or ratio variables.
b. **Spearman's rho (ρ)** is used to analyse the relationship between ordinal variables, or when one (1) variable is ordinal and the other is an interval or ratio variable.
c. **The phi coefficient (ϕ)** is used to analyze the relationship between two (2) dichotomous variables.

It must be noted that these only indicate the strength of the relationship rather than the cause-and-effect relationship. Wang and Sasivongpakdi (2014). This thesis uses Pearson's correlation coefficient and Spearman's rho to analyse ordinal and interval/ratio variables. Lastly, multivariate analysis scrutinises more than two (2) variables (one dependent variable and several independent variables). The result from this analysis was used to explain the strength of the relationship, which is similar to a simple regression analysis.

c. Description of the research respondents

There were 30 respondents who participated in the study. Three (3) respondents were disqualified, the reasons for which will be discussed in chapter 4. Valid respondents comprised of 19 males and 8 females. The participants consisted of people in various job categories, but these were mainly from supervisory level up to senior management level, including university students. Sibanye Stillwater employees made up a huge portion of the respondents. Post-graduate qualifications were the highest level of education, while high school or lower qualifications were the least common level of education among respondents.

Data was collected through an online questionnaire survey using the QualtricsXM software. After the data was collected, the respondents' answers were downloaded to the Microsoft Excel package, where each and every variable was coded accordingly. Data validation was checked in the

QualtricsXM program where it gave the location where the questionnaire was completed. These locations were checked using Google maps and they were shown to be the correct locations, i.e., most of them were done at various company sites. The respondents were given the option to decide whether they wanted to participate in the research or not, by clicking the consent checkbox in the questionnaire. Unfortunately, not all respondents answered all the questions, and those that were not completed were disqualified.

There are various considerations in research data analysis, and I ensured that:

a. A basic understanding of the rationale for selecting one statistical method over the other to obtain better data insights was applied.
b. Statistical advice was sought at the beginning of the analysis, which assisted in designing a survey questionnaire, selecting data collection methods, as well as choosing the samples that were needed.
c. Statistical errors were avoided and a way to deal with everyday challenges like missing data, outliers, data altering, data mining, or developing graphical representation was employed.

3.12. Research Strengths—Reliability and Validity Measures Applied

3.12.1. Reliability

Reliability "*refers to the consistency of a measure of a concept which is concerned with quantitative research*" (Sasivongpakdi & Wang, 2014, p.17). There are three (3) main issues with regard to reliability, and these are:

a) **Stability:** stability of measurement over time.
b) **Internal reliability:** consistence of indicators and
c) **Inter-observer consistency**: relates to observations.

According to the research questions and research approach, internal reliability is the only issue of focus. Internal reliability refers to the way respondent's scores for one indicator in relation to the score of another indicator. This applies to multiple-indicator measures. To ensure internal reliability for this thesis, reverse coded questions were adopted in question 13 of the questionnaire. To further strengthen internal reliability, statistical calculation

“Cronbach’s Alpha” is used to confirm the reliability of the data in which the value of 0.7 or more denotes an acceptable score.

3.12.2. Validity

Validity "*refers to the issue of whether an indicator being used can really measure the concept or not*" (Sasivongpakdi & Wang, 2014, p.17). For this research study two (2) issues of validity will be used, namely,

a) **Internal validity,** which is "*concerned with whether the evidence presented justifies the claims of cause and effect*" (Sasivongpakdi & Wang, 2014, p.17). Multiple regression and simple regression are adopted in data analysis to check for internal validity.
a) **External validity:** "*refers to whether the findings can be generalised to the whole population or not*" (Sasivongpakdi & Wang, 2014, p.17). This issue focused on whether the sample is large enough to draw a conclusion for the whole population or not. Due to the timeframe, a low response from the participants was inevitable. A 30% rule was adopted for the determination of the sample size. It was anticipated that only 100 people (population) would respond to the questionnaire, and the required sample size was to be 30 participants.

3.13. Research Weaknesses—Technical and administrative limitations

i. The technical limitation of this thesis due to the quantitative research strategy used did not have the desired number of participants due to the time constraints as well as the level of response that was desired. As mentioned earlier, only 30 responses were recorded, and the target response was 70–100 responses.
ii. The researcher has limited experience in the data collection process, but the data was collected using the correct approach, i.e., self-completing questionnaires and the software used was the Qualtrics XM programme.
iii. Sample size - the anticipated target population was compromised by the time factor and the limitations imposed by COVID-19 on work and

life in general. However, the researcher made attempts to send a lot of surveys and speak to a lot of officials and students in the period of the data collection.

iv. Due to the nature of the research, further studies are needed to devise more comprehensive solutions to the skills and educational needs of the Fourth Industrial Revolution in the South African platinum mines.

4. PRESENTATION OF RESEARCH RESULTS

4.1. Introduction

This section gives an overview of the data collected using the Qualtrics Online Questionnaire Software and the findings of the survey conducted by SPSS software.

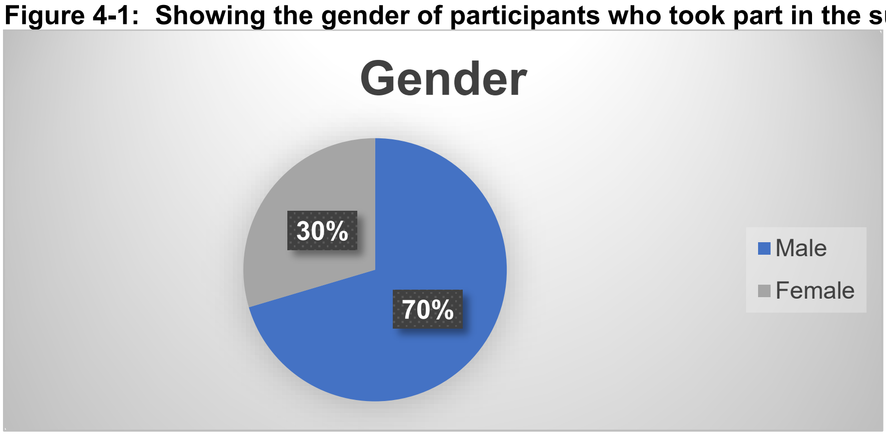
4.2. Descriptive Statistics

This section gives an overview of the descriptive statistics of the demographic characteristics of the respondents from Section A of the questionnaire. A total of 30 questionnaires were submitted, of which 3 were disqualified. The disqualified surveys were either not fully completed or did not match the properties of the targeted population (mining professionals). For the remaining 27 respondents, some of their responses were partially missing, and SPSS was used to transform some of those missing responses using the sample mean calculation. Thus, a total of 27 responses have been taken into consideration for the analysis. It was imperative to review the gender of the participants as part of the demographic analysis of the study.

4.2.1. Gender

In terms of gender, 70.4% comprised of males and 29.6% comprised of females. It must be noted that, males were coded as 1 and females as 2 in SPSS. See *Figure 4-1*, below.

Figure 4-1: Showing the gender of participants who took part in the survey



Source: (Based on Online Surveys, 2021)

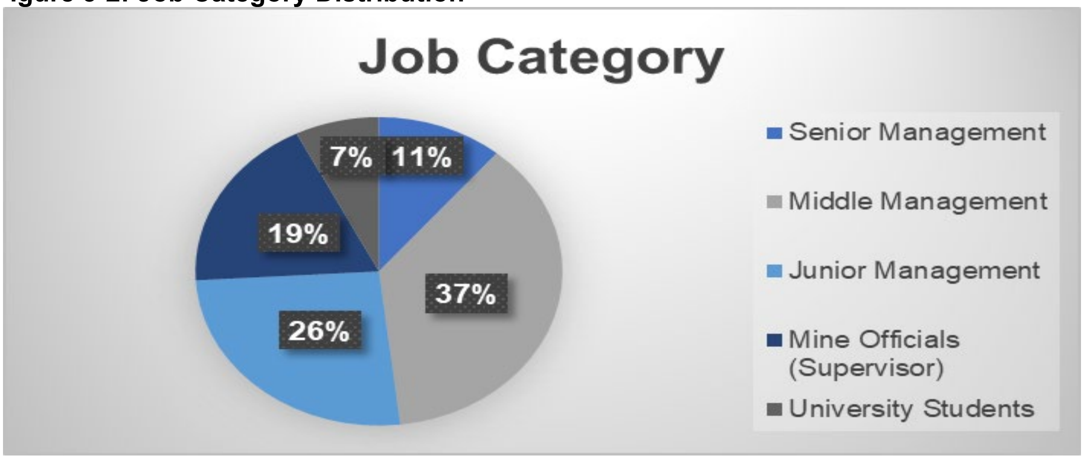
More males seem to be involved in the mining industry, which means they are more affected by the Fourth Industrial Revolution In comparison to females. It was logical that we also look at the job categories of these participants.

4.2.2. Job Category

In terms of job category, the questionnaire had five (5) different options to choose from namely university students, mine officials (supervisors), junior management, middle management and senior management. University students comprised 7.4% of the respondents. Mine officials (supervisors) made up 18.5% of the data. Junior management made up 25.9% of the data. Middle management comprised 37.0% and, lastly, senior management comprised 11.1% of the data. See *Figure 4-2*, below.

Figure 3-1: Job Category Distribution

Figure 3-2: Job Category Distribution



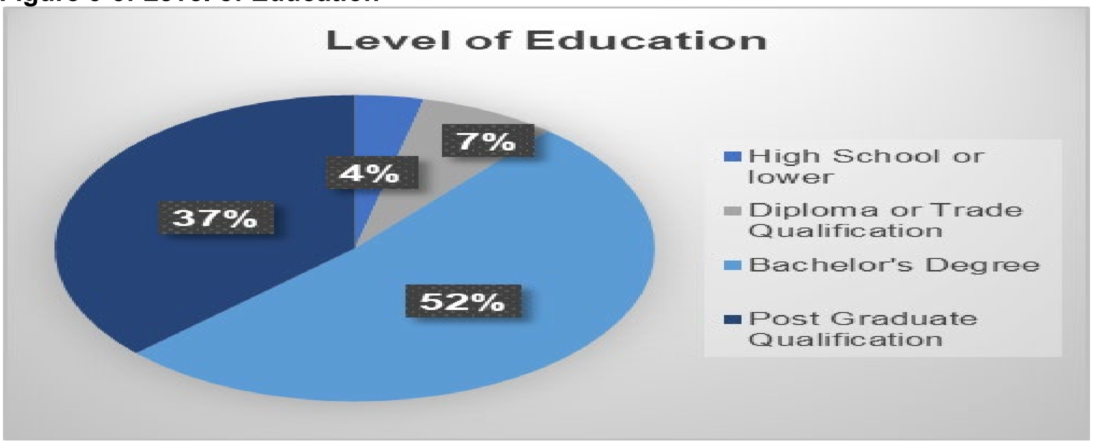
Source: (Based on Online Surveys)

Apart from the existing job categories, the level of education was deemed essential to inform this study.

4.2.3. Level of Education

The current skills and educational background will give an organisation some insight into which population group to target first in terms of re-skilling for the implementation of the Fourth Industrial Revolution technologies. It must be noted that the target population was mine officials up to the level of senior management, including university students. The lower-tier employees (general workers) were omitted from the research due to their lack of understanding in terms of technological advances in the industry.

Figure 3-3: Level of Education



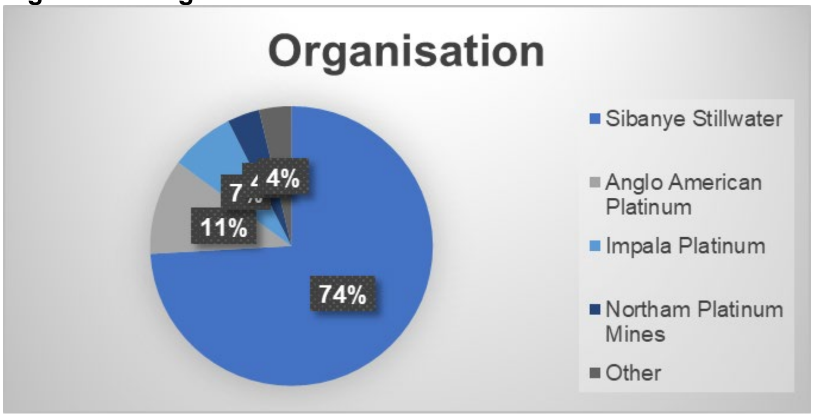
Source: (Based on Online Surveys)

Respondents with high school or lower qualifications within this group comprised 3.7% of the sample data. People with a diploma or trade qualification made up 7.4% of the sample, people with a bachelor's degree comprised 51.9%, and people holding post-graduate qualifications comprised 37.0% of the sample. In addition to the level of education, it was essential to see the distribution of the sample across the organisations they were affiliated with.

4.2.4. Organisation

In terms of organisational affiliation, 74.1% of the respondents belonged to Sibanye Stillwater, 11.1% to Anglo American Platinum, 7.4% to Impala Platinum, and 3.7% to Northam Platinum Mines. The remainder (3.7%) belonged to other platinum companies not listed above. The frequency tables as well as frequency graphs of the demographic information of respondents (Question 1, 3, 4, and 5) are available in *Appendix 2.4*.

Figure 3-4: Organisational Affiliation



(Source: Online Questionnaire)

As can be seen in the foregoing the participants were from various companies. It was interesting to find out how they answered most of the survey questions that had number ordering on the Likert scale. Reliability is the degree to which a research method produces stable and consistent results, The reliability test using Cronbach's Alpha was essential in determining this consistency.

4.3. Reliability test

A reliability test is adopted because Section C and Section D of the questionnaire use multi-item (multi-dimensional) scales to measure the relationship between various Fourth Industrial Revolution technologies that are set to be implemented, to measure the participant's attitude towards these imminent technologies, and to measure the respondent's attitude towards the organisational culture when these technologies are implemented, as well as the innovative culture of the organisation. The test uses Cronbach's Alpha to measure the consistency of the answers among these different indicators. It must be noted that the last two (2) questions of Question 13:

"I fear that I will be redundant due to the increase in the use of AI/Software/Applications" and "I worry about the continuation of my career due to the use of AI/Software/Applications" were reverse coded as they had negative statements about job security when these technologies are implemented.

As mentioned before in Chapter 3, under the reliability section, for internal consistency, Cronbach's Alpha value of 0,7 or more means an acceptable score. SPSS was used to run this test and detailed results are presented in Appendix 2.4. *Table 4-1* below shows the summarised Cronbach's Alpha values for Section C and Section D of the questionnaire.

Table 4-3: Cronbach's Alpha for reliability Test

	Valid	Excluded	Total	Cronbach's Alpha	N of items
Question 11	27	0	27	**0,911**	7
Question 12	27	0	27	**0,792**	3
Question 13	27	0	27	**0,864**	4
Question 14	27	0	27	**0,969**	3
Question 15	**27**	**0**	**27**	**0,924**	**2**

Source: (Based on on- surveys, 2021)

According to **Table 4-1 above**, the results of Cronbach's Alpha for question 11 is 0.911; question 12 is 0.792; question 13 is 0.862; question 14 is 0.969; and question 15 is 0,924. These multi-item questions have passed the reliability test and can be used for analysis when determining relationships. Question 10, on the other hand, was not tested for reliability as it only possessed a one-item scale.

4.4. Organisational Readiness and Stakeholder Engagement

To answer the research question, the answers from the respondents to questions numbers 7, 8, and 9 indicate the following: the number of people working in the organisation, the technological stage of the organisation, and the Fourth Industrial Revolution technologies that are currently being employed and those that are likely to be used in the future. Referring to the literature, Lamprini & Bröchle (2018) argued that "in this new challenging era, experts are calling for leaders and citizens to stand together and shape a future that works for all by putting people first, empowering them and constantly reminding ourselves that all of these new technologies are first and foremost tools made by people for people". A hypothesis test was done to determine whether an association exists between stakeholder engagement and organisational readiness.

When comparing stakeholder engagement (Question 10) and organisational readiness (Question 7,8, and 9), multiple regression from the SPSS program is applied to engagement (dependent variable) and the number of people in the organisation, the technological stage of the organisation and various technologies that are envisaged to be utilised in the industry.

According to Table 4-2, "Descriptive Statistics," there were 24 samples included in this group. The mean score respondents rated for stakeholder engagement is 4.73, which is on the Likert scale of high and very high, number of people in a particular organisation's average score on the Likert scale was rated at 2.46 which is between 4 000 and 8 000 people. The mean score on the technological stage scored by the participants on the Likert scale is 2,33 which fell between second and third industrial revolution.

Table 4-4: Descriptive Statistics of Stakeholder Engagement and Organisational Readiness Multi-regression

Descriptive Statistics			
	Mean	Std. Deviation	N
SMEAN (Engagement)	4.729	.4356	24
Amount of People in the Organisation	2.46	1.382	24
Type of Industrial Revolution	2.33	1.167	24
Internet of things (IoT)	1.25	.897	24
Sensor technology	.88	.797	24
Mobile technologies	1.17	.816	24
Radio-frequency identification (RFID)	.79	.721	24
Real-time location system	1.04	.908	24
Big data	1.00	.978	24
Cloud technology	1.13	.900	24
Embedded IT systems	.88	.850	24
Machine to machine communication	1.21	.721	24

3-D printing	1.13	.992	24
Machine learning	1.04	.908	24
Artificial Intelligence (AI) Robotics & Automation	1.42	.881	24

Source: (Based on Online surveys, 2021)

According to the Likert scale of the various Fourth Industrial Revolution technologies, the mean scores on the Likert scale of IoT were 1.25, which is between current use and probable future use. Sensor technology came up at 0.88, which is close to one, meaning that most participants felt that it was current use. Mobile technologies were 1.17, which fell between current and probable future use. RFID was considered current use due to the mean score of 0.79, and real-time location systems, as well as big data and embedded IT systems, were also scored as being in current use. Cloud technology, machine-to-machine communication, 3-D printing, machine learning, and artificial intelligence (AI) were deemed to be prevalent in the current state and have the prospect of being used in the future. Looking at the coefficients (Table 6) below, the significance (sig) value is the number that is used to show whether independent variables can either infer the dependent variable or not.

If the significance (p-value) is below 0.05, it means that these independent variables can predict or explain the dependent variable, in this case, engagement can be explained by the amount of people in the organisation, technological stage of the organisation and various technologies that are envisaged to be utilised in the industry. From the table, it appeared that only RFID and AI appeared to be able to predict stakeholder engagement i.e., their p-values were smaller than 0.05. All other variables were greater than 0.05 which meant that they will not be able to predict stakeholder engagement. The model that will be used will be given by the following equation:

y= a + b1x1 + b2x2 + b3x3 + ... + bnxn

There are a few assumptions that must be made in order to accept our model, and these are discussed below.

Table 4-5: Multi-regression Analysis of Stakeholder Engagement and Organisational Readiness

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	4.770	.420		11.349	.000		
	Amount of People in the Organisation	.034	.081	.108	.421	.683	.366	2.731
	Type of Industrial Revolution	-.192	.073	-.515	-2.643	.027	.633	1.580
	Internet of things (IoT)	-.065	.143	-.133	-.451	.663	.275	3.634
	Sensor technology	-.183	.297	-.335	-.614	.554	.081	12.351
	Mobile technologies	.277	.197	.519	1.401	.195	.175	5.707
	Radio-frequency identification (RFID)	-.538	.209	-.891	-2.580	.030	.201	4.972
	Real-time location system	.047	.125	.097	.373	.718	.355	2.821
	Big data	.046	.125	.104	.371	.719	.303	3.300
	Cloud technology	-.095	.161	-.195	-.588	.571	.217	4.598
	Embedded IT systems	.186	.190	.364	.983	.351	.175	5.703
	Machine to machine communication	-.078	.165	-.130	-.474	.647	.320	3.122
	3-D printing	.025	.168	.057	.150	.884	.165	6.070
	Machine learning	.090	.200	.187	.448	.665	.138	7.251
	Artificial Intelligence (AI) Robotics & Automation	.345	.152	.698	2.280	.049	.256	3.911

a. Dependent Variable: SMEAN(Engagement)

Source :(Based on Online Surveys, 2021)

a. **Linear relationship:** the model is roughly linear in nature, but as seen in our scatter plot only two (2) explanatory variables have a linear relationship with our dependent variable. i.e., RFID and AI.
b. **F:** The F-value is within normal limits
c. **Parsimony:** The value of R^2 and Adjusted R^2 are in close proximity with one another.
d. **Autocorrelation:** Check the Durbin-Watson value to be between 2-4
e. **Multi-correlation**: Check the condition index to be below 100.
f. **Endogeneity**: Analyse correlations output table (no variables above 0,9 and inter-dependent)
g. **Collinearity**: Check the variance of inflation VIF is below10
h. **Normality**: Analyse histogram and normal curve
i. **Heteroscedasticity**: Check if the observation and the regression best fit line seem to coincide.

Most of the conditions above were met, and the model was accepted. According to the findings, multi-regression providing RFID and AI as independent variables and stakeholder engagement as an independent variable is adopted to find "R" and the "Adjusted R2".

Figure 3-5: Model Summary of Multi-regression between Stakeholder Engagement and Organisational Readiness

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.885[a]	.784	.448	.3236	1.948

a. Predictors: (Constant), Artificial Intelligence (AI) Robotics & Automation, Real-time location system, Type of Industrial Revolution, Internet of things (IoT), Amount of People in the Organisation, Machine to machine communication, Mobile technologies, Cloud technology, 3-D printing, Big data, Machine learning, Embedded IT systems, Radio-frequency identification (RFID), Sensor technology

b. Dependent Variable: SMEAN(Engagement)

Source: (Based on Online Surveys, 2021)

Under Figure 4-5, above, "R" is utilised as an indicator for the strength of the relationship between independent variables (RFID and AI) and the dependent variable (stakeholder engagement). The strength of the relationship among these variables can be classified as strong when "R" is equal to between 1 and 0.7; a moderate relationship if "R" is between 0,6 and 0,4; and weak when "R" is between 0.3 and 0. It must be noted that "Adjusted R2" explains how many percentage of changes in the dependent variable (stakeholder engagement) can be explained by the independent variables (RFID and AI). From the findings in the model summary above, "R" is 0.885, which indicates that there is a strong relationship between stakeholder engagement and RFID with AI. The "Adjusted R2" score of 0.448 tells us that roughly 45% of the variance in stakeholder engagement can be explained by RFID and AI.

We therefore accept the null hypothesis, but further discussion will be provided in Chapter 5.

4.5. Skills Requirements, Job Security and Organisational Culture

To answer this particular research question the answers from the participants were broken down into the types of technologies envisaged to be implemented in the industry (Q11), job security (Q12 and Q13) and organisational culture (Q14 and Q15). The idea is to verify the association of technologies against job security and organisational culture, which would assist mining corporates in the implementation of these technologies. Mohelska & Sokolova (2018) argued that there is no good or bad culture, organisational culture becomes effective when it can support the organisation's strategic objectives. They further identified three (3) types of cultures, namely, bureaucratic culture, innovative culture and supportive culture. These cultures have a direct relationship with employee performance and innovative and supportive cultures. Webber-Youngman (2017) also mentioned that there are ten (10) important skills that are significant for students to cope with the new environment.

4.5.1. IT Infrastructure

To determine whether IT infrastructure skills have a direct relationship with job security and organisational culture, multiple regression analyses from SPSS were performed on the group of participants who answered questions 12, 13, 14 and 15. A descriptive statistics table was generated and the results are displayed in Table 4-4 below.

A total of 27 participants formed the basis of this study, and the average score on the Likert scale for Question 12, which dealt with the use of technology in the organisation. The mean score of those who felt that it was a good idea was 4,2, which is between agree and strongly agree. The mean score of people who felt that it was beneficial was 4, 36 which fell between agree and strongly agree and those who said that that they will enjoy these technologies, the mean score was 4, 17 which was between agree and strongly agree.

In terms of job security, the average score of the participants who felt that they will keep their jobs when these technologies are being implemented was between agree and strongly agree. Those who said that they will continue in the organisation despite the introduction of these technologies were in the category of agree and strongly agree. Those who feared that they would be redundant "neither agreed nor disagreed" or agreed. And lastly, those who were worried about the continuation of their careers either "neither agreed nor disagreed" or "agreed."

Table 4-6: Description Statistics of Information Technology Infrastructure, Job Security and Organisational Culture

Descriptive Statistics

	Mean	Std. Deviation	N
SMEAN (IT Infrastructure)	4.360	.9148	27
SMEAN(Good Idea)	4.200	.7845	27
SMEAN(Beneficial)	4.360	.7275	27
SMEAN(Enjoyment)	4.167	.7679	27
SMEAN(Job security 1)	4.320	.6633	27
SMEAN(Job security 2)	4.280	.5897	27
SMEAN(Job security 3)	3.880	.8910	27
SMEAN(Job security 4)	3.760	.9719	27
SMEAN(Operate)	3.000	1.1094	27
SMEAN(Interaction)	3.400	1.0000	27
SMEAN(Simplicity)	3.000	1.1094	27
SMEAN(Ideas)	3.360	1.0699	27
SMEAN(Scope)	3.040	1.1923	27
SMEAN(Assist)	3.880	.9332	27

Source: (Based on Online surveys, 2021)

In terms of organisational culture (Q14), most respondents "neither agreed nor disagreed" or "agreed" that learning these technologies would be easy. On average, most respondents "neither agreed nor disagreed" or "agreed" that interaction with these technologies would be clear and understandable and those who would find these technologies easy to use "either agreed or disagreed" or agreed.

In terms of Question 15, on average, most employees were either undecided or agreed that these technologies will help them suggest new ideas as seen with the score of 3,36 and those who felt that these technologies will allow them more scope for trying out innovative approaches or systems "either agreed or disagreed".

From the coefficient table below, in *Table 4-5*, employee interaction with IT infrastructure (interaction), ease of use of this technology (simplicity), and the application of IT infrastructure, which stood to help employees come up with new ideas (ideas), reflected that these variables can explain or predict the IT infrastructure skills due to their significance being less than p = 0.05.

Table 4-7: Coefficient Table of Information Technology Infrastructure, Job Security and Organisational Culture

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	6.815	1.822		3.741	.002		
	SMEAN(Good Idea)	.409	.294	.350	1.391	.186	.223	4.483
	SMEAN(Beneficial)	-.086	.244	-.069	-.355	.728	.377	2.655
	SMEAN(Enjoyment)	-.379	.251	-.318	-1.507	.154	.318	3.146
	SMEAN(Job security 1)	.301	.393	.218	.765	.457	.174	5.731
	SMEAN(Job security 2)	-.315	.567	-.203	-.556	.587	.106	9.418
	SMEAN(Job security 3)	.410	.377	.400	1.089	.295	.105	9.519
	SMEAN(Job security 4)	-.305	.303	-.324	-1.004	.332	.136	7.339
	SMEAN(Interaction)	-5.971	1.132	-6.527	-5.275	.000	.009	108.100
	SMEAN(Simplicity)	1.142	.223	1.385	5.129	.000	.194	5.148
	SMEAN(Ideas)	4.561	1.081	5.333	4.219	.001	.009	112.847
	SMEAN(Scope)	.178	.243	.232	.733	.476	.142	7.060
	SMEAN(Assist)	-.413	.229	-.421	-1.806	.092	.261	3.838

a. Dependent Variable: SMEAN (IT Infrastructure)

Source: (Based on Online Surveys, 2021)

Looking at the "Model Summary" below in *Figure 4-6*, a multi-regression analysis providing interaction, simplicity, and ideas (as independent variables) and IT infrastructure (as a dependent variable) was adopted to find "R" and "Adjusted R Square", with "R" used as an indicator of the strength of the relationship between these variables and "Adjusted R Square", which is used to explain how much changes in IT infrastructure can be explained by interaction, ideas, and simplicity. Looking at the results in the model summary, "R" is 0.895, which suggests that there is a strong relationship between IT infrastructure and the independent variables. The "Adjusted R Square" value of 0.632 suggests that 63.2% of the change in IT infrastructure can be explained by the interaction of employees and this technology, which will be clear and understandable, the ease of use of this technology, as well as this technology helping employees come up with new ideas.

Figure 3-6: Model Summary of Information Technology Infrastructure, Job Security and Organisation Culture

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.895[a]	.802	.632	.5551	2.311

a. Predictors: (Constant), SMEAN(Assist), SMEAN(Job security 1), SMEAN(Enjoyment), SMEAN(Job security 3), SMEAN(Simplicity), SMEAN(Beneficial), SMEAN(Good Idea), SMEAN(Scope), SMEAN(Job security 4), SMEAN(Job security 2), SMEAN(Interaction), SMEAN(Ideas)

b. Dependent Variable: SMEAN (IT Infrastructure)

Source: (Based on Online Surveys, 2021)

4.5.2. Automation Technology

SPSS multiple regression analyses were run on the participants who answered questions 12, 13, 14, and 15. A descriptive statistics table was generated, and the results are displayed in *Table 4-6* below.

Table 4-8 Description Statistics of Automation Technology, Job Security and Organisational Culture

Descriptive Statistics

	Mean	Std. Deviation	N
SMEAN(Automation technology)	4.240	.9719	27
SMEAN(Good Idea)	4.200	.7845	27
SMEAN(Beneficial)	4.360	.7275	27
SMEAN(Enjoyment)	4.167	.7679	27
SMEAN(Job security 1)	4.320	.6633	27
SMEAN(Job security 2)	4.280	.5897	27
SMEAN(Job security 3)	3.880	.8910	27
SMEAN(Job security 4)	3.760	.9719	27
SMEAN(Operate)	3.000	1.1094	27
SMEAN(Interaction)	3.400	1.0000	27
SMEAN(Simplicity)	3.000	1.1094	27
SMEAN(Ideas)	3.360	1.0699	27
SMEAN(Scope)	3.040	1.1923	27
SMEAN(Assist)	3.880	.9332	27

Source: (Based on Online Surveys, 2021)

A total of 27 participants formed the basis of this study, and the average score on the Linkert scale for Question 12, which dealt with the use of this technology in the organisation, was 6.8. The mean score of those who felt that it was a "good idea" was 4.2, which is between "agree and strongly agree" The mean score of people who felt that it was beneficial was 4.36, which fell between agree and strongly agree. For those who said that they would enjoy these technologies, the mean score was 4.17, which was somewhere between "agree and strongly agree".

In terms of job security, the average score of the participants who felt that they would keep their jobs when these technologies are being implemented was somewhere between "agree" and "strongly agree." Those who stated that they would remain in the organization despite the introduction of these technologies fell into the "agree" and "strongly agree" categories. Those who feared that they would be redundant "neither agreed nor disagreed" or agreed. And lastly, those who were worried about the continuation of their careers either "neither agreed nor disagreed" or "agreed."

In terms of organisational culture (Q14), most respondents "agreed" that learning these technologies would be easy (mean value of 3.0). On average, most respondents "neither agreed nor disagreed" or "agreed" that interaction with these technologies would be clear and understandable and those who would find these technologies easy to agree with.

In terms of Question 15, on average, most employees were either undecided or agreed that these technologies will help them to come up with new ideas, as seen with the score of 3.36, and those who felt that these technologies will allow them more scope for trying out innovative approaches or systems "either agreed or disagreed."

From the coefficient table below, in *Table 4-7*, employee interaction with automation technology (interaction), ease of use of this technology (simplicity), and the application of automation technology, which stood to help employees create new ideas (ideas), and those who felt that the use of this technology in the organisation is a good idea (good idea), reflected that these variables can explain or predict the automation technology skills due to their significance being less than p = 0.05.

Table 4-9: Coefficient Table of automation technology, job security and organisational culture

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	VIF
1	(Constant)	5.448	2.450		2.224	.043		
	SMEAN(Good Idea)	.961	.395	.776	2.433	.029	.223	4.483
	SMEAN(Beneficial)	-.575	.328	-.431	-1.755	.101	.377	2.655
	SMEAN(Enjoyment)	-.471	.338	-.372	-1.392	.186	.318	3.146
	SMEAN(Job security 1)	-.390	.528	-.266	-.738	.473	.174	5.731
	SMEAN(Job security 2)	.522	.762	.317	.685	.504	.106	9.418
	SMEAN(Job security 3)	.609	.507	.559	1.202	.249	.105	9.519
	SMEAN(Job security 4)	-.516	.408	-.516	-1.265	.227	.136	7.339
	SMEAN(Interaction)	-4.853	1.522	-4.993	-3.189	.007	.009	108.100
	SMEAN(Simplicity)	.732	.299	.835	2.445	.028	.194	5.148
	SMEAN(Ideas)	3.826	1.453	4.212	2.632	.020	.009	112.847
	SMEAN(Scope)	.057	.326	.070	.175	.864	.142	7.060
	SMEAN(Assist)	-.122	.307	-.117	-.397	.697	.261	3.838

a. Dependent Variable: SMEAN(Automation technology)

Source: (Based on Online Surveys, 2021)

When we analyse the "Model Summary" table below in Figure 3, a multi-regression analysis providing good ideas, interaction, simplicity, and ideas (as independent variables) and automation technology (as a dependent variable) was adopted to find "R" and "Adjusted R Square", with "R" used as an indicator of the strength of the relationship between these variables and "Adjusted R Square", which is used to explain how much changes in automation technology can be explained by good ideas, interaction, ideas, and simplicity. Looking at the results in the model summary, "R" is 0.826 which suggests that there is a strong relationship between automation and the independent variables. The "Adjusted R Square" value of 0,410 suggests that only 41% of the change in automation technology can be explained by the interaction of employees and this technology, which will be a good idea when implemented in the organisation, clear and understandable, the ease of use of this technology, as well as this technology helping employees create new ideas.

Figure 3-7: Model Summary of Automation Technology, Job Security and Organisation Culture

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.826[a]	.682	.410	.7464	1.767

a. Predictors: (Constant), SMEAN(Assist), SMEAN(Job security 1), SMEAN (Enjoyment), SMEAN(Job security 3), SMEAN(Simplicity), SMEAN(Beneficial), SMEAN(Good Idea), SMEAN(Scope), SMEAN(Job security 4), SMEAN(Job security 2), SMEAN(Interaction), SMEAN(Ideas)

b. Dependent Variable: SMEAN(Automation technology)

Source: (Based on Online Surveys, 2021)

4.5.3. Data Analytics

SPSS multiple regression analyses were run on the participants who answered questions 12, 13, 14, and 15. A descriptive statistics table was generated, and the results are displayed in *Table 4-8* below.

A total of 27 participants formed the basis of this study and the average score on the Likert scale for Question 12, which dealt with the use of technology in the organisation. The mean score of those who felt that it was a good idea was 4.2, which is between agree and strongly agree. The mean score of people who felt that it was beneficial was 4.36, which fell between agree and strongly agree. For those who said that they would enjoy these technologies, the mean score was 4.17, which was between agree and strongly agree.

Table 4-10: Description Statistics of Data Analytics, Job Security and Organisational Culture

Descriptive Statistics

	Mean	Std. Deviation	N
SMEAN(Data Analytics)	4.320	.9081	27
SMEAN(Good Idea)	4.200	.7845	27
SMEAN(Beneficial)	4.360	.7275	27
SMEAN(Enjoyment)	4.167	.7679	27
SMEAN(Job security 1)	4.320	.6633	27
SMEAN(Job security 2)	4.280	.5897	27
SMEAN(Job security 3)	3.880	.8910	27
SMEAN(Job security 4)	3.760	.9719	27
SMEAN(Operate)	3.000	1.1094	27
SMEAN(Interaction)	3.400	1.0000	27
SMEAN(Simplicity)	3.000	1.1094	27
SMEAN(Ideas)	3.360	1.0699	27
SMEAN(Scope)	3.040	1.1923	27
SMEAN(Assist)	3.880	.9332	27

Source: (Based on Online Surveys, 2021)

In terms of job security, the average score of the participants who felt that they will keep their jobs when these technologies are being implemented was between agree and strongly agree. Those who said that they will continue in the organisation despite the introduction of these technologies were in the category of agree and strongly agree. Those who feared that they would be redundant "neither agreed nor disagreed" or agreed. And lastly, those who were worried about the continuation of their careers either "neither agreed nor disagreed" or "agreed."

In terms of organisational culture (Q14), most respondents "neither agreed or disagreed" or "agreed" that learning these technologies will be easy, on average most respondents, "neither agreed or disagreed" or "agreed" that interaction with these technologies would be clear and understandable and those who would find these technologies easy to use "either agreed or disagreed" or agreed.

In terms of Question 15, on average, most employees were either undecided or agreed that these technologies will help them to come up with new ideas, as seen with the score of 3.36, and on average, most agreed that these technologies will allow them more scope for trying out innovative approaches or systems.

From the coefficient table below, in ***Table 4-9***, employee interaction with data analytics (interaction), ease of use of this technology (simplicity), and the application of data analytics, which stood to help employees come up with new ideas (ideas), reflected that these variables can explain or predict the data analytics skills due to their significance being less than p = 0.05.

Table 4-11: Coefficient Table of Data Analytics, Job Security and Organisational Culture

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	6.283	2.252		2.790	.014		
	SMEAN(Good Idea)	.757	.363	.654	2.083	.056	.223	4.483
	SMEAN(Beneficial)	-.278	.301	-.223	-.923	.372	.377	2.655
	SMEAN(Enjoyment)	-.665	.311	-.562	-2.138	.051	.318	3.146
	SMEAN(Job security 1)	.417	.486	.305	.860	.405	.174	5.731
	SMEAN(Job security 2)	.021	.700	.013	.029	.977	.106	9.418
	SMEAN(Job security 3)	.170	.466	.167	.365	.720	.105	9.519
	SMEAN(Job security 4)	-.455	.375	-.487	-1.214	.245	.136	7.339
	SMEAN(Interaction)	-5.045	1.399	-5.556	-3.606	.003	.009	108.100
	SMEAN(Simplicity)	.661	.275	.808	2.403	.031	.194	5.148
	SMEAN(Ideas)	4.582	1.336	5.398	3.429	.004	.009	112.847
	SMEAN(Scope)	-.257	.300	-.337	-.856	.406	.142	7.060
	SMEAN(Assist)	-.372	.283	-.383	-1.318	.209	.261	3.838

a. Dependent Variable: SMEAN(Data Analytics)

Source: (Based on Online Surveys, 2021)

When we analyse the "Model Summary" table below in Figure 4-8, a multi-regression analysis providing good ideas, interaction, simplicity and ideas (as independent variables) and data analytics (dependent variable) was adopted to find "R" and "Adjusted R Square", with "R" used as an indicator of the strength of the relationship between these variables and "Adjusted R Square", which is used to explain how much changes in automation technology can be explained by good ideas, interaction, ideas, and simplicity. Looking at the results in the model summary, "R" is 0.832, which suggests that there is a strong relationship between automation and the independent variables. The "Adjusted R Square" value of 0.429 suggests that only 42.9% of the change in data analytics can be explained by the interaction of employees with this technology, which will be a good idea when implemented in the organisation, clear and understandable, the ease of use of this technology, as well as this technology helping employees come up with new ideas.

Figure 3-8: Model Summary of Data Analytics, Job Security and Organisation Culture

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.832[a]	.693	.429	.6861	2.209

a. Predictors: (Constant), SMEAN(Assist), SMEAN(Job security 1), SMEAN (Enjoyment), SMEAN(Job security 3), SMEAN(Simplicity), SMEAN(Beneficial), SMEAN(Good Idea), SMEAN(Scope), SMEAN(Job security 4), SMEAN(Job security 2), SMEAN(Interaction), SMEAN(Ideas)

b. Dependent Variable: SMEAN(Data Analytics)

Source: (Based on Online Surveys, 2021)

4.5.4. Data Security/Communications Security

In order to determine whether Data security/Communications Security skills have a direct relationship with job security and organisational culture, multiple regression analyses from SPSS were performed on the group of participants who answered questions 12, 13, 14 and 15. A descriptive statistics table was generated, and the results are displayed in *Table 4-10* below.

Table 4-12: Description Statistics of Data Security/Communications Security, Job Security and Organisational Culture

Descriptive Statistics	Mean	Std. Deviation	N
SMEAN(Data Security/Communications Security)	4.360	.7786	27
SMEAN(Good Idea)	4.200	.7845	27
SMEAN(Beneficial)	4.360	.7275	27
SMEAN(Enjoyment)	4.167	.7679	27
SMEAN(Job security 1)	4.320	.6633	27
SMEAN(Job security 2)	4.280	.5897	27
SMEAN(Job security 3)	3.880	.8910	27
SMEAN(Job security 4)	3.760	.9719	27
SMEAN(Operate)	3.000	1.1094	27
SMEAN(Interaction)	3.400	1.0000	27
SMEAN(Simplicity)	3.000	1.1094	27
SMEAN(Ideas)	3.360	1.0699	27
SMEAN(Scope)	3.040	1.1923	27
SMEAN(Assist)	3.880	.9332	27

Source: (Based on Online Surveys, 2021)

The 27 participants formed the basis of this study, and the average score on the Likert scale for Question 12, which dealt with the use of fourth industrial technologies in the organisation. The mean score of those who felt that it was a good idea was 4.2, which is between agree and strongly agree. The mean score of people who felt that it was beneficial was 4.36, which fell between agree and strongly agree. For those who said that they would enjoy these technologies, the mean score was 4.17, which was somewhere between agree and strongly agree.

In terms of job security, the average score of the participants who felt that they will keep their jobs when these technologies are being implemented was between agree and strongly agree. Those who said that they will continue in the organisation despite the introduction of these technologies were in the category of agree and strongly agree. Those who feared that they would be redundant "neither agreed nor disagreed" or agreed. And lastly, those who were worried about the continuation of their careers either "neither agreed nor disagreed" or "agreed."

In terms of organisational culture (Q14), most respondents "neither agreed nor disagreed" or "agreed" that learning these technologies would be easy. On average, most respondents "neither agreed nor disagreed" or "agreed" that interaction with these technologies would be clear and understandable, and those who would find these technologies easy to use "either agreed or disagreed" or agreed.

In terms of Question 15, on average, most employees were either undecided or agreed that these technologies will help them to come up with new ideas, as seen with the score of 3.36, and on average, most agreed that these technologies will allow them more scope for trying out innovative approaches or systems.

From the coefficient table below, in *Table 4-11*, employee interaction with Data security/Communications (interaction), ease of use of this technology (simplicity), and the application of Data security/Communications, which stood to help employees come up with new ideas (ideas), reflected that these variables can explain or predict the Data security/Communications skills due to their significance being less than p = 0.05.

Table 4-13: Coefficient Table of Data Security/Communication Security, Job Security and Organisational Culture

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	6.177	1.971		3.134	.007		
	SMEAN(Good Idea)	.120	.318	.121	.378	.711	.223	4.483
	SMEAN(Beneficial)	-.089	.264	-.083	-.338	.741	.377	2.655
	SMEAN(Enjoyment)	-.276	.272	-.273	-1.016	.327	.318	3.146
	SMEAN(Job security 1)	.054	.425	.046	.128	.900	.174	5.731
	SMEAN(Job security 2)	.286	.613	.217	.467	.648	.106	9.418
	SMEAN(Job security 3)	.182	.408	.209	.447	.662	.105	9.519
	SMEAN(Job security 4)	-.376	.328	-.469	-1.145	.271	.136	7.339
	SMEAN(Interaction)	-3.700	1.225	-4.753	-3.022	.009	.009	108.100
	SMEAN(Simplicity)	.913	.241	1.301	3.790	.002	.194	5.148
	SMEAN(Ideas)	2.802	1.169	3.851	2.396	.031	.009	112.847
	SMEAN(Scope)	-.007	.262	-.011	-.027	.979	.142	7.060
	SMEAN(Assist)	-.280	.247	-.336	-1.133	.276	.261	3.838

a. Dependent Variable: SMEAN(Data Security/Communications Security)

Source: (Based on Online Surveys, 2021)

When we analyse the "Model Summary" table below in Figure 4-9, a multi-regression analysis providing good ideas, interaction, simplicity, and ideas (as independent variables) and Data security/Communications (dependent variable) was adopted to find "R" and "Adjusted R Square", with "R" used as an indicator of the strength of the relationship between these variables and "Adjusted R Square", which is used to explain how much changes in automation technology can be explained by good ideas, interaction, ideas, and simplicity.

Looking at the results in the model summary, "R" is 0.824, which suggests that there is a strong relationship between Automation and the independent variables. The "Adjusted R Square" value of 0.405 suggests that only 40.5% of the change in Data security/Communications can be explained by the interaction of employees with this technology, which will be a good idea when implemented in the organisation, clear and understandable, the ease of use of this technology, as well as this technology helping employees come up with new ideas.

Figure 3-9: Model Summary of Data Security/Communication Security, Job Security and Organisation Culture

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.824[a]	.680	.405	.6005	1.566

a. Predictors: (Constant), SMEAN(Assist), SMEAN(Job security 1), SMEAN (Enjoyment), SMEAN(Job security 3), SMEAN(Simplicity), SMEAN(Beneficial), SMEAN(Good Idea), SMEAN(Scope), SMEAN(Job security 4), SMEAN(Job security 2), SMEAN(Interaction), SMEAN(Ideas)

b. Dependent Variable: SMEAN(Data Security/Communications Security)

Source: (Based on Online Surveys, 2021)

4.5.5. Development of applications of assistance systems

As done in other variables within this construct, in order to find whether the development of applications of assistance systems skills has a direct relationship with job security and organisational culture, multiple regression analyses from SPSS were performed on the group of participants who answered questions 12, 13, 14 and 15. A descriptive statistics table was generated, and the results are displayed in ***Table 4-12*** below.

Table 4-14: Description Statistics of Development of Applications of Assistance Systems, Job Security and Organisational Culture

Descriptive Statistics

	Mean	Std. Deviation	N
SMEAN(Development of applications of assistance systems)	4.160	.9064	27
SMEAN(Good Idea)	4.200	.7845	27
SMEAN(Beneficial)	4.360	.7275	27
SMEAN(Enjoyment)	4.167	.7679	27
SMEAN(Job security 1)	4.320	.6633	27
SMEAN(Job security 2)	4.280	.5897	27
SMEAN(Job security 3)	3.880	.8910	27
SMEAN(Job security 4)	3.760	.9719	27
SMEAN(Operate)	3.000	1.1094	27
SMEAN(Interaction)	3.400	1.0000	27
SMEAN(Simplicity)	3.000	1.1094	27
SMEAN(Ideas)	3.360	1.0699	27
SMEAN(Scope)	3.040	1.1923	27
SMEAN(Assist)	3.880	.9332	27

Source: (Based on Online Surveys, 2021)

As in other variables, 27 participants formed the basis of this study, and the average score on the Linkert scale for Question 12, which dealt with the use of fourth industrial technologies in the organisation. The mean score of those who felt that it was a good idea was 4.2, which is between agree and strongly agree. The mean score of people who felt that it was beneficial was 4.36, which fell between agree and strongly agree. For those who said that they would enjoy these technologies, the mean score was 4.17, which was somewhere between agree and strongly agree.

In terms of job security, the average score of the participants who felt that they will keep their jobs when these technologies are being implemented, was between agree and strongly agree. Those who said that they will continue in the organisation despite the introduction of these technologies were in the category of agree and strongly agree. Those who feared that they would be redundant "neither agreed nor disagreed" or agreed. Lastly, respondents who were worried about the continuation of their careers either "neither agreed nor disagreed" or "agreed".

In terms of organisational culture (Q14), most respondents "neither agreed nor disagreed" or "agreed" that learning these technologies would be easy. On average, most respondents "neither agreed nor disagreed" or "agreed" that interaction with these technologies would be clear and understandable, and those who would find these technologies easy to use "either agreed or disagreed" or agreed.

In terms of Question 15, on average, most employees were either undecided or agreed that these technologies will help them to come up with new ideas, as seen with the score of 3.36, and on average, most agreed that these technologies will allow them more scope for trying out innovative approaches or systems.

From the coefficient table below, in ***Table 4-13,*** employee interaction with the development of applications of assistance systems (interaction), ease of use of this technology (simplicity), and the application of Data security/Communications, which stood to help employees come up with new ideas (ideas), reflected that these variables can explain or predict the Data security/Communications skills, due to their significance being less than p = 0.05.

Table 4-15: Coefficient Table of Development of Applications of Assistance Systems, Job Security and Organisational Culture

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	5.669	2.132		2.659	.019		
	SMEAN(Good Idea)	.200	.344	.173	.581	.571	.223	4.483
	SMEAN(Beneficial)	-.202	.285	-.162	-.709	.490	.377	2.655
	SMEAN(Enjoyment)	-.380	.294	-.322	-1.290	.218	.318	3.146
	SMEAN(Job security 1)	-.405	.460	-.296	-.880	.394	.174	5.731
	SMEAN(Job security 2)	.999	.663	.650	1.506	.154	.106	9.418
	SMEAN(Job security 3)	-.010	.441	-.010	-.023	.982	.105	9.519
	SMEAN(Job security 4)	-.295	.355	-.316	-.830	.420	.136	7.339
	SMEAN(Interaction)	-3.492	1.325	-3.853	-2.636	.020	.009	108.100
	SMEAN(Simplicity)	1.042	.261	1.275	3.997	.001	.194	5.148
	SMEAN(Ideas)	2.924	1.265	3.451	2.311	.037	.009	112.847
	SMEAN(Scope)	-.445	.284	-.585	-1.566	.140	.142	7.060
	SMEAN(Assist)	-.254	.268	-.262	-.950	.358	.261	3.838

a. Dependent Variable: SMEAN(Development of applications of assistance systems)

Source: (Based on Online Surveys, 2021)

When we analyse the "Model Summary" table below in *Figure 4-10*, a multi-regression analysis providing good ideas, interaction, simplicity, and ideas (as independent variables) and development of applications of assistance systems (dependent variable) was adopted to find "R" and "Adjusted R Square", with "R" used as an indicator of the strength of the relationship between these variables and "Adjusted R Square", which is used to explain how much changes in Data security/Communications can be explained by good ideas, interaction ideas, and simplicity. Looking at the results in the model summary, "R" is 0.850, which suggests that there is a strong relationship between Development of applications of assistance systems and the independent variables.

The "Adjusted R Square" value of 0.405 suggests that only 40.5% of the change in Development of applications of assistance systems can be explained by the interaction of employees and this technology, which will be a good idea when implemented in the organisation, clear and understandable, the ease of use of this technology, as well as this technology helping employees come up with new ideas.

Figure 3-10: Model Summary of Development of Applications of Assistance Systems, Job Security and Organisation Culture

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.850[a]	.723	.486	.6497	1.985

a. Predictors: (Constant), SMEAN(Assist), SMEAN(Job security 1), SMEAN (Enjoyment), SMEAN(Job security 3), SMEAN(Simplicity), SMEAN(Beneficial), SMEAN(Good Idea), SMEAN(Scope), SMEAN(Job security 4), SMEAN(Job security 2), SMEAN(Interaction), SMEAN(Ideas)

b. Dependent Variable: SMEAN(Development of applications of assistance systems)

Source: (Based on Online Surveys, 2021)

4.5.6. Collaborative Software

SPSS multiple regression analyses were run on the group of participants who answered questions 12, 13, 14, and 15. A descriptive statistics table was generated and the results are displayed in Table 16 below. In terms of the descriptive statistics of the data, 27 participants formed the basis of this study and the average score on the Likert scale for Question 12, which dealt with the use of fourth industrial technologies in the organisation. The mean score of those who felt that it was a good idea was 4.2, which is between agree and strongly agree. The mean score of people who felt that it was beneficial was 4.36, which fell between agree and strongly agree. For those who said that they would enjoy these technologies, the mean score was 4.17, which was between agree and strongly agree.

In terms of job security, the average score of the participants who felt that they will keep their jobs when these technologies are being implemented was between agree and strongly agree. Those who said that they will continue in the organisation despite the introduction of these technologies were in the category of agree and strongly agree. Those who feared that they would be redundant "neither agreed nor disagreed" or agreed. And lastly, those who were worried about the continuation of their careers either "neither agreed nor disagreed" or "agreed."

In terms of organisational culture (Q14), most respondents "neither agreed nor disagreed" or "agreed" that learning these technologies would be easy. On average, most respondents "neither agreed nor disagreed" or "agreed" that interaction with these technologies would be clear and understandable, and those who would find these technologies easy to use "either agreed or disagreed" or agreed.

In terms of Question 15, on average, most employees were either undecided or agreed that these technologies will help them to come up with new ideas, as seen with the score of 3.04, and on average, most agreed that these technologies will allow them more scope for trying out innovative approaches or systems.

Table 4-16: Description Statistics of Collaborative Software, Job Security and Organisational Culture

Descriptive Statistics

	Mean	Std. Deviation	N
SMEAN(Collaborative Software)	4.400	.9199	27
SMEAN(Good Idea)	4.200	.7845	27
SMEAN(Beneficial)	4.360	.7275	27
SMEAN(Enjoyment)	4.167	.7679	27
SMEAN(Job security 1)	4.320	.6633	27
SMEAN(Job security 2)	4.280	.5897	27
SMEAN(Job security 3)	3.880	.8910	27
SMEAN(Job security 4)	3.760	.9719	27
SMEAN(Operate)	3.000	1.1094	27
SMEAN(Interaction)	3.400	1.0000	27
SMEAN(Simplicity)	3.000	1.1094	27
SMEAN(Ideas)	3.360	1.0699	27
SMEAN(Scope)	3.040	1.1923	27
SMEAN(Assist)	3.880	.9332	27

Source: (Based on Online Surveys, 2021)

From the coefficient table above, in Table 4-14, employee interaction with development of applications of assistance systems (interaction), ease of use of this technology (simplicity), and the application of Data security/Communications, which stood to help employees come up with new ideas (ideas), reflected that these variables can explain or predict the Data security/Communications skills due to their significance being less than p = 0. 05.

When we analyse the "Model Summary" table below in Figure 4-11, a multi-regression analysis providing good ideas, interaction, simplicity, and ideas (as independent variables) and development of applications of assistance systems (dependent variable) was adopted to find "R" and "Adjusted R Square", with "R" used as an indicator of the strength of the relationship between these variables and "Adjusted R Square", which is used to explain how much changes in Data security/Communications can be explained by good ideas, interaction, ideas, and simplicity. Looking at the results in the model summary, "R" is 0.850, which suggests that there is a strong relationship between Development of applications of assistance systems and the independent variables.

Table 4-17: Coefficient Table of Collaborative Software, Job Security and Organisational Culture

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	5.348	2.394		2.234	.042		
	SMEAN(Good Idea)	.215	.386	.183	.557	.586	.223	4.483
	SMEAN(Beneficial)	-.209	.320	-.165	-.651	.525	.377	2.655
	SMEAN(Enjoyment)	-.306	.330	-.255	-.924	.371	.318	3.146
	SMEAN(Job security 1)	-.011	.516	-.008	-.021	.984	.174	5.731
	SMEAN(Job security 2)	.320	.745	.205	.429	.674	.106	9.418
	SMEAN(Job security 3)	.395	.495	.382	.797	.439	.105	9.519
	SMEAN(Job security 4)	-.330	.399	-.349	-.828	.422	.136	7.339
	SMEAN(Interaction)	-3.877	1.488	-4.215	-2.606	.021	.009	108.100
	SMEAN(Simplicity)	1.120	.293	1.351	3.827	.002	.194	5.148
	SMEAN(Ideas)	2.753	1.421	3.202	1.938	.073	.009	112.847
	SMEAN(Scope)	-.032	.319	-.042	-.100	.921	.142	7.060
	SMEAN(Assist)	-.158	.300	-.160	-.525	.608	.261	3.838

a. Dependent Variable: SMEAN(Collaborative Software)

Source: (Based on Online Surveys, 2021)

The "Adjusted R Square" value of 0.371 suggests that only 37, 1% of the change in Collaborative software can be explained by the interaction of employees and this technology, which will be a good idea when implemented in the organisation, clear and understandable, the ease of use of this technology, as well as this technology helping employees come up with new ideas.

Figure 3-11: Model Summary of Collaborative Software, Job Security and Organisation Culture

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.813[a]	.661	.371	.7296	1.715

a. Predictors: (Constant), SMEAN(Assist), SMEAN(Job security 1), SMEAN (Enjoyment), SMEAN(Job security 3), SMEAN(Simplicity), SMEAN(Beneficial), SMEAN(Good Idea), SMEAN(Scope), SMEAN(Job security 4), SMEAN(Job security 2), SMEAN(Interaction), SMEAN(Ideas)

b. Dependent Variable: SMEAN(Collaborative Software)

Source: (Based on Online Surveys, 2021)

4.5.7. System Thinking and Process Understanding

SPSS multiple regression analyses were run on the participants who answered questions 12, 13, 14, and 15. A descriptive statistics table was generated, and the results are displayed in *Table 4-16* below. In terms of the descriptive statistics of the data, 27 participants formed the basis of this study, and the average score on the Likert scale for Question 12, which dealt with the use of fourth industrial technologies in the organisation, was reached. The mean score of those who felt that it was a good idea was 4.2, which is between agree and strongly agree. The mean score of people who felt that it was beneficial was 4.36, which fell between agree and strongly agree. For those who said that they would enjoy these technologies, the mean score was 4.17, which was between agree and strongly agree.

Table 4-18: Description Statistics of System thinking and Process Understanding, Job Security and Organisational Culture

Descriptive Statistics

	Mean	Std. Deviation	N
SMEAN(Non-technical skills such as systems thinking and process understanding)	4.120	.8467	27
SMEAN(Good Idea)	4.200	.7845	27
SMEAN(Beneficial)	4.360	.7275	27
SMEAN(Enjoyment)	4.167	.7679	27
SMEAN(Job security 1)	4.320	.6633	27
SMEAN(Job security 2)	4.280	.5897	27
SMEAN(Job security 3)	3.880	.8910	27
SMEAN(Job security 4)	3.760	.9719	27
SMEAN(Operate)	3.000	1.1094	27
SMEAN(Interaction)	3.400	1.0000	27
SMEAN(Simplicity)	3.000	1.1094	27
SMEAN(Ideas)	3.360	1.0699	27
SMEAN(Scope)	3.040	1.1923	27
SMEAN(Assist)	3.880	.9332	27

Source: (Based on Online Surveys, 2021)

In terms of job security, the average score of the participants who felt that they will keep their jobs when these technologies are being implemented was between agree and strongly agree. Those who said that they will continue in the organisation despite the introduction of these technologies were in the category of agree and strongly agree. Those who feared that they would be redundant "neither agreed nor disagreed" or agreed. And lastly, those who were worried about the continuation of their careers either "neither agreed nor disagreed" or "agreed."

In terms of organisational culture (Q14), most respondents "neither agreed nor disagreed" or "agreed" that learning these technologies would be easy. On average, most respondents "neither agreed nor disagreed" or "agreed" that interaction with these technologies would be clear and understandable, and those who would find these technologies easy to use "either agreed or disagreed" or agreed.

In terms of Question 15, on average, most employees were either undecided or agreed that these technologies will help them to come up with new ideas, as seen with the score of 3.04, and on average, most agreed that these technologies will allow them more scope for trying out innovative approaches or systems.

Table 4-19: Coefficient Table of Systems Thinking and Process Understanding, Job Security and Organisational Culture

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	4.963	2.256		2.200	.045		
	SMEAN(Good Idea)	.299	.364	.277	.822	.425	.223	4.483
	SMEAN(Beneficial)	.099	.302	.085	.327	.749	.377	2.655
	SMEAN(Enjoyment)	-.423	.311	-.384	-1.360	.195	.318	3.146
	SMEAN(Job security 1)	-.290	.487	-.227	-.596	.561	.174	5.731
	SMEAN(Job security 2)	.353	.702	.246	.504	.622	.106	9.418
	SMEAN(Job security 3)	-.224	.467	-.236	-.480	.639	.105	9.519
	SMEAN(Job security 4)	.315	.376	.361	.837	.417	.136	7.339
	SMEAN(Interaction)	-2.489	1.402	-2.939	-1.776	.098	.009	108.100
	SMEAN(Simplicity)	.825	.276	1.081	2.991	.010	.194	5.148
	SMEAN(Ideas)	2.236	1.339	2.826	1.671	.117	.009	112.847
	SMEAN(Scope)	-.314	.300	-.443	-1.047	.313	.142	7.060
	SMEAN(Assist)	-.492	.283	-.542	-1.737	.104	.261	3.838

a. Dependent Variable: SMEAN(Non-technical skills such as systems thinking and process understanding)

Source: (Based on Online Surveys, 2021)

From the coefficient table above, in Table 4-17, employee interaction with systems thinking and process understanding and ease of use of this technology (simplicity) due to their significance being less than p = 0.05,

When we analyse the "Model Summary" table below in Figure 9, a multi-regression analysis providing good ideas, interaction, simplicity, and ideas (as independent variables) and Development of applications of assistance systems (dependent variable) was adopted to find "R" and "Adjusted R Square", with "R" used as an indicator of the strength of the relationship between these variables and "Adjusted R Square", which is used to explain how much changes in Data security/Communications can be explained by good ideas, interaction, ideas, ideas, and simplicity. Looking at the results in the model summary, "R" is 0.803, which suggests that there is a strong relationship between the development of applications of assistance systems and the independent variables.

Figure 3-12: Model Summary of Systems Thinking and Process Understanding, Job Security and Organisation Culture

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.803[a]	.645	.341	.6874	2.483

a. Predictors: (Constant), SMEAN(Assist), SMEAN(Job security 1), SMEAN (Enjoyment), SMEAN(Job security 3), SMEAN(Simplicity), SMEAN(Beneficial), SMEAN(Good Idea), SMEAN(Scope), SMEAN(Job security 4), SMEAN(Job security 2), SMEAN(Interaction), SMEAN(Ideas)

b. Dependent Variable: SMEAN(Non-technical skills such as systems thinking and process understanding)

Source: (Based on Online Surveys, 2021)

The "Adjusted R Square" value of 0.341 suggests that only 34.1% of the change in Development of applications of assistance systems can be explained by the interaction of employees and this technology, which will be clear and understandable.

5 SUMMARY, CONCLUSIONS, LIMITATIONS, RECOMMENDATIONS AND FUTURE RESEARCH

5.1. Introduction

The following section presents the summary of the analysis that was done, which answers the research questions and hypotheses. Conclusions are also drawn with relation to answering these questions, as well as limitations and recommendations.

5.2. Organisational readiness and stakeholder engagement

According to Lamprini & Bröchler (2018), collaboration is needed by all stakeholders, i.e., educational institutions, mining corporates and the government to solve the wicked problem of job losses that are imminent when technology is finally rolled out in the industry. This suggests that there is a relationship between this engagement, the type of industrial revolution, and various types of Fourth Industrial Revolution technologies. *Table 5-1* below, shows the empirical findings of the relationship between stakeholder engagement, job security and the type of industrial revolution and various types of Fourth Industrial Revolution technologies.

Table 5-1:Relationship Table illustrating existing or non-existing correlation between Organisational Readiness and Stakeholder Engagement

Association	**Existing/Not Existing**
Stakeholder engagement & number of people in the organisation	Not existing
Stakeholder engagement & type of industrial revolution	**Existing** (it must be noted that most respondents' average response was falling between the third and fourth industrial revolution)
Internet of things (IoT) & Stakeholder engagement	Not existing

Sensor Technology & Stakeholder engagement	Not existing
Mobile technologies & Stakeholder engagement	Not existing
Radio-frequency identification (RFID) & Stakeholder engagement	**Existing**
Stakeholder engagement & Big Data	Not existing
Stakeholder engagement & Cloud technology	Not existing
Embedded IT systems & Stakeholder engagement	Not existing
Machine to machine communication & Stakeholder engagement	Not existing
Stakeholder engagement & 3-D printing	Not existing
Machine learning & Stakeholder engagement	Not existing
Artificial Intelligence & Stakeholder engagement	**Existing**

Source: (Based on Online Surveys, 2021)

It is observed from the literature that there is a need for collaboration, especially for leaders and citizens to stand together and shape a future that works for all by putting people first, empowering them, and constantly reminding ourselves that all of these new technologies are first and foremost tools made by people for people.

Collective action is needed by stakeholders in the industry to solve the issue of job losses that are bound to happen when these technologies are implemented. A counter argument was observed that the industry is traditionally reluctant to transform itself to cater to any technological developments. Lamprini & Bröchler (2018) further argued that in order to gain a common and shared view, humanity first needs to adapt to the changes in technology in order to shape a society with competitive economies and highly-skilled individuals that can face these challenges head on. From the empirical results above, the type of industrial revolution, radio-frequency identification, and artificial intelligence have an association or influence on stakeholder engagement.

From the questionnaire, most respondents mentioned that their organisation are either in the second or third industrial revolution, which proves the theory that industry is reluctant to move with the times.

The results also showed that respondents perceived that high to very high stakeholder engagement is needed to implement the Fourth Industrial Revolution technologies, with much emphasis on RFID and AI. Most participants felt that RFID was being used currently (a mean value of 0.79, which is closer to 1 than the current use on the Likert scale). Artificial intelligence (AI), on the other hand, was seen by the participants as either being used currently or still being used in the future. This was due to it having a mean value of 1.42 on the Linkert Scale (where 1 = current use and 2 = probable future use).

In terms of the research question, we needed to find out if there was a need for stakeholder engagement in terms of the readiness and implementation of modern technologies. A null hypothesis stated that there is a strong relationship between stakeholder engagement and organisational readiness when implementing these technologies. From the empirical findings it was determined that the type of industrial revolution was significant and that most respondents felt that the industry was between the 3rd and the 4th industrial revolution. This is an important observation, as it shows that most people are of the opinion that the industry is not yet modern and there is room for this transition. In terms of the technology that is poised to be implemented, radio-frequency identification (RFID) and artificial intelligence (AI) were found to be significant when a regression was run. Other technologies were not found to be significant in the regression model that was run. Going back to the research question and the null hypothesis, it was observed that a strong relationship existed in the regression model (R = 0.885), but with the adjusted R squared of 0,448, the findings suggested that RFID and AI including the transition from third to fourth industrial revolution, only had 44.8% influence meaning that there are other factors to be considered to come to a definite conclusion.

The research question is somewhat partially answered, and I cannot say with a definite answer that organisational readiness when transforming the industry to a digital industry, stakeholder engagement is essential. What the results suggest is that it must not be ruled out completely.

5.3. Skills Requirements, Job Security and Organisational Culture

The research question's aim was to find out if skills requirements are affected by job security and organisational culture (strategy) in the implementation of Fourth Industrial Revolution technologies in the industry. To rigorously ascertain that, the null hypothesis was set to say that there was a strong relationship between skills requirements (for these technologies), organisational culture and job security when, subsequently, rolling out these technologies. From the literature, it was seen that technological change or innovation demanded a change in the educational requirements and skill sets of future employees in order for them to be relevant in the future world of work. There were four (4) main groupings of technologies that were needed for adoption, and these technologies needed new skill sets among potential employees. These groupings of technologies were mentioned to be:

i. Analytics and intelligence
ii. Data, computational power, and connectivity
iii. Analytics and intelligence, and
iv. Human-machine interaction

From the organisational culture point of view, the literature indicates that there is no good or bad culture, but rather, the organisational culture becomes effective when it can support the overall organisational strategic objectives. There were three (3) cultures that were mentioned, i.e., bureaucratic culture, innovative culture, and supportive culture. Due to the nature of this research, innovative culture was adopted, and this does not suggest that the other two (2) cultures were deemed less important, but rather, due to the title being that of technology, it made sense to keenly set the innovative culture as a base.

It was also seen that these cultures had a direct relationship with employee performance and innovative and supportive cultures. The literature also demonstrates that an innovative culture stimulated creativity, which led to employees' being result-orientated. This calls for a collaborative environment that brings together stakeholders who will work together for the development of the right skill set for these technologies.

To answer the research question and accept or reject the null hypothesis, an analysis was done to determine whether skills requirements are affected by organisational culture and job security in the previous chapter, and the findings of these empirical results are presented in *Table 5-2* below. The skills requirements were divided into seven (7) different skill sets that were required for the implementation of these technologies, that is. Development of Assistive System Applications, Collaborative Software, System Thinking, and Process Understanding.

Table 5-2: Relationship Table illustrating existing or non-existing correlation between Skills Requirements, Job Security and Organisational Culture

Association	**Existing/Not Existing**
IT Infrastructure & Organisational Culture and Job Security	**Existing** (Interaction, Simplicity and ideas were influencers)
Automation Technology & Organisational Culture and Job Security	**Existing** (Good idea, Interaction, Simplicity and ideas were influencers)
Data Analytics & Organisational Culture and Job Security	**Existing** (Interaction, Simplicity and ideas were influencers)
Data Security/Communications Security & Organisational Culture and Job Security	**Existing** (Interaction, Simplicity and ideas were influencers)
Development of Applications of Assistance Systems & Organisational Culture and Job Security	**Existing** (Interaction, Simplicity and ideas were influencers)
Collaborative Software & Organisational Culture and Job Security	**Existing** (Simplicity and ideas were influencers)

System Thinking and Process Understanding & Organisational Culture and Job Security	**Existing** (Simplicity was the influencer)

Source: (Based on Online Surveys, 2021)

Looking at the summarised results above, most respondents perceived all the listed skill sets and educational requirements for these skills as being rated between high and very high according to their average score (4.360). Job security dimensions did not appear as an influencer or having a relationship with these skill sets in terms of IT infrastructure, data analytics, data security, communications security, and development of assistance system applications.

This can be interpreted as having a low impact when formulating a framework for skills needed for the industry. Even though they received an average rating of 3.00 to 4.00, it indicated that participants either agreed or disagreed with the statements, with few agreeing with this statement. Even though that was the case, they had an influence due to their significance value being less than p = 0.005.

This can mean that when these technologies are implemented, from an organisational culture point of view, these organisations must make sure that these technologies are clear and easy to understand, the applications must be easy for employees to use, and it must be able to stimulate innovative ideas as these employees are interacting with these technologies.

Automation technology had an added dimension to the variables that influenced it. Most participants felt that the skills required for this type of technology were between high and very high (an average score of 4.20), and that it was a good idea to implement this technology in organisations. This is a very interesting result due to most mines in the industry being conventional and mechanized. These results suggest that there is a need for the industry to adopt automation technology. In terms of collaborative software, ease of use and the ability of these technologies to assist employees to come up with good ideas were seen to be influencers. This can be true in that, as they will be collaborative in nature, it will be easier and will stimulate innovative ideas as the end-user will always be in a team and won't be afraid to make mistakes. Lastly, non-technical skills such as system thinking and process understanding had only ease of use as an influencer. This can be tied up to the literature where Webber-Youngman (2017) mentioned that the ten (10) most important technical skills that are important for future employees when coping with the new environment are complex problem solving, critical thinking, creativity, people management, coordinating with others (collaboration), emotional intelligence, and so forth.

Reverting back to the research question and the research question null hypothesis, it was seen that job security did not have a relationship with skills requirements, but organisational culture was an influencer for the right skill set that is needed for the industry. It can thus be said that organisational culture is a vital cog in getting the right skill set when implementing the Fourth Industrial Revolution technologies in the platinum mine industry.

Due to the empirical results, the null hypothesis was accepted, but it must be noted that only organisational culture, not job security, had a relationship with it. When the right culture is developed in the organisation, people will not be afraid of the new developments that are coming to the industry. Most respondents had either a bachelor's degree or a post-graduate degree, and they were in the younger age category. It justifies that these people value culture more than job security, meaning that they are not afraid to lose their jobs as long as the organisational culture meets their expectations.

5.4. Limitations of the Study

A bigger sample is required to establish a more refined result and more time and resources are needed to successfully complete research of this nature. Research of this nature does not only require quantitative techniques but also qualitative techniques in order to get the views of mining executives and other stakeholders. However, the time constraints and the restrictions to interaction imposed by the COVID-19 pandemic made this very difficult. Initially, the research was planned as such, but due to time constraints, a quantitative approach was performed.

5.5. Recommendations

It is recommended that a larger sample be taken into consideration and an awareness of various industrial revolutions be done as there is a bias on whether the industry is between the second and the third industrial revolution. Employees and mining students need to be trained on the elements of the Fourth Industrial Revolution that are currently being used, which they are not necessarily aware of.

When the industry finally adopts the new technologies, care must be taken to involve all the necessary stakeholders. The government, corporates and universities, including organised labour, must work together to make this a success. Organised labour should be involved to have an idea of which occupations are going to be suited for people that do not have formal education or are partially educated.

5.6. Future Research

Future research must be carried out, with a particular emphasis on an in-depth examination of the educational and skill needs profile of the future employee, as well as how other technologies can benefit the mining industry. There are a few areas that are recommended or suggested for future research, and these are:

1. The research must not only focus on the platinum sector but rather on the mining industry as a whole, due to the mining industry's being one (1) of the major contributors to the country’s Gross Domestic Product (GDP). Such findings will apply to the entire industry rather than just the platinum mining industry, where the findings may be incompatible with other sectors.

2. Government, through policy in the education sector and consultation with other stakeholders in the industry, must take the lead in ensuring that the right curriculum is designed for these technological advances from primary school level all the way up to the tertiary level. Mining corporates must also invest more in research and development (R & D) in order to ensure that comprehensive research is done on the psychological well-being of future employees, as this will be a game-changer for the industry.
3. Multiple regression was performed to test the null hypotheses. Other regression models, i.e., ordinal regression and logarithmic regression, are also recommended, and these might unearth better results.

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Appendix 1.1: Permission Letter

Permission Letter

Wits Business School

To:

Sibanye Stillwater Employees

Sibanye Stillwater

Rustenburg

South Africa

Dear Sibanye Employees

My name is Tshepo Timothy I am an MBA student at Wits Business School. As part of my studies I am doing a research entitled: ***Assessing the Pre-Fourth Industrial Revolution Educational and Skills Needs in the South African Platinum Mining Industry.***

The aim of the study is:

1. To explore the available technologies that will benefit the platinum mining industry in the near future
2. To determine the skills and educational requirements that will empower current and future employees to be relevant when the fourth industrial revolution is implemented.
3. To identify the factors that will affect organisational cultures on employee productivity when these skills and knowledge are introduced in the South African platinum industry
4. To feed into policy in the South African Platinum mining industry and Higher Education Institutes Curriculum Planners in terms of the proper implementation of these skills and knowledge by the platinum mining companies.

As part of my MBA Research Report, different people will be interviewed ranging from industry experts, employees, academics, students as well as communities to find out about:

I. What fourth industrial revolution technologies will be available in future for the platinum mining industry?

II. What are the skills and educational requirements that will empower current and future employees to be relevant when the fourth industrial revolution is implemented?

III. What are the factors that will affect organisational cultures on employee productivity when these skills and knowledge are introduced in the South African platinum industry?

IV. What level of engagement is required by educational institutions, the mining corporates, and the government in order to develop the curriculum needed for the fourth industrial revolution?

I would like to recognise the experts and people who contribute to this research and acknowledge them in my report. By agreeing to participate I recognise you as part of the contributing experts. However, if you do not agree with this, I will not compel you. Your participation in this interview is voluntary, confidential and will be treated with anonymity. The interview will be done at Sibanye Stillwater Hex River Complex in Rustenburg.

I would therefore appreciate your written consent, if you are willing to participate in the study. There are no benefits, financially or otherwise to be gained from participation.

If you have any questions during or afterwards about this research, feel free to contact me or my supervisors on the details listed below. This study will be written up as a research report which will be available online through the university library website, if you wish to receive a summary of this report. The data collected from this research project will be stored in the Witswaterand University archives. With your permission the data collected from this research project may be used by other researchers (optional). If you have any concerns or complaints regarding the ethical procedures of this study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrec-medical.researchoffice@wits.ac.za.

Thank you for taking time to read through this letter.

Yours Faithfully

Tshepo Timothy

Signature

Cell Number: 0726462213/0834595376 Email Address: ogomoditsetimothy@gmsil.com

Or

Supervisors

Dr Kambidima Wotela Cell: Email: kambidima.wotela@wits.ac.za

Thandiwe Chidzungu Cell: 0744351520 Email: thandiwe.chidzungu@wits.ac.za

Appendix 1.2: One-page bio of the researcher including declaration of interest in the research and funders, if any

Graduate School of Business Administration
University of the Witwatersrand, Johannesburg

Wits Business School

10. Summary CV of applicant

10.1 List your academic qualifications. Include dates or current registration status

1. N.Diploma Minerals Surveying - 2008
2. B-Tech Degree (MRM) - 2009
3. Post Graduate Diploma in Business Administration - 2019

10.2 Describe any ethics content training you have previously received (e.g. ethics short courses; online courses; ethics CPD courses; ethical input as part of a research methods course)

No training received

Appendix 2.1: Ethics Documentation

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: Not available.

This certificate is only valid with a legitimate ethics protocol number and signed by the Researcher (below).

This certificate is only valid if accompanied by formal permission from the relevant stakeholder(s).

Project title	The Fourth Industrial Revolution in the South African platinum mining industry
Investigator / Researcher	Mr Tshepo Timothy
Nature of Project	MBA (Research Article)
Decision of the Committee	Approved unconditionally
Issue Date of Certificate	2021-03-09
Expiry date	Date of submission of the project report
Chairperson	Prof Anthony Stacey +27 11 717 3587 +27 82 880 4531 Anthony.Stacey@wits.ac.za

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

09 March 2021
Date:

Appendix 2.2: Gender of Respondents

Table 6-1: Gender Frequency Distribution

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	19	70.4	70.4	70.4
	Female	8	29.6	29.6	100.0
	Total	27	100.0	100.0	

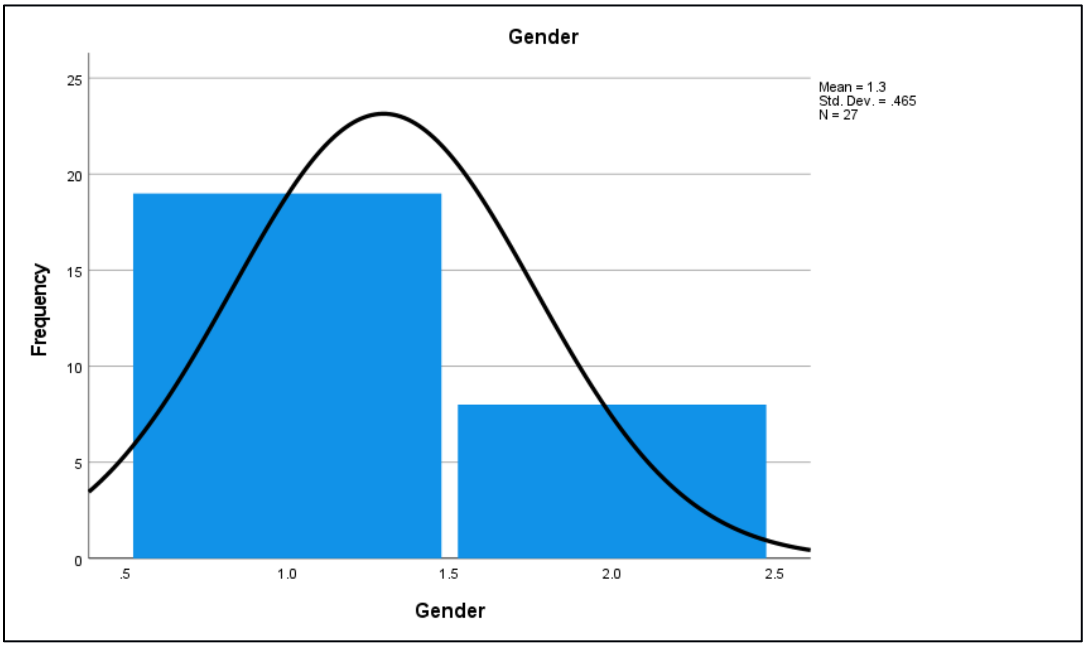


Figure 6-1: Gender Histogram

Appendix 2.3: Job Category

Table 6-2: Job Category Frequency Distribution

Job Category

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	University Student	2	7.4	7.4	7.4
	Mine Official (Supervisor)	5	18.5	18.5	25.9
	Junior Management	7	25.9	25.9	51.9
	Middle Management	10	37.0	37.0	88.9
	Senior Management	3	11.1	11.1	100.0
	Total	27	100.0	100.0	

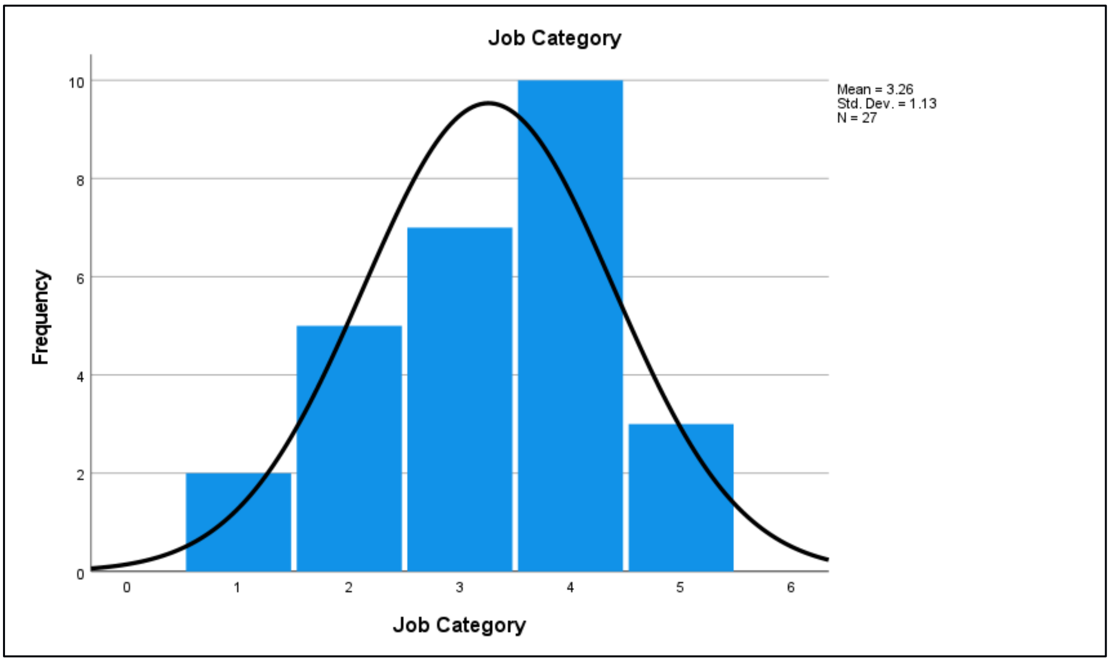


Figure 6-2: ***Job Description Histogram***

Appendix 2.4: Level of Education

Table 6-3: Level of education Frequency Distribution

Level of Education		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High School or lower	1	3.7	3.7	3.7
	Diploma or Trade Qualification	2	7.4	7.4	11.1
	Bachelors Degree	14	51.9	51.9	63.0
	Post Graduate Qualification	10	37.0	37.0	100.0
	Total	27	100.0	100.0	

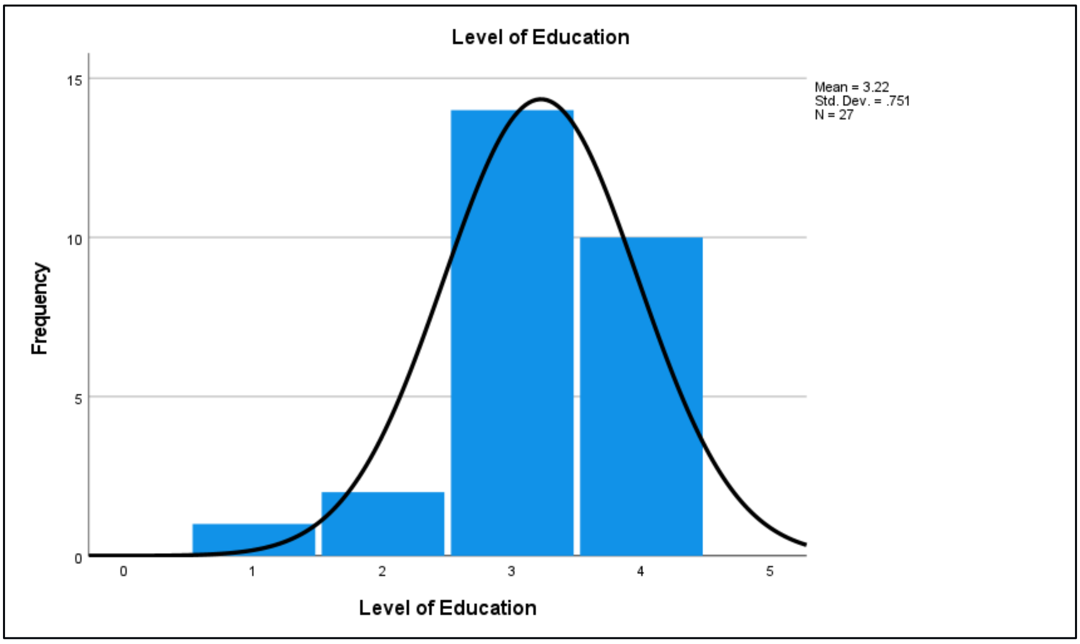


Figure 6-3: ***Level of Education Histogram***

Appendix 2.5: Organisation

1. Organisation

Table 6-4: Organisation Frequency Distribution

Organisation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sibanye Stillwater	20	74.1	74.1	74.1
	Anglo Amarican Platinum	3	11.1	11.1	85.2
	Impala Platinum	2	7.4	7.4	92.6
	Northam Platinum	1	3.7	3.7	96.3
	Other	1	3.7	3.7	100.0
	Total	27	100.0	100.0	

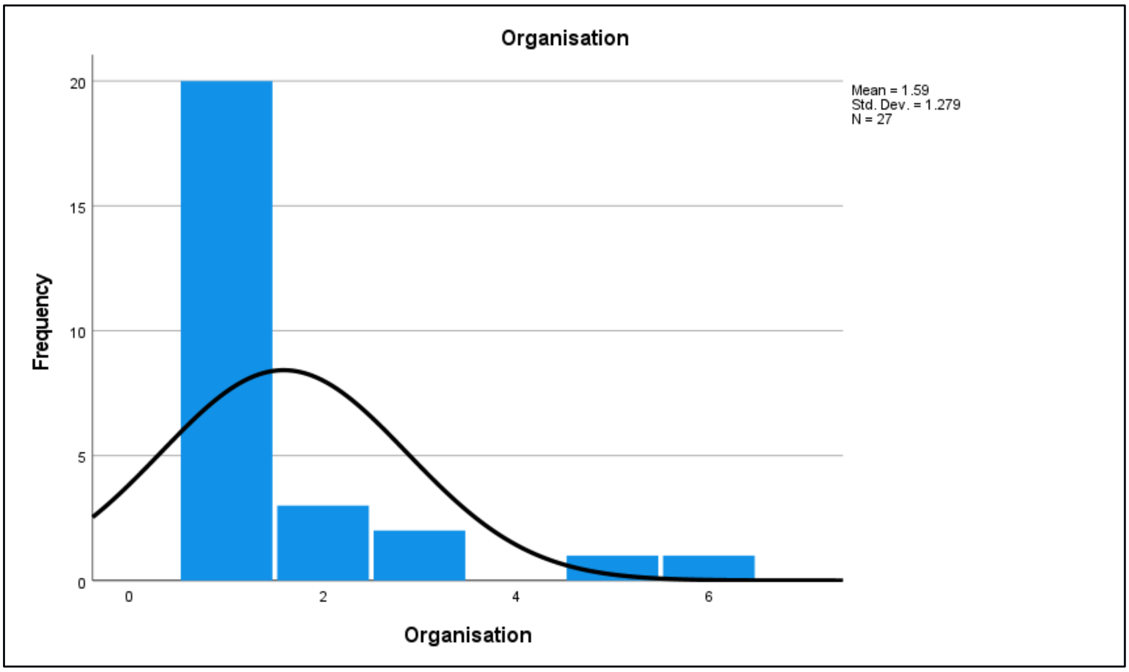


Figure 6-4: Organisation Histogram

Appendix 2.6: RELIABILITY TESTS

Question 11

Case Processing Summary

		N	%
Cases	Valid	27	100.0
	Excluded[a]	0	.0
	Total	27	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.911	7

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
SMEAN(ITI)	25.600	18.308	.812	.888
SMEAN(AT)	25.720	18.271	.756	.894
SMEAN(DA)	25.640	18.606	.775	.892
SMEAN(DSCS)	25.600	20.154	.678	.903
SMEAN(DAAS)	25.800	18.692	.764	.893
SMEAN(CS)	25.560	18.083	.840	.885
SMEAN(NTS)	25.840	20.975	.491	.921

Question 12

Case Processing Summary

		N	%
Cases	Valid	27	100.0
	Excluded[a]	0	.0
	Total	27	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics	
Cronbach's Alpha	N of Items
.792	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
SMEAN(OTU)	8.527	1.632	.711	.629
SMEAN(DTU)	8.367	1.846	.656	.694
SMEAN(Enjoyment)	8.560	1.929	.541	.813

Question 13

Case Processing Summary

		N	%
Cases	Valid	27	100.0
	Excluded[a]	0	.0
	Total	27	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics	
Cronbach's Alpha	N of Items
.864	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
SMEAN(Jobsecurity)	11.920	5.071	.557	.883
SMEAN(Jobsustainability)	11.960	4.729	.818	.809
SMEAN(Jobredundancy)	12.360	3.683	.789	.794
SMEAN (Careersustainability)	12.480	3.394	.792	.801

Question 14

Case Processing Summary

		N	%
Cases	Valid	27	100.0
	Excluded[a]	0	.0
	Total	27	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.969	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
SMEAN(Operate)	6.400	4.154	.970	.926
SMEAN(Interaction)	6.000	4.923	.867	1.000
SMEAN(Simplicity)	6.400	4.154	.970	.926

Question 15

Case Processing Summary

		N	%
Cases	Valid	27	100.0
	Excluded[a]	0	.0
	Total	27	100.0

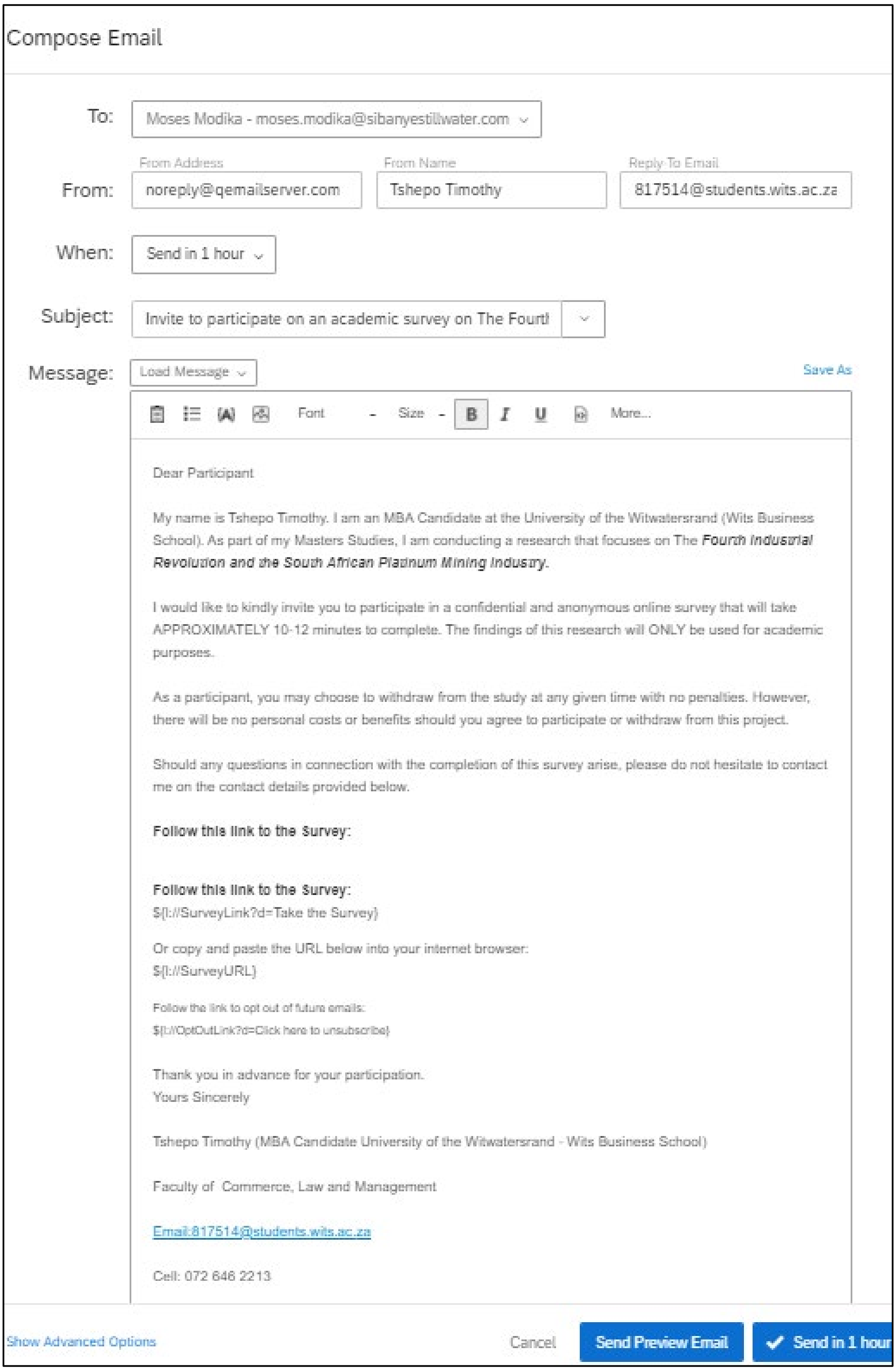
a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.924	2

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
SMEAN(Ideas)	3.040	1.422	.864	.
SMEAN(Scope)	3.360	1.145	.864	.

Appendix 3.1: Dully filled in data collection instrument(s)



Compose Email

To: Moses Modika - moses.modika@sibanyestillwater.com

From: From Address: noreply@qemailserver.com | From Name: Tshepo Timothy | Reply-To Email: 817514@students.wits.ac.za

When: Send in 1 hour

Subject: Invite to participate on an academic survey on The Fourth

Message: Load Message | Save As

Font | Size | B | I | U | More...

Dear Participant

My name is Tshepo Timothy. I am an MBA Candidate at the University of the Witwatersrand (Wits Business School). As part of my Masters Studies, I am conducting a research that focuses on The ***Fourth Industrial Revolution and the South African Platinum Mining Industry.***

I would like to kindly invite you to participate in a confidential and anonymous online survey that will take APPROXIMATELY 10-12 minutes to complete. The findings of this research will ONLY be used for academic purposes.

As a participant, you may choose to withdraw from the study at any given time with no penalties. However, there will be no personal costs or benefits should you agree to participate or withdraw from this project.

Should any questions in connection with the completion of this survey arise, please do not hesitate to contact me on the contact details provided below.

Follow this link to the Survey:

Follow this link to the Survey:
${l://SurveyLink?d=Take the Survey}

Or copy and paste the URL below into your internet browser:
${l://SurveyURL}

Follow the link to opt out of future emails:
${l://OptOutLink?d=Click here to unsubscribe}

Thank you in advance for your participation.
Yours Sincerely

Tshepo Timothy (MBA Candidate University of the Witwatersrand - Wits Business School)

Faculty of Commerce, Law and Management

Email:817514@students.wits.ac.za

Cell: 072 646 2213

Show Advanced Options | Cancel | Send Preview Email | Send in 1 hour

Figure 6-5: Qualtrics XM Online Questionnaire (Source: Qualtics XM)

The Fourth Industrial Revolution and the South African Platinum Mining Industry

IQ Score: Fair

Section A: Demographic Questions

Q1

What is your gender?

- Male
- Female
- Prefer not to say

Q2

Which age category do you fall under?

- 18-30
- 31-40
- 41-50
- 51+

Q3

What job category do you fall under?

- Senior Management
- Middle Management
- Junior Management
- Mine Official (Supervisor)
- University Student

Q4

What is your highest level of education?

- High School or lower
- Diploma or Trade Qualification
- Bachelors Degree
- Postgraduate Qualification

Q5

What organisation do you belong to?

- Sibanye Stillwater
- Anglo American Platinum
- Impala Platinum
- Modikwa Platinum Mine
- Northam Platinum Mine
- Other

Q6

If the answer was "other" in Q5, please specify

Import from library | + Add new question

Section B: Organisation Questions

Q7

How many people work in your organisation?(including both full-time and part-time but excluding contractors)

- Between 1 and 3 999
- Between 4 000 and 7 999
- Between 8 000 and 11 999
- 12 000 and more

Q8

At what technological stage is your organisation currently?

- First industrial revolution - mechanised production process
- Second industrial revolution - mass production
- Third industrial revolution - automation and use of digital technology
- Fourth industrial revolution - fusion of physical, digital and biological technologies

Q9

What fourth industrial revolution technologies are currently used and will be available in future for the platinum mining industry? (Choose one option in each technological innovation)

	Current use	Probable future use
	Current Use	Probable future use
Internet of things (IoT)	○	○
Sensor technology	○	○
Mobile technologies	○	○
Radio-frequency identification (RFID)	○	○
Real-time location system	○	○
Big data	○	○
Cloud technology	○	○
Embedded IT systems	○	○
Machine to machine communication	○	○
3-D printing	○	○
Machine learning	○	○
Artificial Intelligence (AI) Robotics &Automation	○	○

Import from library | + Add new question

Add Block

Section C: Student/Employee Attitude, Satisfaction & Insecurity

Q10

What level of engagement is required by educational institutions, the mining corporates, and the government in order to develop the curriculum needed for the fourth industrial revolution (4IR Technology)?

- ○ Very High
- ○ High
- ○ Moderate
- ○ Low
- ○ Very Low

Q11

Please evaluate the skills and educational requirements that will empower current and future employees to be relevant when the fourth industrial revolution (4IR Technology) is implemented

	Very Low	Low	Moderate	High	Very High
IT infrastructure	○	○	○	○	○
Automation technology	○	○	○	○	○
Data analytics	○	○	○	○	○
Data security/Communications security	○	○	○	○	○
Development of applications of assistance systems	○	○	○	○	○
Collaborative software	○	○	○	○	○
Non-technical skills such as systems thinking and process understanding	○	○	○	○	○

Q12

Please evaluate the following statements with respect to the use of AI software/application (4IR Technology) in your organisatiom

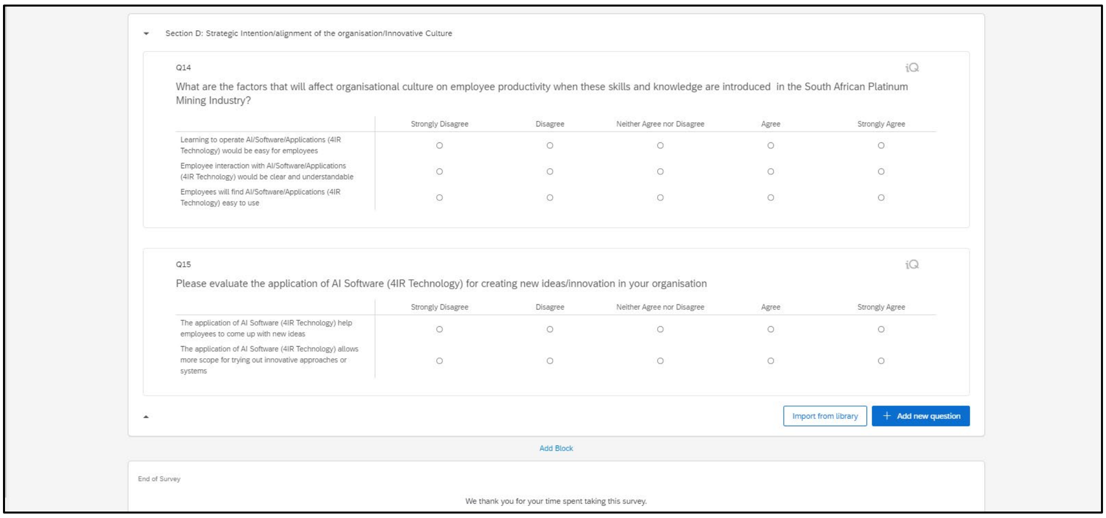
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly agree
Using AI/Software/Applications (4IR Technology) in my organisation is a good idea	○	○	○	○	○
Using AI/Software/Applications (4IR Technology) in my department is beneficial to the organisation	○	○	○	○	○
Using the latest AI/Software/Applications (4IR Technology) is always enjoyable	○	○	○	○	○

Q13

Please indicate the item which best describes your opinion of the feelings of you as a student/future employee regarding your perception due to the implementation of AI/Software/Applications (4IR Technology)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Argee
I am very confident that I will be able to keep my job despite the implementation of the AI/Software/Applications (4IR Technology)	○	○	○	○	○
I think that I will be able to continue working in the organisation despite increase in the use of AI/Software/Applications (4IR Technology)	○	○	○	○	○
I fear that I will be redundant due to the increases in the use of AI/Software/Applications (4IR Technology)	○	○	○	○	○
I worry about the continuation of my career due to the use of AI/Software/Applications (4IR Technology)	○	○	○	○	○

Import from library | + Add new question


Section D: Strategic Intention/alignment of the organisation/Innovative Culture

Q14

What are the factors that will affect organisational culture on employee productivity when these skills and knowledge are introduced in the South African Platinum Mining Industry?

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Learning to operate AI/Software/Applications (4IR Technology) would be easy for employees	○	○	○	○	○
Employee interaction with AI/Software/Applications (4IR Technology) would be clear and understandable	○	○	○	○	○
Employees will find AI/Software/Applications (4IR Technology) easy to use	○	○	○	○	○

Q15

Please evaluate the application of AI Software (4IR Technology) for creating new ideas/innovation in your organisation

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
The application of AI Software (4IR Technology) help employees to come up with new ideas	○	○	○	○	○
The application of AI Software (4IR Technology) allows more scope for trying out innovative approaches or systems	○	○	○	○	○

Import from library

Add new question

Add Block

End of Survey

We thank you for your time spent taking this survey.