EXPLORING EMPLOYEES' RESISTANCE TOWARDS THE CREATION OF AN EXECUTABLE PROCESS MODEL FOR INNOVATION ADOPTION IN MINING

BY

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DECLARATION

I, Sibongile Amos Xheko, affirm that all the work presented in this research article is my original work, except for any referenced contributions and acknowledgments. This submission satisfies the requirements for the Master of Business Administration degree at the University of the Witwatersrand, Johannesburg, and has not been previously submitted for any other degree or examination at this or any other university.

Amos Xheko

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Signed at: Polokwane, South Africa on the **13th** day of **June 2024.**

DEDICATION

The work is dedicated to my late father, Solomon Skade Xheko. We are grateful that you provided us with an education, something you were never able to have for yourself. I want to express my gratitude to you for your selflessness during the times I was struggling to make ends meet and for your unwavering faith in my potential to become a successful businesswoman in the future.

The beloved underground mining sector in South Africa is the target audience for this work in particular. The goal of this study is to better understand what the industry is doing incorrectly when it comes to implementing cutting-edge technologies in order to enhance the health and safety of workers below ground. For those who have lost their lives due to accidents were in my mind when I navigated through the research, may their souls rest in eternal peace and we hope this research will come up with a way of curbing the accidents caused by underground trackless mobile machines.

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ABSTRACT

Background: Mining is one of the oldest and most essential industries in the world, but it is also one of the most conservative and resistant to change. Despite the potential benefits of modern technology innovation, such as improved productivity, safety, efficiency, and environmental performance, mining companies face significant challenges in adopting and implementing them. In this document, we will identify the biggest challenge for mining companies when they introduce modern technology innovation and suggest some workable solutions to overcome it.

Objective: The purpose of this comprehensive research study is to identify how change management process facilitate the adoption of modern technology like collision avoidance systems (CAS level 9) in the South African mining industry? There has been known and unknown challenges, strategies, and unusual decisions related to implementation of modern technology in the mining sector.

Methods: The study applied a qualitative research approach dissection based on organizations' readiness to implement modern technology, while putting emphasis on change management. In total, 16 individuals were interviewed with four questions posed on each group. The records were obtained from 2015 which was the first year of introducing proximity detection systems, until December 2022 after the pronouncement of the collision avoidance system level 9. Then, we updated the search to the 2023, which was the first year of full implementation of CAS level 9. After removing duplicates and reviewing articles according to inclusion and exclusion criteria, 16 interviewees were used for the study. Finally, the study proposed a conceptual framework of technology implementation executable process model for implementation of new technology based on the literature findings to fight against the loss of life on the mining industry due to collision of vehicle to vehicle or vehicle to man.

Results: The failure of proper technology implementation posed numerous adverse consequences, such as organisational cultural shock, safety crisis, change in user/operator behaviours, and challenges at the organization level to continue business operations. Besides, the strategies included flexibility, strengthening internal efficiency, talent acquisition, and making innovative changes based on organizational assessment and needs for smooth business activities.

Conclusion: The appropriate modern technology strategies implementations would increase employees' well-being, satisfaction, productivity, and health safety at the workplace. Resistance to change was pointed as one of the key factors that leads to failure to implement modern technology innovations in the mining sector. Proper change management process is one of the key factors that will assist the mining industry in the implementation of modern technology.

The following elements were considered important in this research:

1. Comprehending Collision Avoidance Systems: A general introduction to collision avoidance technologies is given, such as automated emergency braking, audible and visual warning, and radar-based systems.
2. Implementation Challenges: Emphasis is given on the difficulties businesses come across in incorporating collision avoidance technologies, including staff opposition, cultural changes, and technological difficulties.

Keywords: Collision Avoidance Systems; automated emergency braking; and organizational adaptability and change management.

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CHAPTER 1: INTRODUCTION

1.1 Purpose of the study

The purpose of the study is to find out how South African mines went about the adoption of collision avoidance systems, after the promulgation by the Chief Inspector of mines. The Level 9 vehicle intervention for collision avoidance rule, which went into effect in December 2022, requires all trackless mobile machinery (TMM) used in mining operations to have an electronic proximity detection system (PDS) (Moore, 2013). Considerable efforts have been made by the Department of Mineral Resources and Energy (DMRE) to enforce safety regulations pertaining to collision avoidance in surface and underground mining (Cornish, 2015). In a mining environment, a collision avoidance system is intended to avert mishaps by identifying possible collisions between machines to humans, machines to equipment, and machines to machines. These systems monitor the environment and give operators alerts in real time using sophisticated sensors, radar, cameras, and communication technology.

1.1.1 **Crucial Elements of Systems for Preventing Collisions**:

Proximity Detection technology (PDT) determines the relative positions of adjacent people, machinery, and objects. The technology has warning alerts that when a possible collision risk is identified, operators are alerted visually, audibly, or tactilely. There is an automated Interventions that saw the introduction of Level 9 systems, these could halt or slow down the machinery automatically if they identify an impending accident. The implementation of the systems came with challenges which required the trackless mobile machines (TMM) Integration with the Collision Avoidance systems (CAS). Collision avoidance systems are easily incorporated into trackless mobile equipment to provide constant monitoring while mining operation is underway.

1.1.2 **Advantages of the collision avoidance systems:**

Enhanced Safety systems safeguard personnel, property, and infrastructure by averting collisions. Once the system has been implemented successfully it yields increased productivity by using real-time data to inform their decisions, operators may maximize efficiency. Another advantage is the Regulatory Compliance which could be achieved by adherence to safety standards that are ensured by meeting Level 9 requirements. Some of the Industry Leaders include well known and accredited manufacturers and installers, at some instances electronics specialists had to be lured

to assist in the design, installation, and commissioning of the system. These are pioneers in proximity sensing and collision avoidance, who have spent more than 15 years perfecting their technology.

Their ability to provide top-notch solutions is a result of their partnerships with international technology integrators. Environmental condition within the harsh mining environment of South Africa, led to the introduction of Collision Avoidance System (CAS) suppliers who have been effectively implemented (Ramjack, 2015).

In conclusion, collision avoidance systems are essential to the mining industry in South Africa for preserving personnel safety, machinery, and output. Their adoption demonstrates a dedication to legal compliance and the desire by Chief Executive Officers' drive for zero harm when it comes to safety.

1.2 Background of the study

The Earth Moving Equipment Safety Round Table (EMESRT), is a global project comprising major mining corporations, the main objective for the establishment of this platform was based on the high number of fatalities and mishaps in the mining industry worldwide (Global, n.d.). This project managed to bring together different original equipment manufacturers (OEM) with an aim of coming with a special design to be able to minimise the rate at which accidents were taking place on the mines. For this initiative to be successful EMESRT urged the Original Equipment Manufacturers (OEM) to come up with systems that could make it safe for persons at the mines whilst ensuring that the system adopted is maintainable to achieve the objective for its usage.

For the tripartite (the employer, the state and the employees' representatives) to work effectively EMERST looked at the different equipment suppliers and started investigating their capabilities in terms of internet of things (IoT) systems and technology that will be able to back the Collision Avoidance System (CAS)' level 9 requirements. During the initial state it was discovered that certain original equipment manufacturers had no solutions to the requirements of the technology to activate the retard and stop functionality. This opened opportunities for those who had the technology to start engaging with the equipment suppliers who were required to have it but had shortcomings, all these joint ventures were facilitated by EMERST.

Their development shows a dedication to preserving sustainable mining methods, lowering accident rates, and safeguarding human life. The introduction of collision avoidance (CAS) offers a Safety Imperative because of its deep-level mines, intricate tunnels, and large machinery. In the past, mining accidents brought on by collisions

involving humans, equipment, and vehicles have resulted in casualties, deaths, and lost productivity. As a result, the sector has made safety measures such as the installation of collision avoidance systems a priority.

The South African Chamber of Mines played a significant role in bringing different equipment suppliers, electronics suppliers, and mining houses together to assist each other in achieving what was already hinted at by the DMRE pertaining to retard and stop functionality. These businesses made significant contributions to the advancement of collision avoidance technologies in South Africa. These programs organised by the South African Chamber of Mines aimed to promote safety in addition to the compliance culture. This saw ongoing Innovation and Research programs by different industry specialists including Scientists who started looking at how to improve collision avoidance systems.

Summary of the incidents

Below is the summary of the incidents that took place since the introduction of the Proximity Detection Systems (PDS):

Main ideas:

- The document reports on the accidents and fatalities related to underground trackless mobile machinery (TMM) from 2015 to 2023. The document provides a description of the accidents that occurred in each year, as well as an analysis of the potential root causes, observations, and recommendations.
- The document shows that most of the fatalities were caused by poor visibility, incorrect positioning, and failure to follow procedures.
- The document highlights the common factors that contributed to the collision of TMM and pedestrians, such as the lack of cameras, proximity warning devices, traffic light systems, and collision prevention systems.
- The document suggests that the installation of collision avoidance system level 9 could reduce the loss of lives in the underground environment**.** The document states that the system can detect, warn, and automatically stop the TMM when a hazard is noticed in the close vicinity of the machinery, and that it was introduced after an investigation of the previous incidents.
- The information shows that since the introduction of CAS level 9 during December 2022 there were only two fatalities due to the same cause. There is still a long way to go in the introduction of new technology in the mining industry, this study looked

at the introduction of the CAS level 9 system and investigated what process was followed to introduce this.

Below are the statistics of accidents related to underground trackless mobile machinery (TMM) since the introduction of proximity detection systems from 2015 to date:

Table 1: 2015 Fatalities Analysis

Year	Accident description
2015	While walking past a scissor lift cassette, the LHD turned into the lateral 24 as the LHD articulated, he got caught between the LHD & lateral
	The injured was fatally injured when he was struck by a Utility Vehicle.
	A third LHD entered the diesel bay and collided with a LHD which pinned the LHD driver of that LHD against a LHD that broke down.
	Struck by a moving equipment case while busy drilling holes to install bunting bracket with a hilt-handheld drill
	Whilst loading material driver felt bump on front end loader wheels. When he stopped he noticed a person lying behind the loader

Table 2: 2016 Fatalities Analysis

Year	Accident description
2016	The now deceased was caught in between the goose neck of the toe hall lowbed and the dust curtain of the drill rig.
	Whilst the injured was walking on the plant, he was run over by a front-end loader.
	A worker discovered a body of a contractor employee trapped between the chassis and the bin of a vehicle.
	Whilst the operator positioned the continuous miner to start cutting, the deceased was caught between the cm and sidewall.
	Whilst attending to a breakdown on an LDV, it rolled backwards and struck the deceased against a static UV which was on its way

Table 3: 2017 Fatalities Analysis

Classification (Provisional)	Potential Root Causes	Observations/Recommendations	Common Recommendations
Transportation and Mining (Trackless Mobile Machinery)	(1) Poor visibility for both LHD Operator and deceased	(1) Installation of cameras as a visual aid for the Operators (2) Installation of proximity warning devices for both pedestrians and Operators.	(1) Installation of cameras as a visual aid for the Operators (2) Installation of proximity warning devices for both pedestrians and Operators.
Transportation and Mining (TMM)	(1) Poor visibility for both UV operator and deceased (1) Incorrect positioning of the deceased. (2) Poor communication between the UV operator and the deceased.	(1) Installation of cameras as a visual aid for the Operators (2) Installation of proximity warning devices for both pedestrians and Operators.	
Transportation and Mining (TMM)	(1) Failure to follow procedure, in that two vehicles were following each other on an incline. (2) Possible incorrect hitching of the trailer. (Poor technique used)	1) Investigate traffic light systems to allow only one vehicle on the incline at any one time.	

Table 4: 2018 Fatalities Analysis

Classification (Provisional)	Potential Root Causes	Observations/Recommendations	Common Recommendations
Transportation and Mining (TMM)	(1) Positioning of the deceased on the blind side of the LHD Operator (2) Failure of the LHD Operator to respond to proximity detection warning device	(1) Collision prevention systems (2) Investigate the use of on-board cameras to increase vision of LHD Operators.	(1) Collision prevention systems (2) Investigate the use of on-board cameras to increase vision of LHD Operators. (3) Strict adherance to operating/parking procedures
Transportation and Mining (TMM)	(1) Failure to switch off the machine before exiting the cab (2) Failure to adhere to TMM operating procedure (exiting protocols)	(1) Strict adherance to operating/parking procedures	
Transportation and Mining (TMM)	(1) Incorrect positioning of the deceased in close proximity to the CM while tramming (2) Poor communication between the deceased and CM Operator	(1) Collision prevention systems for electrically driven machines, especially while tramming	
Transportation and Mining (TMM)	(1) Incorrect positioning of the deceased in articulation area of LHD	(1) Installation and maintenance of a barrier wire in articulation area of LHDs	

Table 5: 2019 Fatalities Analysis

Classification (Provisional)	Potential Root Causes	Observations/Recommendations	Common Recommendations
Transportation and Mining (TMM)	1) Failure/absence of a collision prevention system to detect, warn and automatically stop the shuttle car	1) Installation, regular maintenance and testing of collision prevention systems for both machines and pedestrians.	(1) Strict adherence to TMM operating procedures. (2) Investigate hydraulic cut-off when door switch is activated. (3) Installation, regular maintenance and testing of collision prevention systems for both machines and pedestrians. (4) Raising awareness on the importance of strict adherence to procedures
Transportation and Mining (TMM)	(1) Failure of the deceased to carry their lamp on their person at all times (2) Incorrect positioning of the deceased in a known LHD tramming path	No recommendations	
Transportation and Mining (TMM)	(1) Failure to adhere to procedure in that deceased did not apply park brakes/neutral brake (2) Failure to adhere to procedure in that deceased did not install stop blocks during refuelling (3) Failure of door switch to apply brakes	(1) Raising awareness on the importance of strict adherence to procedures (2) Proper maintenance and testing of all safety devices on TMM	

Table 6: 2021 Fatalities Analysis

Classification (Provisional)	Potential Root Causes	Observations/Recommendations	Common Recommendations
Transportation and Mining (TMM)	Potential causes: (1) Pedestrian could not see or hear LHD on time to avoid its path. (2) Possible failure of PDS either on the caplamp or the LHD (3) Possible unsafe positioning of the pedestrian on the "blind side" of the LHD	(1) Always ensure the integrity of the PDS for both caplamps and machines (2) Investigate the need for installation of CPS on LHDs and other diesel-powered TMM	(1) Always ensure the integrity of the PDS for both caplamps and machines through testing stations located strategically. (1) Investigate the need for installation of CPS on LHDs and other diesel-powered TMM (1) Investigate the use of cameras on LHDs to increase Operator visibility. (2) Always ensure the integrity of the PDS for both caplamps and machines through testing stations located strategically. (3) Investigate the use of cameras on LHDs to increase Operator visibility. (3) Investigate the need for installation of CPS on LHDs and other diesel-powered TMM (4) Apply proper change management methods when introducing version updates to existing safety systems. (5) Investigate the use of cameras on LHDs to increase Operator visibility. (6) Apply proper change management methods when introducing version updates to existing safety systems. (7) Only authorised competent persons to operate TMM. (7) Investigate electronic ID system to limit operation of TMM to only authorised persons.
Transportation and Mining (TMM)	Possible causes include: (1) Poor change management in that an old generation caplamp was being used with a new generation CPS on the machines. (2) Allowing persons (Spotters) to work in close proximity to TMM as part of their daily duties. (3) Failure to report and repair dysfunctional caplamp and machine units.	(1) Always ensure the integrity of the PDS for both caplamps and machines through testing stations located strategically. (2) Investigate the use of cameras on LHDs to increase Operator visibility. (3) Apply proper change management methods when introducing version updates to existing safety systems.	
Transportation and Mining (TMM)	Potential causes: (1) Deceased not positioned in a safe area, given that he was sitting in a loading stub. (2) Possible failure of PDS either on the caplamp or the LHD or failure to respond to the warnings by either the deceased or LHD Operator.	(1) Always ensure the integrity of the PDS for both caplamps and machines (2) Investigate the need for installation of CPS on LHDs	

Table 7: 2023 Fatalities Analysis

Region	Accident Description	Potential Contributing Factors	Observations/Recommendations
MP	The now deceased woman Security Officer was fatally injured when she was trapped under both second axil tyres of the dump truck. The now deceased was doing access control at the mine gate and when she was done taking the truck driver's details, the boom gate was opened and the truck proceeded forward, then a scream was heard and she was discovered.	(1) Incorrect positioning by the deceased near dump truck tyres. (2) Poor communication between the deceased, the boom gate operator and the dump truck driver. (3) Failure by the dump truck driver to observe the surroundings before moving. (4) Poor visibility due to time of day.	(1) Investigate the use of positive communication between security personnel before opening boom gate. (2) Ensure sufficient lighting around security checkpoints. (3) Investigate the use of parking distance controllers for dump trucks.
MP	The now deceased Engineering Fitting Assistant was fatally injured in a TMM accident. Two employees were walking up the decline when the utility vehicle (UV) was on its way down the same decline. The UV Operator was apparently looking down and on looking up, the two employees were in front of the UV. Upon being warned by the UV Operator, one of the two employees stood at a place of safety and one employee got fatally injured by the UV.	(1) Lack of separation of pedestrians from TMM (physical or time based). (2) Poor key control allowing unauthorised persosn to operate TMM. (3) Lack of a dedicated testing area separate from normal operations. (4) Failure by the Operator to respond to warning device. (5) Failure by the Operator to focus in idrection of travel (looked down inside machine).	(1) Implementation of sound separation principles. (2) Institute procedure for TMM testing away from normal operations. Ensure strict adherence to maintenance and testing procedures (3) Ensure proper key control measures are in place with frequent audits for system gaps. (4) Where a significant risk of collision exists, collision prevention systems to be installed.

1.3 Problem Statement

1.3.1 Main problem

The implementation of technology in the form of collision avoidance system has been promulgated by the minister of minerals, resources, and energy in December 2022. The pronouncement instructed that all underground mining trackless mobile machines should have a system that enables the underground machine to retard and stop in a case where the operator of such machine does not respond when approaching a hazard. The implementation of technology in the mining industry has seen both negative and positive outcomes, questions had been raised trying to understand why this has been the case. From the previous experiences there seem to be challenges in having an executable process model for innovation implementation in mining, this study is going to be focussing on that.

Organisational resistance to change is one of the barriers to the adoption of technological innovations in the mining industry. Existing innovation models usually do not incorporate the environment in which innovation takes place, the role of people, or how to include them in the innovation adoption processes. Because innovations require changes to the mining process, which impacts value, the characteristics of mining make them hard to adopt.

The study explored how the mining industry adopted innovations in collision avoidance system (CAS). The researcher used a qualitative exploratory approach and interviewed highly skilled mining practitioners. The goal was to create an executable process model for innovation adoption specific to the mining context. Drawing from empirical data and existing literature on innovation and change management, the study emphasized the active involvement of people in the innovation process.

1.3.2 Statement of purpose

The primary aim of this study is to explore the factors contributing to the unsuccessful implementation of new technology within the South African mining sector. Specifically, the study will investigate the challenges surrounding the adoption of collision avoidance systems (CAS) for underground trackless mobile machines and personnel. The research will emphasize the critical role of change management in facilitating successful technology integration.

The RSA TMM Regulations (8.10) were formulated during 2012/13 and were officially released on February 27, 2015 (RSA Government Gazette, 1996). Although auto slowing and stop technology, as defined by the end user (mines) or supplier(s), is commonly referred to as CAS Level 9, the RSA TMM Regulations impose highly strict standards on collision prevention systems (RSA Government Gazette, 1996). The distinction between CAS Level 9 and Collision Prevention Systems (CPS) is what leads to a great deal of misunderstanding over the RSA regulatory compliance status of CAS Level 9 systems. The primary aim of this study is to explore the factors contributing to the unsuccessful implementation of new technology within the South African mining sector. Specifically, i will investigate the challenges surrounding the adoption of collision avoidance systems (CAS) for underground trackless mobile machines and personnel. My study will emphasize the critical role of change management in facilitating successful technology integration.

1.4 Research Objective

The aim of this study is to understand the main contributing factors that leads to the failure of implementing change management during the rolling out of technology innovation in mining. To get clarity on the topic the following points were dealt with in depth:

1.4.1 To evaluate the effectiveness of change management when rolling out collision avoidance systems with an aim of reducing the number and severity of accidents on the mines.

1.4.2 To identify the factors that affect the adoption of technology by operators and other technology users in an underground situation.

1.4.3 To investigate the impact of behaviour of users of technology (operators and other workers) in an underground condition.

1.5 Significance of the Study

Introduction

Mining is one of the oldest and most essential industries in the world, but it is also one of the most conservative and resistant to change. Despite the potential benefits of modern technology innovation, such as improved productivity, safety, efficiency, and environmental performance, mining companies face significant challenges in adopting and implementing them. In this document, i will identify the biggest problem for mining companies when they introduce modern technology innovation and suggest some workable solutions to overcome it.

The Biggest Problem: The Human Factor

According to a survey conducted by Global, Ernst & Young (2018), the biggest barrier to digital transformation in mining is not the lack of technology, but the lack of skills, culture, and organizational alignment. In other words, the human factor is the biggest problem for mining companies when they introduce modern technology innovation. This problem can manifest in numerous ways, such as:

- Lack of awareness and understanding of the benefits and risks of modern technology innovation among the management, the workforce, and the stakeholders.
- Lack of trust and confidence in the reliability, security, and usability of modern technology innovation, especially among the older and more experienced workers.
- Lack of skills and competencies to operate, maintain, and optimize modern technology innovation, resulting in low adoption rates, deficient performance, and high turnover.
- Lack of collaboration and communication between the different departments, functions, and levels of the organization, leading to silos, conflicts, and inefficiencies.
- Lack of change management and leadership support to drive the cultural and behavioural changes required for successful technology innovation.

The importance of this study is observed because mining industry is one of the industries that employ old conventional ways of extracting minerals from deep levels underground, for this to happen humans are on the forefront of performing this function. There has been a couple of technology implantation throughout the industry and one of such was in the trackless mobile machines space. The Mine Health and Safety Act of South Africa (1996) introduced collision avoidance systems which started with the implementation of proximity detection system as a prerequisite for all underground mobile machines. This was driven by the number of accidents and loss of lives of underground mining employees. The initial level 7 which required the employer to ensure that the operator of an underground machinery is made aware of any hazards around their machinery, prompting the operator to respond to the identified hazards. The rollout process took place however the industry continued to experienced accidents which most of them resulted in fatalities, this prompted the introduction of a more robust system with an aim of curbing the incidents from underground trackless mobile machinery. The reason for the study is to assist in identifying the causes that led to the failure of the previous

intervention (level 7) by the minerals council of South in their aim to promote zero harm in the mining sector.

The impact of the failure to prevent accidents impacts the company in the form of financial loses when an incident of this nature occurs. The leadership on different operations are also impacted because they have the responsibility to assess risk and produce mitigating measures, in a case of more fatalities they fell the pressure imposed on the operation. The labour or employees' representatives (union) is another party that is impacted especially when the system fail, leading to the loss of life.

The main goal of this study is aimed at the senior management in the industry due to the reasons provided in the above section. The outcome of the study could be useful to direct the industry in terms of how to do things differently in the future. The other important stakeholders who might have interest in this study is the minerals council, the department of mineral resources and energy and the trade unions on the mining sector.

Management challenges with the introduction of modern technology in the mining industry.

Possible Solutions: The Human-Centred Approach

To overcome the human factor problem, mining companies need to adopt a human-centred approach to technology innovation, which means putting the people at the centre of the design, development, and deployment of modern technology innovation. This approach can involve the following steps:

- Engage and involve the end-users and the stakeholders in the initial stages of technology innovation, to understand their needs, expectations, and concerns, and to co-create solutions that are relevant, useful, and acceptable.
- Educate and inform the management, the workforce, and the stakeholders about the benefits and risks of technology innovation, and provide them with clear and consistent messages, feedback, and guidance.
- Empower and enable the workforce to acquire the skills and competencies needed to operate, maintain, and optimize technology innovation, and provide them with adequate training, coaching, and support.
- Encourage and facilitate the collaboration and communication between the different departments, functions, and levels of the organization, and create a culture of innovation, learning, and teamwork.

- Ensure and demonstrate the change management and leadership support for technology innovation, and align the vision, strategy, and incentives with the desired outcomes and behaviours.

1.5.1 **Change management** plays a pivotal role in the successful implementation of technology within organizations.

1.5.1.1 **Minimizing Resistance**:

- Technology shifts can interrupt existing habits and procedures, causing opposition from workers who may prefer the current situation.
- Change management helps find possible causes of opposition and uses methods to overcome them, making it more probable that employees will accept the new technology (Abbas, 2023).

1.5.1.2 **Ensuring User Adoption**:

- Making a technology implementation work is not just about making the technology functional; it's about making sure that users adopt and use it well.
- Change management aims to get users on board, offer training and assistance, and help people and teams adopt the new technology without any problems.

1.5.1.3 **Maximizing ROI (Return on Investment)**:

It takes a lot of resources for organizations to get and set up new technologies. To make the most out of their investment, it’s important that the technology is not only put in place but is used well and productively. By helping users adapt to the new technology, change management makes sure that its advantages are maximized (Abbas, 2023).

To conclude, change management is crucial for dealing with the challenges of technology adoption, covering both mental and practical elements, and finally reaching effective implementation (Abbas, 2023; Kutner, 2021).

1.5.2 This study had research questions that guided its purpose and scope. The following research questions were the focus areas throughout the study:

- How can change management be implemented correctly to see the benefits of technology introduction in the South African mines?

- What are the factors that undermine change management efforts in the mining industry?
- How does awareness of technology implementation assist employers to improve health and safety of employees?
- Is the implementation of technology been done accordingly in the mining industry?
- How can collision avoidance adoption be implemented without any challenges in the South African mining industry?

1.5 Delimitations of the Study

The study focused on a proximity detection system technology that is designed and used for the underground trackless mobile machines to activate collision avoidance system, this meant that the proximity detection devices used on track bound machines was excluded. The sample size for the study is 16 and a mine that the study took place is a platinum group metals' mine. For the study to have relevance the period that was considered started in 2020 until when the pronouncement was made in 2022. The reason for the period chosen was based on the implementation of this type of technology (collision avoidance system) at the operation where data was collected switched to the technology in 2020. This excluded the years prior to the implementation because during that period the operation was still only on proximity detection system level 7.

1.6 Assumptions

This research assumed that the employees of the selected research site were aware of the technology initiatives that have been applied to their business unit. This study assumed that every employee at the selected site knew about the collision avoidance system that the minister of minerals, resources and energy had announced in December 2022.

CHAPTER 2. LITERATURE REVIEW

2.1 Introduction

According to Errida & Lotfi, (2020), managers in any organisation are to access change readiness for adopting new technology. They further mentioned that there are four

factors that affect the adoption of a PMM such as leadership, communication, strategy alignment and organizational culture. The four factors include:

- The low readiness of some employee groups, such as site managers and support functions staff, who feel they lack the necessary knowledge and are unsure about the management's support.
- The inadequate organizational readiness in terms of process adaptability, organizational system, people ability, time availability and skill development.
- The poor project management maturity, as the main processes and good practices are poorly defined and documented.
- The absence of change management activities and a formal approach for managing the human side of change.

  High level of project management maturity within the company as it has clear project management standards, processes, and tools. Moderate level of change management maturity as the company has some change management practices but they are not consistent or formalized. The authors concluded that the proposed model can help managers to identify the readiness gaps and the areas of improvement for adopting a PMM in their organizations (Errida & Lotfi, 2020).

  To address these challenges, the authors suggested some actions that could help build change readiness for implementing a Project Management Methodology (PMM). These are: communication, empowerment and coaching, training, executive engagement, development of project management culture and building capacity of change (Errida & Lotfi, 2020).

Table 8: Gaps on Literature reviews of change management

Source	**Topic**	**Limitations/Critiques**
Rozenkowska (2023)	Behavioural intentions	Not always predetermined, may result from social influences or situational factors
Various authors	Theory of Planned Behaviour (TPB)	Does not account for emotions, moral norms, self-identity, or other factors
Fishbein and Ajzen (2009)	TPB	Can be extended with additional predictors if conceptually and empirically distinct
Robin et al. (2011)	TPB-based longitudinal research	Intention is a much stronger predictor than other components of the TPB model

Marikyan, Davit & Papagiannidis (2023)	TRA	Intention is the best single indicator of behaviour
Various scholars	TPB	Past behaviour can have a direct effect on future behaviour
Various scholars	TPB	Conceptual and operational issues, such as definition and measurement of PBC
Sniehotta et al. (2015)	TPB	Limited predictive power, especially with "inclined abstainers"

Gaps in Technology adoption and business sustainability

From the literature used to support this study a couple of authors including Ramjack, (2015) and (Ediriweera & Wiewiora, 2021) did research about the topic of implementation of new technology in different applications however the responses are familiar to the mining industry. According to Ramjack, (2015) and (Ediriweera & Wiewiora, 2021), there were gaps that were identified under this topic and those are listed as follows:

- What technological advancements are better suited to promote seamless technology implementation?
- To what extent do technical factors (e.g., infrastructure, design) affect implementation of new technology?
- To what extent do cultural differences affect implementation of new technology?
- To what extent do individuals' beliefs and personality traits affect implementation of new technology?
- To what extent do digital technologies and innovative solutions reduce accidents in mines especially underground?
- How can the engagement of stakeholders, including employees, and employees' representatives (trade unions), be effectively integrated into the technology adoption process to promote smooth implementation of new technology?
- How does the performance of technology correspond to the anticipated sustainability benefits?

Conclusion

Technological advancements might have positive or negative impacts on sustainability of a business like in case of a mining company. It's essential to understand the adoption of these technologies to achieve better sustainability. In this study, i identified and discussed the main opportunities and challenges of technology

adoption in a mining sector looking with emphasis on authors sustainability of a business which will be brought by steady safety performance. In addition, a bibliometric analysis is used to identify and explore research gaps. These research gaps were the foundation for recommending future research questions and areas of study. The insights drawn from this study provide several theoretical contributions to the existing literature and offer valuable practical implications for practitioners, policymakers, and developers/suppliers.

Theoretically, the study contributes to understanding the relationship between technology adoption and sustainable business while looking at the safety aspects of employees. By examining the opportunities and challenges associated with adopting collision avoidance technologies in mining, the study highlights these technologies' potential benefits and drawbacks in achieving sustainability and proper implementation. This can inform theoretical models that seek to explain the relationship between technology adoption and users' reaction towards technology implementation. Additionally, by identifying and discussing the key drivers and barriers to technology adoption, the study can assist in developing effective policies and strategies for promoting effective technologies that support sustainable business.

2.2 Overview of the Collision Avoidance System

A Proximity Detection System (PDS) warns both parties when two equipped vehicles and/or pedestrian come close to each other. Mining vehicle operators, whether underground or above ground, have difficulty seeing the people, other mining equipment, or possibly hazardous objects near their machine because of its large size and blind spots. Proximity detection systems enhance the operator's awareness by detecting potential collision threats and notifying the operator with sound and sight (Liu et al., 2023). Equipped pedestrians also get a sound and sight warning when there is an equipped vehicle close by that poses a potential danger.

A lot of work has been done by many organizations in the past few years to create standards for proximity detecting devices (Greyvensteyn, 2018). This makes it easier for clients to choose a system that suits their needs, because they have a measurable user requirement.

Åhlén, (2014) defines three different levels of control for the user requirement as follows:

- Level 7: Operator awareness - This is a system that notifies the operator of a potential hazard.
- Level 8: Advisory controls - This system gives guidance to the operator on how to act.
- Level 9: Intervention controls - This is a collision avoidance system that takes over from the operator.

In underground mining operations, a collision avoidance system (CAS) is a safety device intended to avoid collisions between automobiles and pedestrians (Greyvensteyn, 2018; Zhao et al., 2017). To warn vehicles and pedestrians of impending collisions and stop accidents, the CAS system combines sensors, alerts, and automated braking (Greyvensteyn, 2018). While CAS intervenes by either stopping or slowing down the vehicle to prevent or at least lessen the severity of collisions between equipped vehicles and equipped pedestrians, PDS enhances the operator's awareness by detecting potential collision threats and warning the operator visually and audibly (Liu et al., 2023).

Sensors can be added to objects so that a system can identify, alert, and take appropriate action if there is a chance of a collision (Zhao et al., 2017).

Challenges with implementation of new technology

Implementing new technology in an organization can bring many benefits, such as increased efficiency, productivity, innovation, less safety interruptions, and customer satisfaction. However, it can also pose significant challenges for managers, who need to ensure that the technology is aligned with the strategic goals, compatible with the existing systems, and adopted by the employees. In this document, we will discuss some of the common management challenges when it comes to implementation of new technology in mining and/or any other sector and provide some suggestions on how to overcome them.

Challenge 1: Resistance to Change

Challenge	Factors	Consequences	Source
Resistance to Change	Fear of losing jobs, skills, or status, lack of trust in management or	Can hinder successful adoption of technology, lower performance,	Bovey, W. H., & Hede, A. 2001

	technology, preference for familiar ways of working	morale, and satisfaction among employees	

Challenge 2: Integration Issues

Challenge	Source	Issue	Result	Impact
2: Integration Issues	Davis, F. D. (1989)	Incompatibility, complexity, or inconsistency of new technology with current infrastructure, data, or workflows	Disruptions, errors, or inefficiencies in operations, affecting quality and reliability of products/services	Increased costs and risks, reduced return on investment

Challenge 3: Resource Constraints

Challenge	Constraints	Impact	Source
Resource Constraints	Time, money, or human resources	Affects scope, quality, or speed of implementation and can compromise outcomes and benefits of new technology	Kotter, 1995

Challenge 4: Lack of Skills and training

Challenge	Issue	Consequences
Lack of Skills and training	New technology requires new skills and competencies	Lower productivity, higher errors, frustration, dissatisfaction, affect adoption and acceptance

Conclusion on the identified challenges

Implementing new technology in an organization can be a challenging task for managers, who need to deal with various issues, such as resistance to change, integration issues, and resource constraints. However, by applying some of the strategies discussed in this document, managers can overcome these challenges, and ensure a successful and smooth implementation of the new technology. This can lead

to improved performance, innovation, and competitiveness of the organization, and increased satisfaction and engagement of the employees and the customers.

Change management

Proper change management can help organizations overcome resistance, align stakeholders, communicate effectively, and sustain the change over time. Some benefits of proper change management implementation are as listed in the table below:

Aspect	Description
Change management	Process of planning, implementing, and evaluating organizational changes to achieve desired goals and outcomes
Benefits	Overcome resistance, align stakeholders, communicate effectively, sustain change over time
Increased employee engagement and satisfaction	Employees involved in change process, understand rationale and benefits, receive adequate training and support
Reduced costs and risks	Identify and mitigate potential challenges and risks, reduce costs and negative impacts
Improved performance and innovation	Adoption of new technologies, processes, products, or services, improve efficiency, quality, customer satisfaction, and competitiveness, foster culture of continuous learning and improvement

Benefits of proper change management

Proper change management is essential for any organization that wants to adapt and thrive in a dynamic environment. According to Kotter (1995), proper change management involves eight steps: creating a sense of urgency, forming a powerful coalition, developing a clear vision, communicating the vision, empowering others to act, creating short-term wins, consolidating gains, and anchoring the change in the culture. Some of the benefits of following these steps identified by Kotter (1995) are:

- **Creating a sense of urgency**: This can motivate the organization to initiate and support the change, rather than complacent or resistant. It can also help create a shared understanding of the need and direction of the change.
- **Forming a powerful coalition**: This can leverage the influence and expertise of key leaders and stakeholders who can champion and guide the change. It can also increase the credibility and legitimacy of the change initiative.

- **Developing a clear vision**: This can provide a coherent and compelling picture of the desired future state and the benefits of the change. It can also help align the goals and strategies of the change with the mission and values of the organization.
- **Communicating the vision**: This can ensure that everyone in the organization understands and supports the vision and the change. It can also help build trust and commitment among the employees and customers.
- **Empowering others to act**: This can remove the barriers and obstacles that may hinder the implementation of the change. It can also encourage the participation and empowerment of the employees and customers who are affected by the change.
- **Creating short-term wins**: This can demonstrate the progress and success of the change and provide feedback and recognition to the change agents and supporters. It can also reinforce the momentum and confidence of the change effort.
- **Consolidating gains**: This can ensure that the change is not reversed or diluted by the pressures of the status quo or the emergence of new challenges. It can also help institutionalize and integrate the change into the normal operations and systems of the organization.
- **Anchoring the change in the culture**: This can make the change a permanent and pervasive part of the organization's identity and values. It can also help sustain the change and enable further adaptation and innovation.

All about implementing new technology in the mining industry

One possible gap that has been identified when implementing new technology in the mining industry is the lack of alignment between the technology and the organizational culture and processes. According to Oyewobi, Windapo, Rotimi, and Ojelabi (2019), the adoption of new technology in the mining industry requires a change management strategy that considers the human, social, and environmental factors that may affect the acceptance and use of the technology. The authors suggest that the technology should be compatible with the existing values, norms, and practices of the organization, and that the stakeholders should be involved in the decision-making and implementation processes. To prevent this gap from recurring, the mining industry should conduct regular assessments of the organizational culture and processes, and identify the potential barriers and facilitators for the technology adoption. The mining industry should also communicate and consult with the stakeholders throughout the technology innovation process and address their needs and expectations.

Another possible gap that has been identified when implementing new technology in the mining industry is the lack of adequate skills and competencies among the employees. According to Osanloo, Paré, and Nadeau (2016), the introduction of new technology in the mining industry creates new demands for technical, operational, and managerial skills, as well as the ability to adapt to changing work environments. The authors recommend that the mining industry invests in training and education programs that enable the employees to acquire and update the necessary skills and knowledge to use the new technology effectively and efficiently. To prevent this gap from recurring, the mining industry should conduct regular analyses of the skill and competency requirements for the new technology, and design and deliver tailored and flexible training and education programs for the employees. The mining industry should also provide opportunities for the employees to learn from each other and from external experts and foster a culture of continuous learning and improvement.

A third possible gap that has been identified when implementing new technology in the mining industry is the lack of sufficient security and privacy measures to protect the data and information generated by the technology. According to Yu, Ding, and Zhou (2018), the mining industry faces various challenges in ensuring the confidentiality, integrity, and availability of the data and information collected, processed, and transmitted by the new technology, such as big data, cloud computing, and Internet of things. The authors propose that the mining industry adopts a comprehensive and proactive approach to data and information security and privacy, which includes risk assessment, policy formulation, compliance monitoring, and incident response. To prevent this gap from recurring, the mining industry should adopt and implement the best practices and standards for data and information security and privacy, and update them regularly to cope with the emerging threats and vulnerabilities. The mining industry should also educate and train the employees and other stakeholders on the importance and principles of data and information security and privacy, and establish clear roles and responsibilities for the data and information management.

These are some of the gaps that have been identified when implementing new technology in the mining industry, based on the literature review. To address these gaps, the mining industry needs to adopt a holistic and integrated perspective that considers the technical, organizational, human, and ethical aspects of the technology innovation process.

Table 9: Gaps on Literature reviews of change management

Gap	Issue	Solution	Prevention	References

Lack of alignment	Technology not compatible with organizational culture and processes	Change management strategy considering human, social, and environmental factors	Regular assessments of organizational culture and processes, communication, and consultation with stakeholders	Oyewobi, Windapo, Rotimi, and Ojelabi (2019)
Lack of skills and competencies	New technology creates new demands for technical, operational, and managerial skills	Investment in training and education programs	Regular analysis of skill and competency requirements, tailored and flexible training and education programs, opportunities for learning, culture of continuous improvement	Osanloo, Paré, and Nadeau (2016)
Lack of security and privacy measures	Challenges in ensuring confidentiality, integrity, and availability of data and information	Comprehensive and proactive approach to data and information security and privacy	Adoption and implementation of best practices and standards, regular updates, education and training, clear roles and responsibilities for data and information management	Yu, Ding, and Zhou (2018)

Resistance to change literature

- Establishing a supportive and collaborative culture that encourages experimentation, learning, and feedback, and that empowers the employees to participate in the decision-making and problem-solving processes of technological change (Ghodrati et al., 2015; Baines et al., 2017). This can help to reduce the fear and anxiety of the employees, and to enhance their sense of ownership and involvement in the change initiative.
- Providing adequate and timely education and training for the employees to equip them with the necessary skills and knowledge to use the new technology, and to address their concerns and expectations (Yu et al., 2018; Ziemski, 2018). This can help to increase the confidence and competence of the employees, and to foster a positive attitude towards the change.
- Creating a flexible and adaptive organizational structure that can accommodate the changes brought by the new technology, and that can facilitate the coordination and integration of different functions and units (Yu et al., 2018; Ghodrati et al., 2015). This can help to streamline the workflows and processes, and to optimize the resource allocation and utilization.
- Rio Tinto, one of the world's largest mining companies, has been implementing a comprehensive and ambitious program of automation and digitalization across its operations, aiming to improve its productivity, safety, and sustainability. However, the company has also faced significant challenges in managing the organizational and human aspects of the change, such as the resistance from the unions, the impact on the local communities, and the need for reskilling and redeploying the workers (Fitzgerald and Howe, 2017). To address these challenges, the company has adopted a collaborative and inclusive approach, involving the stakeholders in the design and implementation of the change, providing extensive training and development opportunities for the employees, and creating new roles and career paths for the displaced workers (Fitzgerald and Howe, 2017).
- Barrick Gold, the world's second-largest gold producer, has launched a digital transformation initiative to modernize its mining operations, leveraging technologies such as artificial intelligence, cloud computing, and data analytics. However, the company has also encountered difficulties in changing the culture and mindset of its workforce, which was accustomed to the traditional and hierarchical ways of working (Ziemski, 2018). To overcome this challenge, the company has created a dedicated digital team that works closely with the operational teams, fostering a culture of co-creation, innovation, and continuous improvement. The company has also invested

in training and coaching the employees, and rewarding and recognizing their contributions to the digital transformation (Ziemski, 2018).

One possible cause for the resistance to change in the mining industry is the entrenched culture of risk aversion and conservatism that has been shaped by the historical, social, and economic factors of the sector (Baines et al., 2017). Mining companies tend to focus on short-term operational efficiency and profitability, rather than long-term strategic innovation and transformation (Ziemski, 2018). Moreover, the adoption of new technology often requires significant upfront investment, organizational restructuring, and workforce reskilling, which may encounter various barriers and uncertainties in the complex and dynamic mining environment (Ghodrati et al., 2015).

To overcome the resistance to change and facilitate the adoption of new technology in the mining industry, some of the strategies that have been suggested by different authors are:

- Developing a clear and compelling vision and roadmap for technological change that aligns with the organizational goals and values, and communicates the benefits and risks to all stakeholders (Ziemski, 2018; Baines et al., 2017). This can help to create a shared understanding of the need and direction for change, and to generate commitment and support from the top management, the employees, and the external partners.
- Engaging and empowering the employees and managers at all levels of the organization, and fostering a culture of collaboration, trust, and learning that supports innovation and experimentation (Yu et al., 2018; Ghodrati et al., 2015). This can help to reduce the fear and anxiety associated with change, and to enhance the involvement and ownership of the people who are affected by and responsible for the implementation of the new technology.
- Providing adequate training and education to enhance the digital literacy and competencies of the workforce, and creating opportunities for knowledge sharing and feedback among the users and developers of the new technology (Yu et al., 2018; Ziemski, 2018). This can help to improve the skills and confidence of the employees to use the new technology effectively, and to facilitate the continuous improvement and adaptation of the technology based on the user feedback and experience.
- Leveraging external partnerships and networks with technology suppliers, research institutions, industry associations, and government agencies, to access diverse

sources of expertise, funding, and support for technological change (Baines et al., 2017; Ghodrati et al., 2015). This can help to overcome the resource and knowledge constraints that may limit the innovation capacity of the mining companies, and to benefit from the best practices and lessons learned from other sectors and regions.

2.3 Theoretical Framework

The Technology Acceptance Model (TAM) Framework

There are a couple of technology acceptance models applied across the different industry (Koul, Sahil & Eydgahi, 2017). These models aid in the comprehension of how people accept and use new technologies. For this study emphasis was put on the Technology Acceptance Model, below is a look at the different types of such models:

2.3.1 The TAM, or Technology Acceptance Model:

Fred Davis created TAM in 1986, with an emphasis on technology adoption in the information sciences field It revolves around two main ideas (F. Davis, 1986):

- Users' perception of a technology's ease of use is known as perceived ease of use.
- Perceived usefulness is defined as the advantages of utilizing the technology as perceived.

Mit & Carehive (2020) emphasised that users' attitudes and intentions for implementing the technology are influenced by these perceptions.

2.3.2 Technology-Organization-Environment (TOE) Framework:

This model looks at how environmental and organizational elements affect the adoption of new technologies (Vagnani, G; Gatti, C & Proietti, 2019). It takes into account elements including external environment, organizational structure, and culture (Mit & Carehive, 2020).

2.3.3 Task Technology Fit (TTF):

This model evaluates how well a technology fits users' demands and tasks. It highlights how technology fits into particular occupational requirements (Goodhue & Thompson, 1995).

2.3.4 Innovation Diffusion Theory (IDT):

Everett Rogers developed IDT, which examines how innovations proliferate within a social structure (Mit & Carehive, 2020). This theory takes into account variables such as adopter classifications, societal norms, and communication channels (Ruud, E; Watts Simmonds, 2016).

2.3.5 Rational Choice Theory

One can find two prominent theoretical frameworks for technology adoption: Technology Acceptance Model (TAM), and the Theory of Planned Behaviour (TPB) (Koul, Sahil & Eydgahi, 2017). This research examined the Technology Acceptance Model framework to comprehend how it influenced the adoption of the collision avoidance system for the underground trackless environment. This was considered important for understanding the research questions raised in chapter one regarding the adoption of technology for South African mining industry.

TAM has been used in various domains, such as information systems (C. Davis, 1989). TPB, on the other hand, is frequently used in marketing research studies and is well known for doing so (Rozenkowska, 2023). Therefore, it is a relevant model to use when examining how consumers adopt different technologies, and this was suitable because the mining companies are seen as customers of the technology of the collision avoidance system.

Technology Acceptance Model examines the Perceived Usefulness (PU and the Perceived Ease of Use (PEOU as the mental response from the user. PU is important for the researcher to understand how the user perceives the usefulness of the new technology that is being suggested. This was an area that was explored to try and understand how the benefits of any technology are communicated to the end user from the start of the implementation process. It has been observed that workers especially in the underground environment will support adoption of technology if they know that the technology in question has few or no difficulties when it comes to ease of use (Lööw, 2022). This is called Perceived Ease of Use (PEOU, and it has a large role because once the workers can be assured of the ease of use there is a likelihood that such technology will achieve the support it was intended for. Figure 1. below shows the original TAM theoretical framework which analyses the external variables that will facilitate or hinder technological adoption.

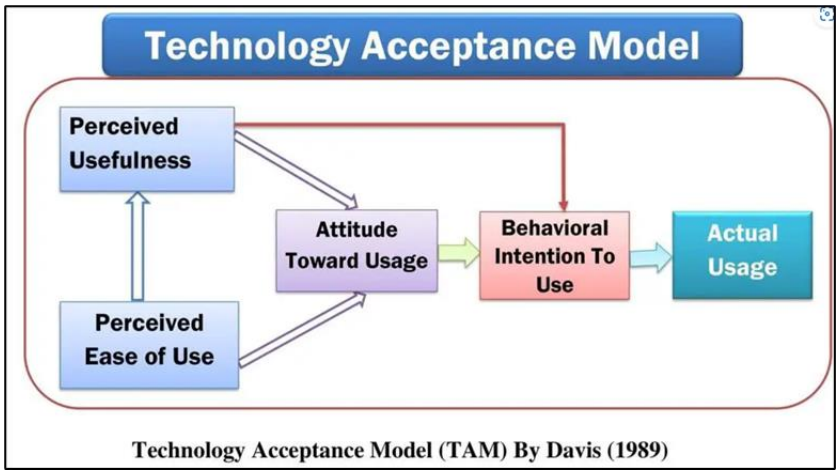


Figure 1: Technology Acceptance Model (TAM)

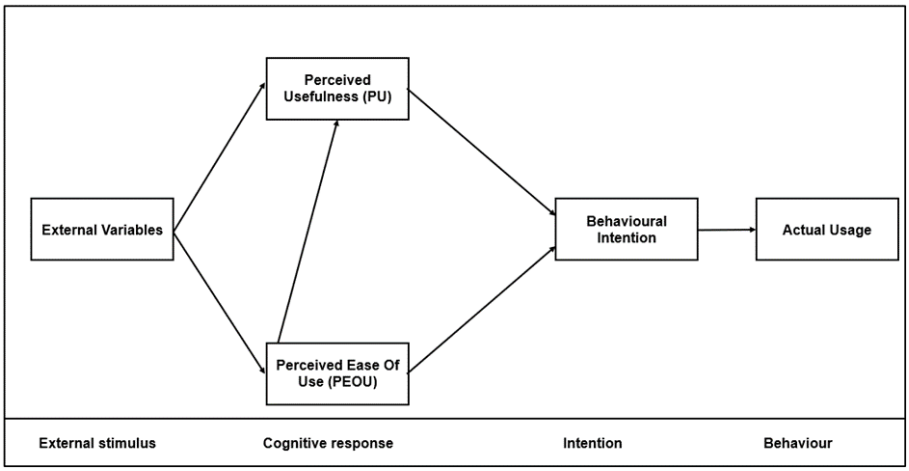


Figure 2 Technology Acceptance Model (TAM)

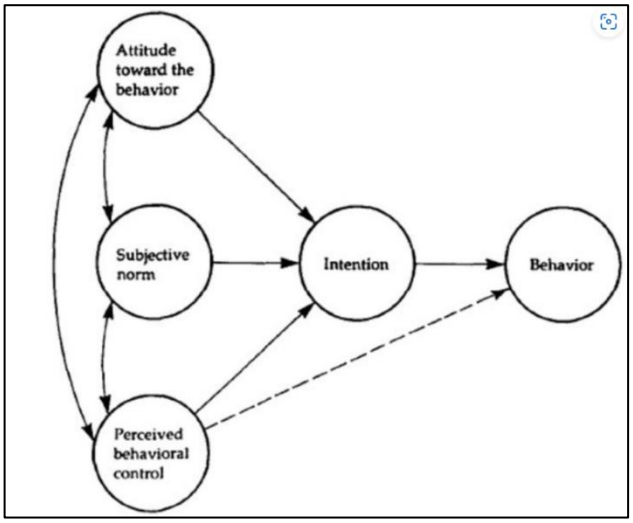


Figure 3 The Theory of Planned Behaviour Model (Ajzen, 1991, p. 182)

Ajzen (1975) first proposed this theory but Ajzen & Fishbein (1980) later revised it to analyse how individuals behave in volitional situations(Sparks, Paul; Shepherd, 1992). The existing literature has shown that TPB focuses on predicting deliberate human behaviour and then combines it with the construct of perceived behavioural control (Montaño & Kasprzyk, 2015)(Sparks, Paul; Shepherd, 1992). The literature has provided enough evidence that by adding the perceived behavioural control construct, TPB can improve its prediction of behavioural intentions (Madden et al., 1992. A study that compared the TRA and TPB models for ten different behavioural scenarios found that TPB explained behavioural intentions much better than TRA because of the inclusion of the perceived behavioural control construct (Madden et al., 1992). Moreover, Madden et al. (1992) found that the higher the level of perceived behavioural control, the more it improved the explanation.

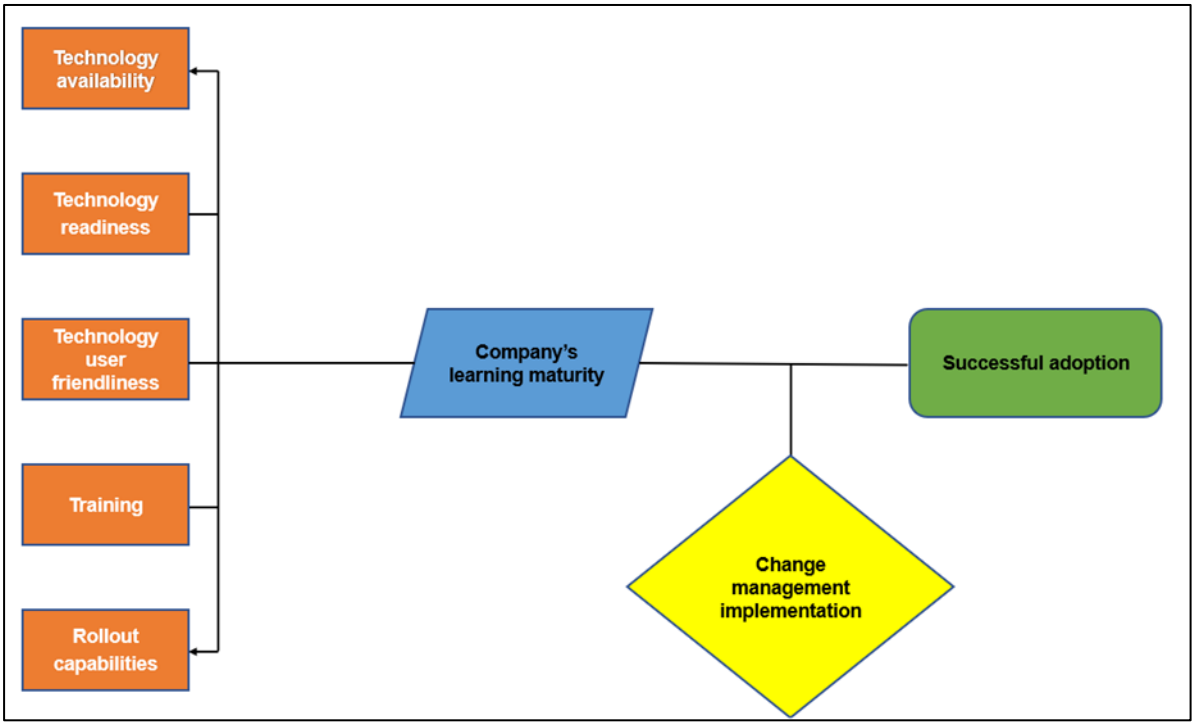


Figure 4: Conceptual/Theoretical Framework

2.4 Dominant views on the theory of change management

Managing change is a complex form of applied leadership that requires attention in various areas (Gill, 2003). All the essential factors that affect the outcome of a project's change must be considered. The effective change manager must make sure that each stage of the process follows the plan and that none of the many possible pitfalls jeopardizes the project's success (Burnes, 2011).

2.4.1 Factors That Contribute to the Success of Change Management

Organisational change management can be defined as a systematic process by which an organization plans, implements, and evaluates its change effort to achieve the intended outcome (Hassan, 2018). The recognition of change as a strategic force and its cost in businesses has increased the need for researchers to explore deeply how managers and change agents can better manage workplace change projects (Hassan, 2018). According to Hassan (2018) organizational Change Management is concerned with supporting the process of change by changing strategies, structures, and processes. He also suggested that employees in an organization have an important role in the change process, where their response to change determines whether the change efforts succeed or fail.

According to Kitchen et al., (2002), it is essential to comprehend change and the factors that influence it. They first highlighted that internal and external factors need to be taken into account, as these can affect the success or failure of the proposed change (Kitchen et al., 2002). They recommended that it is important to understand the reasons behind certain events and the following are some of the questions that are usually asked by someone who has attempted to enact a change and it failed (Kitchen et al., 2002):

2.5.1 What makes change management initiatives fail so often? This question could be cleared or responded to once a change was introduced and the management of change was not followed to understand the cause of that change.

2.5.2 How can failure be avoided? The response to this question was expected to be gathered during the interviews because it could be the solution to the prevention of doing the same mistake like in the past.

2.5.3 How can the risk posed by change be reduced? The expectation from the change management process is that if there are risks that can be observed, how these could be reduced in a case where they cannot be eliminated.

It is essential that any organisation develops a way of communication to make sure that everyone understands the change that is going to be introduced well (Kitchen et al., 2002).

Organizational change is influenced by both internal and external forces (Hassan, 2018). Hassan (2018) stated that internal elements that affect organizational change often led to external changes. Hassan (2018) highlighted some of the factors that could motivate an organization to seek change: those include low productivity, absenteeism, turnover, union involvement, and leadership participation.

Although the factors mentioned above are considered as internal, they are connected to external factors because they are often created to deal with external factors such as competition, the need to meet market demand, changes in technology, changes in government regulations, and social pressure (Hassan, 2018).

2.5.4 **Address the human component of change methodically**:

People will have worries when there is a major change (Neilson et al., 2004). It should be fully embedded into the program that guides and supports decision-making to communicate and enable strategies direction. It should be based on an honest evaluation of the organization's history, readiness for change, and capacity to adapt (Neilson et al., 2004). It should also link multiple transformations initiatives.

A formal way of managing change should be developed early, starting with the leadership team and then involve key stakeholders and leaders, and it should be updated as change spreads through the company (Neilson et al., 2004). One of the four pillars of any transformation strategy must be a disciplined approach to change management like in the picture below.

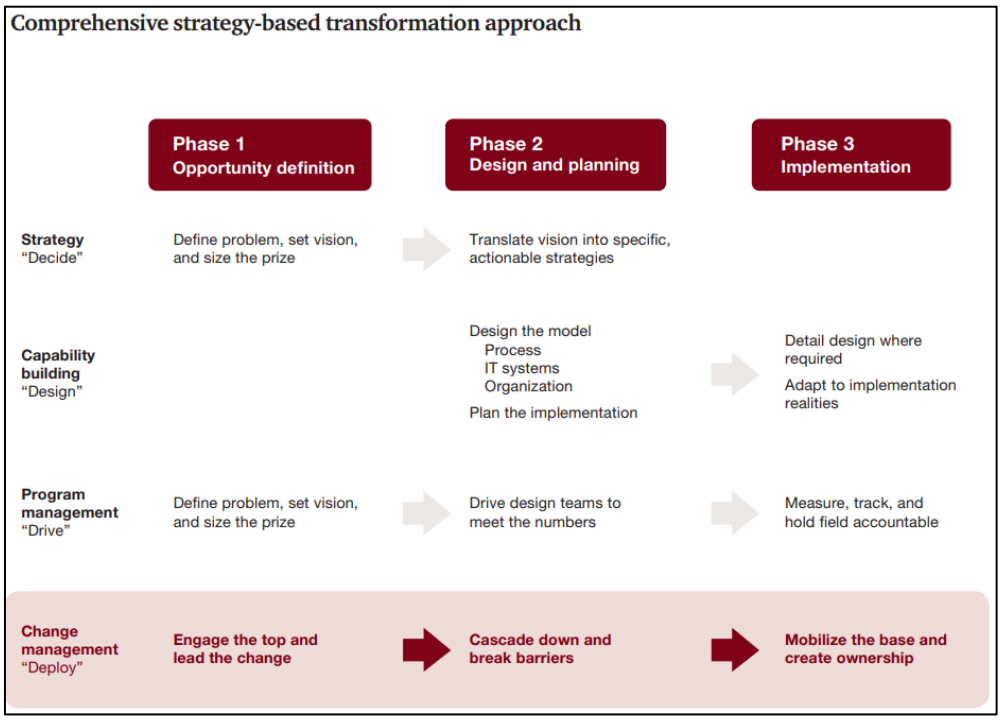


Figure 5: Comprehensive Strategy-Based on Transformation Approach (Neilson, et al., 2004)

2.5.5 **Change begins at the top and begins on the first day**:

People at all levels of an organization struggle with change, and they look to the CEO and the leadership team for guidance, help, and vision when it is coming (Neilson et al., 2004). Neilson et al., (2004) state that executive teams that work well together, have a shared commitment to the change's direction, know the culture and behaviours they want to create, and can exemplify those changes themselves are more likely to succeed.

2.5.6 **Real change occurs at the organizational level**:

Transformation efforts affect different levels of the organisation as they progress through the phases of creating the strategy/targets, designing, and executing (Weddle, B; Bucy, M; Schaninger, B; & VanAkin, 2021). They highlighted that plans need to be in place to identify leaders and assign roles for design and execution across the organisation (see Cascading ownership diagram below). The leadership team and their direct reports are often responsible for developing the strategy and defining the goals (Weddle, B; Bucy, M; Schaninger, B; & VanAkin, 2021). Senior managers and the next level of executives should form design teams that are prepared to lead the change and work together across boundaries (Neilson et al., 2004). Individual contributors and line managers are essential for execution. There need to be leaders at each of these levels who have been chosen and trained, who are dedicated to making the change happen and who align with the organisation's goal (Lööw, 2022).

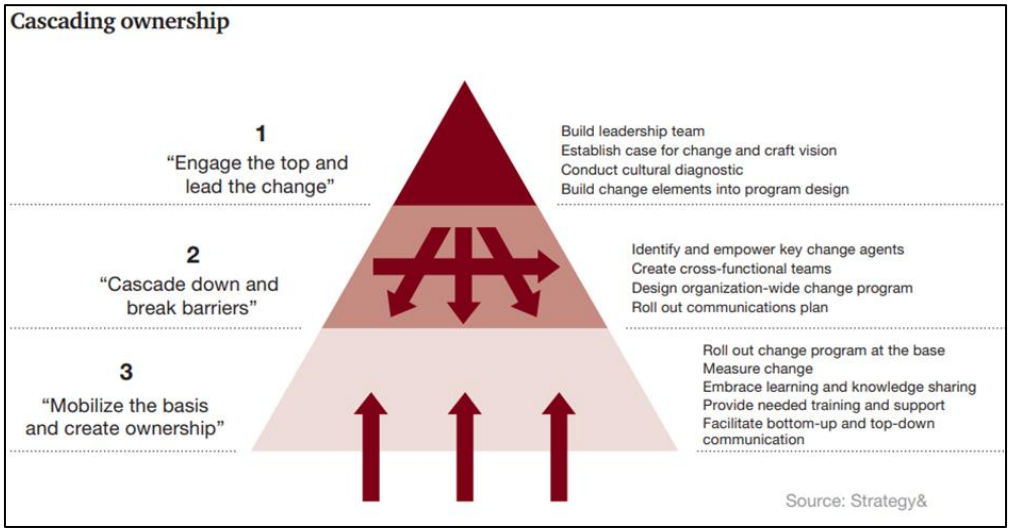


Figure 6: Cascading ownership (Neilson, et al., 2004)

2.5.7 **Face reality, show faith, and create a vision**.

People tend to be sceptical and will question the need for change, the path the organization is taking, and if they are willing to personally contribute to making change happen (Neilson et al., 2004). Neilson et al., (2004) stated that people will seek leadership for direction. They also suggested that ways to create or impose alignment among the leadership team include making a formal argument for change and writing a vision statement.

2.5.8 **Create ownership, not just buy-in**:

Large-scale transformation programs require distributed leadership that can shape decisions that the senior team is aware of and unaware of (Neilson et al., 2004) (see figure 7 below. To create a strong base of support for change among the employees, change leaders must exceed expectations during the transition (Neilson et al., 2004).

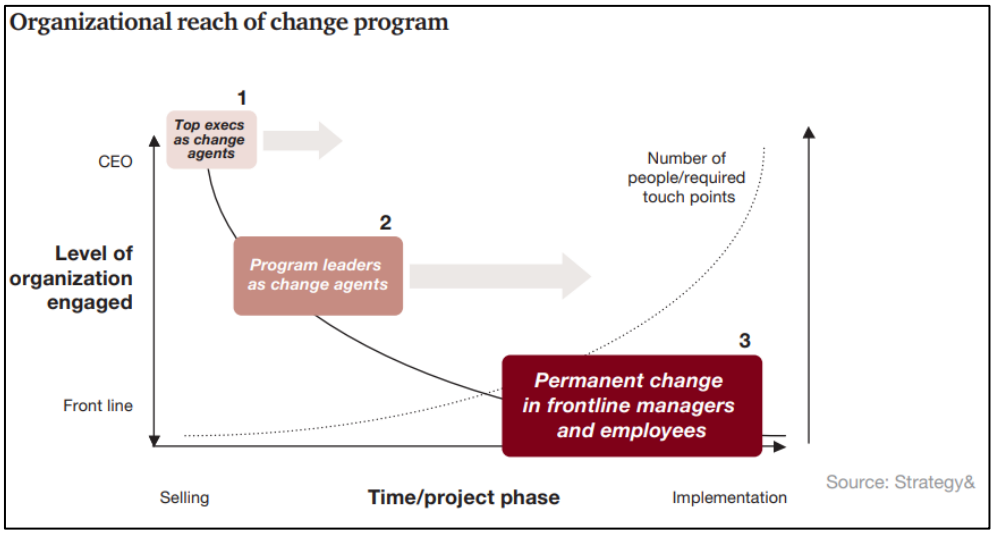


Figure 7: Organisational Reach of Change Program (Neilson, et al., 2004)

2.6 Descriptive models

A descriptive model identifies the main factors and components that affect the performance of any company, including the success rate of any reform or resolution. There are various descriptive models that explain and recognize the different components that influence the results of organizational change efforts (Errida, A; Lofti, 2021). These models emphasize the different aspects and offer different perspectives. In the late 1970s, two consultants from McKinsey, Thomas Peters and Robert Waterman, developed the most used model, called the McKinsey's 7-S (Smith et al., 2014). According to Smith et al., (2014) this model deals with the interrelation between elements of strategy and it is widely used when dealing with this topic. The 7-S model includes what is required for any organization to go through when there is a change that must be undertaken (Smith et al., 2014). For this to happen, there needs to be staffing

that can enable the change, the systems to be followed are also important, and the structure that must be followed to achieve such change (Smith et al., 2014). This model has given businesses the opportunity to improve in achieving goals that any organization is planning to undertake.

2.6.1 The Action Research Model/Theory

This kind of change model is not only concerned with the change itself, but also with how the person affected by the change behaves. Burnes (2020) argues that this kind of change model also allows the testing of the method of changing behaviour. The model is action-oriented, which means that there must be a goal that needs to be achieved for the change to happen. The model gives the researcher chances of trying different frameworks in a real situation. The first step according to this model is to identify or diagnose a need for change, this is called the unfreezing phase (Burnes, 2020). This step is important for this specific research because the new change that is introduced in the form of collision avoidance system will be compared with existing models of change. The introduction of the CAS level 9 was motivated by the regulation issued by the department of minerals, energy, and resources. The second step is to introduce an intervention (moving), this is where an alternative is introduced. For the purposes of this research, the introduction of CAS level 9 came as a replacement of the PDS level 7 that was in use which didn't achieve the expected results. Finally, the researcher is given an opportunity to evaluate and stabilize change, this is commonly known as the refreezing phase. It is suggested that this process be done in the form of drills, in the mining industry there are fire drills that are usually conducted with the aim of making employees aware of what to do during a fire or an emergency.

The same could be applied to this research model, the person who must implement the change can focus on how and when to freeze, move, and unfreeze at any given time.

CHAPTER 3. RESEARCH METHODOLOGY

3.1 Research Strategy

The research questions stated in chapter one were examined using the research methodology and design described in this section. These research questions aimed to explore factors that enabled and/or prevented technology adoption for collision avoidance system (CAS) in the South African mining industry. The focus was on understanding employees' resistance to the implementation of technology (collision

avoidance system) in the mining industry. The research questions considered the behaviour of mine workers towards the implementation and adoption of technology.

The purpose of this study was to develop a method that could address the research questions posed in the first chapter. The study adopted an exploratory approach with an emphasis on discovery, which involved collecting data from the participants, analysing the factors identified in the relevant literature, and creating a model based on the research findings (Saunders et al., 2019). This approach is consistent with the qualitative research methodology, which is considered a rigorous way of examining the key aspects of the study phenomenon (Soiferman, 2010). According to Saunders et al. (2019), exploratory research aims to generate new insights and investigate topics from a new perspective.

This study used a qualitative approach to explore the challenges that could prevent the adoption of new technology in the underground environment in South African mining setup. TAM is a common theoretical framework for examining how people make decisions about whether to adopt new technologies or not. To do this, sample interviews of people of different Paterson grades (organisational levels within the selected business unit) were carried out.

3.2 Research Design

According to Saunders et al., (2019), qualitative research studies often use three types of research designs: exploratory, analytical, and interpretative. The main purpose of this study was to examine the factors that influence or hinder the adoption of technological innovation in mining settings, with a focus on the South African context.

One of the reasons why qualitative research method is suitable for technology acceptance method with emphasis on collision avoidance system is that it allows for a deeper understanding of the users' perceptions, attitudes, and experiences with the technology. Qualitative research method enables the researcher to explore the complex and contextual factors that influence the adoption and use of technological solutions in the mining industry, such as organizational culture, safety norms, user motivation, and user training (Venkatesh et al., 2016). The research method used entailed data collection in the form of sample interviews (see appendix 1 – 14), this enabled the researcher to gain rich and detailed insights into the users' needs, preferences, and challenges with the technology, as well as the benefits and barriers of adopting it (Saunders et al., 2019). Qualitative research method also allows for the development of a conceptual model or theory that can explain the phenomenon under study, which is

useful when there is a lack of existing frameworks or models in the literature (Soiferman, 2010). Therefore, qualitative research method is appropriate for investigating the technology acceptance method with emphasis on collision avoidance system, as it can provide valuable information for designing, implementing, and evaluating the technology in the mining industry. This, strategy used one or more detailed descriptions of the case or cases, with a focus on their context (Aberdeen, 2013). Aberdeen (2013) agreed with what Yin (2009) observed, that qualitative case study strategy lets researchers study the effects of complex phenomena in their environment. South Africa is rich with different types of minerals, for this study a platinum group producing company was chosen.

The study used semi-structured interviews to analyse responses from participants across four Paterson grades within the mine. The data from four levels within the business unit provided context on the factors affecting technology adoption with the CAS system as the focus point for the different groups. The study needed access to the four different levels in a typical mining organisation, namely: - senior management, middle management, officials/supervisors, and the equipment operators. The data collected was analysed to identify factors that hinder the adoption of collision avoidance systems in their operation.

3.2.1 Population and Sample

The study used a purposive sampling technique to select the participants for the data collection. Purposive sampling is a non-probability sampling method that involves selecting cases that are relevant to the research objectives and questions, based on the researcher's judgement and criteria (Saunders et al., 2019).

The main advantage of purposive sampling is that it allows for the selection of information-rich cases that can provide in-depth and meaningful insights into the phenomenon under study (Soiferman, 2010). The main disadvantage of purposive sampling is that it may introduce biasness and limit the generalizability of the findings, as the sample may not be representative of the population (Saunders et al., 2019).

Saunders et al., (2019) recommended that the sample design for semi-structured interviews should have between five and 25 participants. This number is within the suggested range of sample sizes by authors and other papers that propose 12 interviews are enough for a qualitative study to reach saturation (Guest et al., 2006).

The sample size was determined by the principle of data saturation, which is achieved when no new or relevant information emerges from the data collection (Saunders et al., 2019). According to Soiferman (2010), the sample size in qualitative research depends

on the scope and complexity of the research topic, the quality and richness of the data, and the availability and accessibility of the participants. The researcher obtained the contact details of the participants from the human resources department of the business unit. the researcher explained to the management of the business unit the aim of the study and the informed them about the sample size that they would like to interview. Most of the interviews were face to face however where this was not possible an email invitation was forwarded to the participants requesting for a video or virtual meeting. The email invitation explained the purpose and objectives of the study, the data collection methods, including the ethical considerations. The email invitation also included a consent form and a demographic questionnaire that the participants had to complete and return before the interview.

The interviews lasted between 45 to 60 minutes and were audio-recorded with the permission of the participants. The interviews were guided by a semi-structured interview protocol that consisted of open-ended questions. The interview protocol was pilot tested with two participants who were not part of the final sample, to check the clarity, relevance, and appropriateness of the questions. Based on the feedback from the pilot test, the interview protocol was refined and finalized before the commencement of the actual data collection.

3.2.2 Research Paradigm

The research paradigm that guided this study was interpretivism, which is a philosophical stance that assumes that reality is socially constructed and subjective, and that the researcher's role is to understand and interpret the meanings and perspectives of the participants (Saunders et al., 2019). Interpretivism is suitable for qualitative research methods, as it allows for the exploration of the contextual and situational factors that influence human behaviour and actions, such as culture, values, beliefs, and emotions (Soiferman, 2010). Interpretivism also acknowledges that the researcher is part of the research process and that his or her own assumptions, experiences, and values may affect the research outcomes (Saunders et al., 2019).

3.3 Validity and Reliability

This is described as the possible factors that can undermine the internal validity and reduce the credibility of the findings, such as changes in the environment, natural development, repeated testing, variability in the measurement tools, bias in the sample, loss of participants, contamination between groups, and competition among groups. The

researcher needs to recognize and eliminate these factors as much as they can to prevent confusing or alternative interpretations of the results.

3.3.1 External Validity

The external validity of this study refers to the extent to which the findings can be generalized or transferred to other contexts or settings, such as other mining sites, other industries, or other technologies (Saunders et al., 2019). The researcher also provided a detailed description of the context and setting of the study, such as the characteristics of the participants, the features of the technology, and the conditions of the environment, to allow the readers to assess the applicability and transferability of the findings to their own situations. Furthermore, the researcher used a theoretical framework of technology acceptance, which is a well-established and widely used model in the literature, to guide the data analysis and interpretation, and to link the findings to the existing body of knowledge. By doing so, the researcher aimed to enhance the reliability and validity of the study and contribute to the advancement of the field.

3.3.2 Internal Validity

The internal validity of this study refers to the extent to which the findings can be attributed to the collision avoidance system technology and not to other confounding factors, such as the characteristics of the participants, the research methods, or the researcher's bias (Saunders et al., 2019). To enhance the internal validity of this study, the researcher used multiple sources of data, such as interviews, documents, and observations, to triangulate the evidence and cross-check the consistency and accuracy of the data. Additionally, the researcher acknowledged and reflected on their own assumptions, experiences, and values that may have influenced the research process and outcomes and maintained a reflexive journal throughout the study.

CHAPTER 4. DATA ANALYSIS AND PRESENTATION OF RESEARCH RESULTS

4.1 Introduction

This chapter investigates the factors that influence employees' acceptance or rejection of the new system and examines the impact of education, awareness, compliance, and

instruction on their behaviour and performance. By understanding the reasons behind employees' resistance, the research seeks to provide insights into how to facilitate the transition and adaptation to the new system, and ultimately, improve the effectiveness and safety of the technology. The four groups of study's analysis were investigated after codes were formulated; themes were formed from the interviews' responses. Each group's responses are compiled as depicted below.

4.2 Descriptive Statistics

4.2.1 Data sample and respondents

The data set consists of variables from a PGM producing mine located at the Eastern Limb of the Bushveld. The mine operation has over 4000 employees in total. The study selected sixteen people from four different Paterson grades and asked each group members questions related to their level. All sixteen participants had more than 5 years of mining experience and more than 70% of them were present when the CAS level 9 system was first implemented. One person in the operators' group could not answer some of the questions, so this person's response was removed or left out from the list of interviewees. Hair et al., (2022) supports the removal of participants when some data is missing from the variables in question.

4.2.2 Description of the sampled respondents

The dependent variables type for "Perceived usefulness and perceived ease of usefulness for collision avoidance systems" in a qualitative study are ordinal variables. Ordinal variables are variables that have a natural order or ranking, but the differences between the values are not equal or meaningful. For example, a Likert scale that measures the level of agreement or satisfaction with a statement is an ordinal variable, because it has a clear order from strongly disagree to strongly agree, but the distance between each category is not necessarily the same or quantifiable.

4.2.3 Analysis of the results per group

i. Senior management responses

This group is seen as the decision makers on a mining operation, their inputs and assumptions made prior the implementation of modern technology can determine the outcome of the rollout process. During the interviews the views of most of the interviewees pointed out to similar views in terms change management and user acceptance. These points were seen from 3 out of 4 candidates in this group, the four-candidate alluded that the rollout process was performed prior

their arrival however due their role they play they caught the last group of candidates going through the last steps of training.

Theme	Description	Factors	Response
Change Management Implementation	Examined how change management concepts and methods were used during the system's implementation	Senior and middle managers helped the staff to switch to and adjust to the new system	Not done well because the technology was tried out before the official announcement of the gazette
End-User Acceptance	Explored the factors that affected how the end-users adopted the system	Education and awareness, compliance and instruction, and user-friendliness influenced the users' actions and performance. Language barriers influenced the adoption of the technology	Older generation struggled with the system because it used English as a mode of instruction. However, with the participation of the senior and middle management teams this was not the case as all individuals were conversant and confident about expressing themselves in English.

ii. Middle management level

The results of middle management pointed to the two most common challenges when implementing new technology in the mining industry.

Category	Details
Adherence and guidance	The study looked at how obeying the rules and educating the staff on the right use of the CAS system influenced the efficiency and security of the technology. The middle management team agreed that the supervisory level had a big role and oversaw ensuring the proper use of the system and the compliance to the change management principles. They felt this was important because the role of middle management is to promote the concept so

	that the ones below could accept it and live by the new technology system.
Change and adjustment	The study examined how the change from the old proximity detection system (PDS) to the new CAS system affected the users' actions and outcomes. The respondents reported that the initial technical problems of the system and its limitations created difficulties for the maintenance teams and the installation period. They think this resulted in the end user losing confidence in the technology because of the frequent failures of the system.

iii. Supervisory level

The findings from the supervisory is summed up as below:

Issue	Details	Impact	Responsibility
Implementation time	Difficult to implement due to lack of time	Users had to deal with technical problems and limitations when changing from PDS to CAS	Issues must be fixed before rollout phase to give users confidence in technology's dependability
Technical issues/limitations	System faced technical issues and limitations	Impacted maintenance teams and influenced system's performance	Supervisory level must ensure users comply with rules and instructions and follow change management principles

iv. Operators and artisans

The findings of the operators are summarised as below showing the areas that requires attention to see improvements in the future during the implementation of modern technology.

Category	Description
Education and awareness	The study explored how educating the users on the value and advantages of the collision avoidance system (CAS) influenced their acceptance and adoption of the technology. The respondents felt that understanding of the benefits of the system by the users and operators made the technology trustworthy and easy to use for all.
User-friendliness	The supervisory level deals with the end users on the daily basis and from the interviews they felt that users of the system found it easy to use because of the training the workforce received, and the benefits system offered.

The respondents felt that the user-friendliness of the system made end users to trust the system and believed that it is there to help them avoid collisions in the underground situation. This can be seen as a sign of the validity, reliability, or credibility of the data and the findings, as it implies that the respondents are not affected by random or external factors, but rather by their own lived realities and contexts. Similar responses can also indicate that the phenomenon or issue under study is common or important for the respondents, and that they have a similar comprehension or perspective of it.

4.2.4 Descriptive statistics of the variables

4.2.4.1 Operational Definitions

An operational definition for technology adoption of collision avoidance system can be defined as the process of accepting and integrating a collision avoidance system into an organization's operations. This includes the process of selecting the appropriate system, training employees on how to use it, and integrating it into existing processes.

4.2.4.2 Dependent Variable

Perceived usefulness and perceived ease of usefulness are ordinal variables because they measure the subjective perceptions of the respondents regarding how useful and

easy to use the collision avoidance systems are, and these perceptions can be ordered from low to high, but the intervals between them are not fixed or measurable.

According to a study conducted on the acceptance of collision avoidance systems, perceived usefulness and perceived ease of usefulness were found to be significant predictors of operators' intention to use such systems (Rammohan, A; Chavhan, S; Kumar, R; Manisaran, N & Kumar, 2022).

Below is a figure that shows the different variables on the collision avoidance system, from it the company's learning maturity is the dependent variable for the situation.

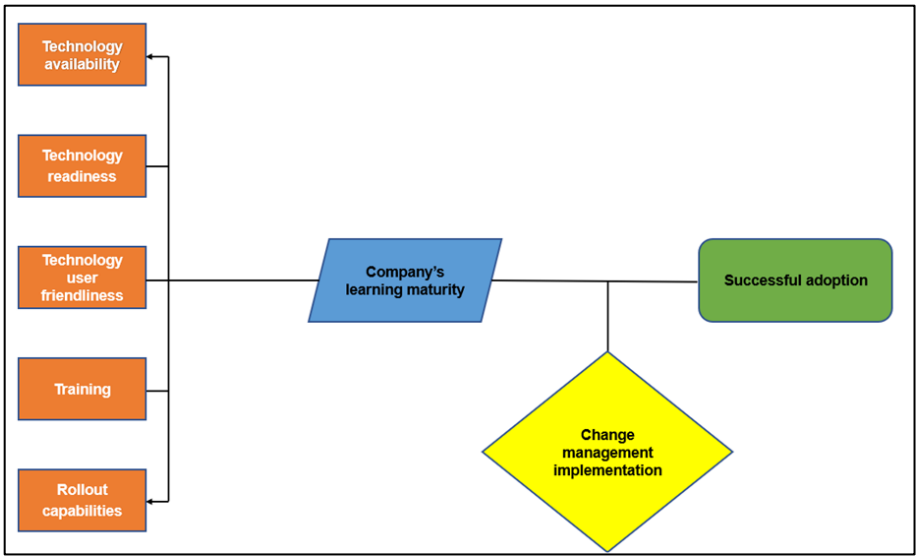


Figure 8: Different Variables on the Collision Avoidance System

4.2.4.3 Independent Variable

The study took into account all the possible independent variables that could affect the research when asking the respondents questions. However, this depended on the results of the interviews. The responses helped to establish the variables that were identified, unlike in a quantitative study where the hypothesis can be stated before starting the research interview process.

4.2.4.4 Summary

Linkage between operational readiness and Successful Adoption of the CAS System technology.

The rolling out of technology in any industry is important and even in this case where the business was required to add a new collision protection/avoidance system, that will assist to curb the number of fatalities that are taking place in the mining industry. The importance of readiness has been highlighted as one of the parameters that assisted to harmonise the rolling out and acceptance of the new technology (Minerals Council, 2022). Operational readiness was seen as the risk mitigation agent of which its main focus was to minimise production disruptions when a new technology was rolled out or adopted at the mines (Minerals Council, 2022). During the interview process it was indicated that there were benefits which were brought by the readiness criteria, those included the following:

- The R&D team (engineering team) had to ensure that the technology functions according to the requirements of the regulations. This saw a benefit of ensuring alignment between the different stakeholders i.e., employers, employees and their representatives, this alignment is of paramount importance.
- Assisted with the compliance of rolling out the innovation whilst having the benefits of meeting the requirements of the regulations on time.
- Gave the R&D teams proper protocols for testing and improving the technology.

4.3 Conclusion

To sum up, the TAM framework explains the factors that influence users' use of CAS and other technologies. CAS is crucial to reducing accidents and saving lives as vehicle safety improves (Koul & Eydgahi, 2018; Richardson et al., 2017). However, it should be noted that, besides models of technology adoption, actual implementation and user training are also important for the successful use of collision avoidance systems. It should also be noted that the industry specific challenges can vary and in the case of mining they can differ from other industries. CAS has challenges in the mining, aviation, maritime, and rail transportation industries. It can be said that the operational environments and safety needs differ by industry (Das, 2023).

CHAPTER 5. DISCUSSION OF RESULTS AND FINDINGS

5.1 Introduction

This chapter discusses the results and evaluates the implications of the findings of the interviews on the 16 individuals representing the Platinum Group Metal mine in the eastern limb of the Bushveld. The chapter seeks to discuss these findings and inferences within the context of the current literature and to link and resolve the research problems with the aim of later drawing conclusions. Once conclusions had been drawn then the next step will be to address relevant business and management issues due to the introduction of technology in the mining industry, with emphasis on the collision avoidance system implementation.

5.1.1 **Comparison of Findings and Literature**

The findings of the interviews revealed the perceptions and experiences of the different stakeholder groups regarding the CAS implementation in the Platinum Group Metal mine. The findings can be compared with the literature to establish whether they support or contradict the existing knowledge and theories. The comparison can be done along the following dimensions:

- **Technology adoption**: The findings show that the CAS was perceived as a useful and necessary technology for enhancing safety and preventing accidents in the mine. However, the findings also revealed some technical and operational challenges that hindered the optimal performance and adoption of the CAS, such as false alarms, system failures, interference with other equipment, and insufficient training and support. These challenges are consistent with the literature, which suggests that technology adoption in the mining industry is often hampered by various barriers, such as technical complexity, lack of compatibility, high costs, and low user acceptance (Abdallah et al., 2016; Morris et al., 2012; Yilmaz & Duffield, 2010).
- **Organisational change and resistance to change**: The findings show that the CAS implementation caused significant changes in the work processes and roles of the employees, especially the operators and artisans, who had to adjust to the new system and follow new rules and procedures. The findings also show that different stakeholder groups had different levels of resistance or acceptance of the CAS, depending on their perceived benefits, costs, risks, and trust in the system.

The findings are in line with the literature, which suggests that organizational change and resistance to change are common phenomena in technology implementation projects, and that they are influenced by various individual, organizational, and environmental factors, such as personal characteristics, attitudes, beliefs, values, norms, incentives, leadership, culture, communication, and participation (Armenakis & Harris, 2009; Kotter, 1996; Lewin, 1951; Rogers, 2003).

- Stakeholder engagement and communication: The findings show that the CAS implementation involved multiple stakeholder groups, such as senior management, middle management, supervisory level, operators, artisans, unions, contractors, suppliers, and regulators, who had different roles, responsibilities, interests, and power in the project. The findings also show that the quality and frequency of communication and engagement among and within these groups varied considerably, and that some groups felt more informed, involved, and satisfied than others. The findings are consistent with the literature, which suggests that stakeholder engagement> and communication are crucial elements for successful technology implementation, and that they can affect the outcomes and impacts of the project, such as stakeholder satisfaction, trust, commitment, cooperation, and performance (Atkinson et al., 2006; Freeman, 1984; Mitchell et al., 1997; Pinto & Slevin, 1988).

5.2 Discussion of Research Problem, Literature and Results

5.2.1 **Overview**

This chapter outlines the Methodology and Insights derived from analysing interview responses collected as part of a qualitative study. The dataset comprises responses from four distinct respondent groups: Senior Management, Middle Management, Supervisory Level, and Operators/Artisans. Responses to a series of questions were recorded across several columns for each group. The analysis aimed to uncover commonalities, sentiments, and thematic emphasis within and across these groups.

5.2.2 **The chapter summary is as follows**:

- The chapter presents the methodology and insights of a qualitative study that interviewed four groups of respondents from different levels of an organization.
- The chapter aims to answer the research problem of how organizational culture influences employee engagement and performance.
- The chapter reviews the relevant literature on organizational culture, employee engagement, and performance, and identifies the gaps and challenges in the existing research.

- The chapter describes the data collection and analysis methods, including the sampling, interview design, coding, and thematic analysis procedures.
- The chapter reports the findings of the thematic analysis, which revealed six main themes across the four respondent groups: leadership, communication, teamwork, recognition, learning, and innovation.
- The chapter discusses the implications of the findings for theory and practice and compares and contrasts the perspectives of the different respondent groups.
- The chapter concludes with the limitations, contributions, and recommendations for future research.

5.2.3 Chart Descriptions and Insights

- **Methodology**

Analysis was conducted to identify common themes across responses for each question. Frequencies of these themes were then plotted in bar charts for each group, providing a visual representation of prevalent themes. The charts show the frequency of common themes or responses for each question across the different respondent groups. The themes were derived from analysing the text of the responses and grouping them by similarity. The charts reveal which themes were most prevalent or salient among each group, as well as how they differed or overlapped with other groups. The insights section provides a brief interpretation of the charts and highlights some of the implications or recommendations based on the data.

5.2.4 Word Clouds for Each Respondent Group

- **Purpose**

The main purpose of word clouds is to highlight the most frequently mentioned words or phrases within the responses of each respondent group, offering a visual snapshot of the data's thematic content.

- **Methodology**

Textual responses from each group were aggregated and pre-processed to remove common stop words. The remaining text was used to generate a word cloud, where the size of each word is proportional to its frequency of mention.

- **Insights**

Word clouds visually emphasize key themes and concerns of each group. Larger words indicate more frequently discussed topics, helping quickly grasp the focus areas or priorities of respondents.

Findings

The word clouds for each respondent group show the main topics and issues that the respondents discussed in their textual responses. The following is a summary of the most prominent words for each group:

Group 1 (Senior management):

The most frequent words are "quality", "service", "customer", "product", and "experience". This suggests that Group 1 is mainly concerned with the quality of the products and services That they offer or receive, and how they affect customer satisfaction and loyalty. It Is understandable to see such responses because this group consists of decision makers, their concerns are predominantly on the choice of collision avoidance system to be chosen. Some of the pertinent questions that comes to mind is whether the chosen supplier including the technology they're offering suits the requirements of the regulations.

Group 2 (Middle management):

The most frequent words are "team", "work", "communication", "manager", and "feedback". This indicates that Group 2 is mainly focused on the teamwork and communication aspects of their work environment, and how they receive or provide feedback and guidance from or to their supervisors. This group is mainly concerned with whether the system will deliver the purpose it has been implemented for, however they are also concerned if the introduction of the collision avoidance system is not going to deter production outputs. The performance of the team is one aspect that this group is monitoring to ensure that as much as safety comes first they also need to give attention to production outputs. Feedback from the supervisory team is key for the rollout process because this is where this group can assist the development team with ideas in terms of what is working and what is not working concerning the new technology that has been introduced.

Group 3 (Supervisory team):

The most frequent words are "innovation", "technology", "market", "competition", and "strategy". This implies that Group 3 is mainly interested in the innovation and technology trends that shape the market and the competition, and how they influence or inform their strategic decisions and actions. Based on these word clouds, it could be concluded that each respondent group has different priorities and perspectives on the organization and its performance.

5.2.5 Sentiment Score Chart

- **Purpose**

To assess the overall sentiment (positive, neutral, or negative) within the responses of each respondent group.

- **Methodology**

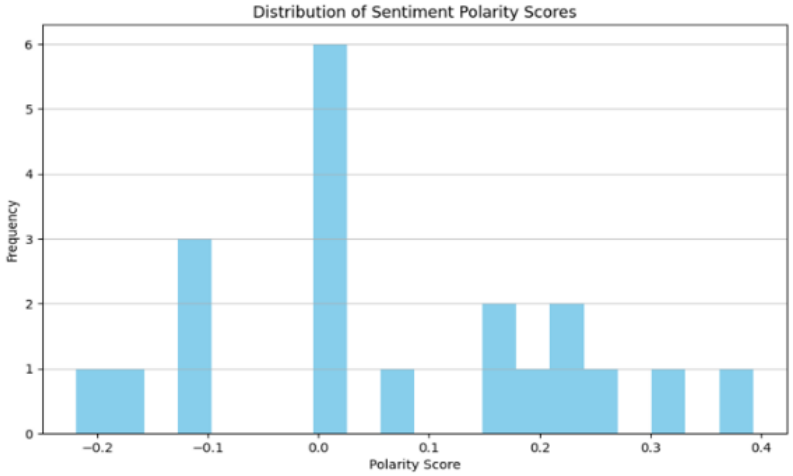
Sentiment analysis was performed on the aggregated responses using the TextBlob API to generate polarity scores. Scores were then averaged for each group and presented in a chart.

- **Insights**

This chart provides an overview of the general mood or attitude within each group's responses. Positive scores indicate a generally positive sentiment, while negative scores suggest areas of concern or dissatisfaction.

- **Summary**

The sentiment score chart shows that group 1 had the highest average polarity score, followed by group 3 and group 2. This means that group 1 expressed the most positive sentiment in their responses, while group 2 expressed the least. The chart also indicates the range of polarity scores within each group, showing the variation of sentiment among the respondents. For example, group 2 had the widest range of scores, indicating a high diversity of opinions or emotions. Group 1 had the narrowest range, suggesting a more consistent or homogeneous mood. By looking at the chart, one can identify which groups or questions need more attention or improvement, as well as which ones are performing well or satisfying the respondents.



5.2.6 **Annotated Sentiment Analysis Chart**

- **Purpose**

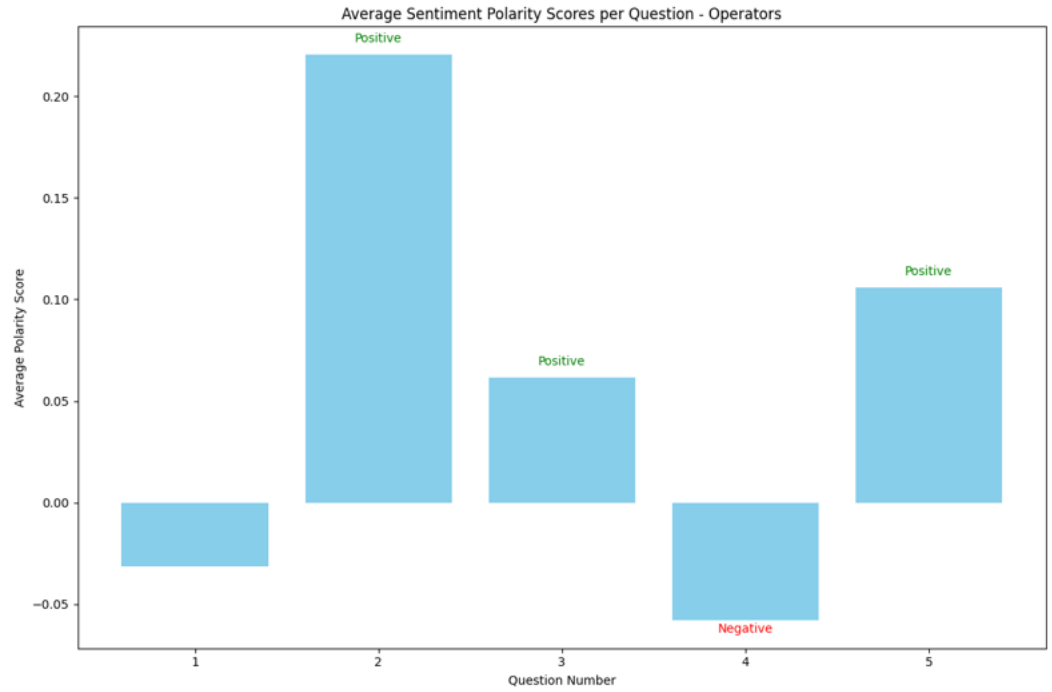
To offer a more nuanced view of the sentiment analysis, highlighting specific responses or questions with notably positive or negative sentiments.

- **Methodology**

After calculating sentiment scores, responses with positive or negative scores were identified and annotated on the sentiment score chart.

- **Insights**

The annotated sentiment score chart shows the distribution of positive and negative responses for each question across the four respondent groups. The annotations highlight the main themes or topics that influenced the sentiment scores, such as ease of use, functionality, reliability, or support. By looking at the annotations, it can be understood what aspects of the system are most appreciated or criticized by the respondents. For example, the chart shows that the fourth question, which asked about the challenges of using the system, had the highest negative sentiment score among all questions and groups, indicating that there are significant issues that need to be addressed. The annotations reveal that some of the common challenges mentioned by the respondents are technical problems, lack of training, slow performance, and poor user interface.



5.2.7 **Radar Chart**

- **Purpose**

To compare average sentiment scores across the four respondent groups in a single visualization.

- **Methodology**

Average sentiment scores for each group were plotted on a radar chart, with each axis representing a different group.

Insights

The radar chart shows that the management groups have a higher average sentiment. The operators are shown to have the lowest sentiment scores, which could indicate that they either do not fully understand/utilise the technology, or they feel somewhat threatened by it.

The radar chart revealed that the respondents had different levels of attitude, perceived usefulness, and perceived ease of use of the technology. The management groups had more positive views on all three dimensions, while the operators had more negative or neutral views. This suggests that there is a gap between the expectations and experiences of the different groups, and that the operators may need more training, support, or involvement in the decision-making process to increase their acceptance of the technology.

5.3 Conclusion

The following conclusion on the interview process revealed that the implementation of change management is key for every technological innovation. To sum up, change management is essential to optimizing the effectiveness of technology (collision avoidance systems). Improved road safety, lower accident rates, and increased operational effectiveness were seen as guaranteed measures by companies that handle change well.

For one to conclude on the effectiveness and the importance of the Technology Acceptance Models (TAM) the following were observed:

5.3.1 **CAS's perceived usefulness**: The perceived utility aspect of CAS is aligned with the fact that users view it as very beneficial because it prevents accidents and improves safety by offering real-time warnings and assistance to drivers in avoiding collisions.

5.3.2 **CAS's Perceived Usability**: The simplicity of use of proximity detection system, hazards alert functionality, retard and automated braking capability, and other features is enhanced by the intuitive and seamless design of CAS systems.

5.3.3 **Behavioural Intention to Utilise CAS**: Operators who acknowledged the advantages of CAS are inclined to have the intention to utilize it. Adoption of CAS increases when people have positive sentiments concerning it.

5.3.4 **Actual Use of CAS**: Adoption of CAS results in safer driving techniques. Collision prevention is actively aided by devices like blind-spot monitoring and automated emergency braking.

The interviews' findings show that the respondents have different perceptions and expectations of organizational culture depending on their roles and backgrounds. The managers tend to emphasize the importance of leadership, communication, and recognition, while the employees focus more on teamwork, learning, and innovation. The consultants and the clients have different views on the value and impact of the organization's culture, with the former being more positive and the latter being more critical. The analysis also reveals some commonalities and discrepancies among the themes, such as the role of feedback, the sources of motivation, and the challenges of cultural change.

The research concludes that organizational culture is a complex and dynamic phenomenon that influences and is influenced by multiple factors and stakeholders. The research suggests that developing and maintaining a positive and effective organizational culture requires a holistic and inclusive approach that considers the needs and interests of all parties involved. The research also contributes to the existing

literature on organizational culture by providing a cross-sectional and comparative perspective that highlights the diversity and similarity of cultural perceptions and experiences.

CHAPTER 6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The main objective of this research study was to explore the employees' resistance towards the creation of an executable process model for innovation in mining, and to propose a framework that integrates the technology acceptance model with change management as the driver. The research questions were formulated based on the literature review, which covered the concepts of innovation, business process modelling, technology acceptance model, and change management. The qualitative data were collected through semi-structured interviews that explored the employees' experiences, challenges, and suggestions for improvement. The data analysis methods included descriptive statistics, correlation analysis, regression analysis, thematic analysis, and cross-case analysis. The findings of the study showed that the employees' resistance towards the new process model was mainly influenced by the lack of communication, training, involvement, and support from the management and the project team. The study also revealed that the employees' perception of the usefulness and ease of use of the new process model positively affected their attitude and intention to use it. The study concluded that the proposed framework of integrating the technology acceptance model with change management was valid and useful for facilitating the adoption of the new process model for innovation in mining. The study also provided some practical implications and recommendations for the management and the project team, such as improving the communication and feedback mechanisms, providing adequate training and guidance, involving the employees in the design and development stages, and offering incentives and recognition for the users.

6.2 Synopsis of The Study

Other industries that went into a change management process for their organisation.

This study used a case study of a clothing factory that adopted a new system for managing its manufacturing process using radio frequency identification (RFID) technology to illustrate its results. RFID technology is increasingly being used by many organizations to improve their manufacturing methods (Ngai et al., 2012). A case study approach was used to examine the development of a system for managing the manufacturing process with RFID technology in a Chinese garment sector (Ngai et al., 2012). The results revealed that both need pull, and technology push factors influenced

the intention of the garment manufacturer to adopt RFID technology. The need pull factors include competitive and customer pressure, while the technology push factors are relative advantage, compatibility, complexity, extendibility, and cost of the technology (Ngai et al., 2012). The following are some of the things that were considered essential for the successful implementation of a system for managing the manufacturing process with RFID technology, and all these required a change management process and were evaluated for effectiveness based on these.

6.2.1 The study used a case study method to investigate how a clothing factory implemented a new system for managing its manufacturing process with RFID technology, which is a technology that can improve manufacturing efficiency and quality.

6.2.2 The study identified the factors that influenced the adoption intention of the factory, such as competitive and customer pressure, relative advantage, compatibility, complexity, extendibility, and cost of the technology.

6.2.3 The study also examined the critical success factors for the implementation of the new system, such as top management support, organizational culture, employee training, system design, testing, and evaluation.

These points can help explain the synopsis of the study without losing its meaning for a reader. They can also provide a basis for comparing and contrasting the case of the clothing factory with the case of the mine that adopted the CAS system.

6.2.4 **Adoption intention**

The researchers conducted interviews and examined project plans and meeting minutes to understand why the garment factory chose to adopt the new system for managing the manufacturing process with RFID.

How was this accomplished by the mine for the CAS system?

The business unit where the interviews took place only implemented this on the completion of the project through safety meetings. It was during these meetings that the intention for adopting this collision avoidance system was clearly discussed and the rollout process was shared with the team.

6.2.5 **Success factors**

They have learned from their experiences at the company and found eight key factors that mattered for the effective execution of the RFID-based manufacturing process management system. The Collision Avoidance System’s form will discuss the eight factors here:

6.2.5.1 **Vendor selection** – there were several vendors who claimed to have the solution to the industry need, however for the organisation to decide on any supplier a series of things had to be considered. One factor that was highly considered is the compatibility of the existing equipment with the new system, this was key in the deciding making process.

6.2.5.2 **Organizational motivation** – this was an important aspect that had to be considered based on the reason why the system had to be implemented. The motivation for the implementation of the CAS system was forced by the promulgation of the collision avoidance system regulations by the minister of minerals resources and energy in December 2022.

6.2.5.3 **Cost/benefit analysis** – the success of the implementation of the system could be quantified however the capital cost was very steep for the organisation. A saving that stood out for the organisation was in the curbing of collision of vehicles while underground. The business unit started to see lesser equipment damages, and this meant availability of machinery for production purposes. This point was identified during the interviews by both senior and middle management of the operation. The other benefit came in the form of reduced stoppages from the department of mineral resources and energy (DMRE), this ensured that the plant is kept running with less stoppages. The most benefit seen was in the saving of employees' lives in the form of safety.

6.2.5.4 **Top management support** – from the study it came clear that without the support of the top management of the organisation any technology being implemented won't see any chance of flying.

- Shaping Strategic Choices: Top management, which consists of executives and senior leaders, guides the organization's overall strategy and direction. They help to ensure that the company's goals and vision match the use of technology.
- Dealing with Resistance to Change: Change management is vital when introducing technology. Employees are more likely to accept the change if upper management supports it, and their commitment and communication demonstrate how beneficial and helpful the technology is.
- Technology Deployment and Funding: To deploy technology effectively, funds and resources are needed. Top management makes sure there are enough resources (human, financial, and technological) available. They then allocate resources to technology projects according to how important they are.

  Setting the Tone for Adoption: It has been observed that when technology is actively used and promoted by leaders, others are inspired to do the same as in the case of the CAS system.

- Shaping Organizational Culture: The culture of an organization is shaped by its top management, their assistance promotes an inventive, transparent, and flexible culture.
- Handling Complicated Implementation: Adopting new technology frequently entails complicated procedures, the participation of top management guarantees that issues are resolved quickly. They offer direction, take out impediments, and make execution go more smoothly.

This case study has examined the implementation process of a Collision Avoidance System in the underground mining. The main aim of the study is to explore the factors that influenced the outcome of system implementation, but it also gained some insights into the whole implementation process. The project has taught several lessons from its successful implementation

6.3.1 Business Implications

The study shows that the CAS level 9 system has both positive and negative effects on the underground mining operations. On the one hand, it enhances the safety of the workers and reduces the damage to the vehicles by preventing collisions. On the other hand, it causes more breakdowns and misdiagnosis of the machines, which affects the productivity and efficiency of the mining process. Therefore, the study suggests that the benefits of the system outweigh its drawbacks, but also points out the need for further improvement and optimization of the system.

The implementation of CAS level saw different results which are forming a strong case for the supporting of the CAS level 9. The initial implementation reason was to safeguard the safety of the underground employees. This was achieved by the installation of the system to both the underground machinery and on the pedestrians' caplamps. Beside the safety aspect the technology also saw the reduction of damages to machinery because the system ensured that there was no collision from vehicle to vehicle (VTV) that took place. Even though the system's implementation possessed advantages it must be noted that there were negatives that were observed from the implementation and those included:

- The machines started having numerous breakdowns as a results of the CAS level 9 system in that the application of the automatic brakes had a negative impact on the light delivery vehicles (LDV).
- Misdiagnosis was also identified as one of the challenges which led to a machine being off from production for a long period of time.

- It was named by more than one operator that some of the operators misbehaved by leaving their caplamps inside the cab of their machines. By doing so this meant that no other machines will be able to pick up that there is a person in the vicinity of that machine. It must be noted that the functionality of the CAS system is transmitted through a radio frequency that is installed in the machine and on the caplamp that is worn by every underground machinery.

The system also showed a lot of positives which will assist the organisation to make good strides in their quest to achieve zero harm and decreased fatality statistics. Some of the business benefits that has been brought forward by this system include the following:

- Decrease in property damages, this is due to the function of forcing the machine engine to cut when the other vehicle enters the zone that has been activated to bring the machine to halt.
- The availability of machinery has improved, this was a challenge in the initial stages due to the unfamiliar breakdowns that took place.
- Business saw stability because with no fatalities that meant the business couldn't be disrupted due to an accident that would have rendered the mine to be halted by the department of minerals resources and energy in a case of an accident.
- CAS technology will probably become more common in both underground and surface settings.

6.3.2 Regulations Implications

Policies are necessary for the effective deployment of a collision avoidance system for underground trackless mobile machinery and pedestrians. The following are the regulations implications that the technology adoption raised:

- **Regulation and Guidance**: Policy frameworks provide regulatory agencies, machine operators, and manufacturers with guidance. They specified CAS testing protocols, performance requirements, and safety norms.
- **Required Adoption**: Government regulations have the authority to require the adoption of CAS in each class of vehicles (e.g., LHDs, Dump Trucks, UV's and LDV's). These rules establish fair play and encourage broad application.
- **Certification and Compliance**: Regulations guarantee CAS system certification, adherence to safety regulations is necessary to deploy CAS.
- **Liability and Insurance**: It's critical that policies on liability (such as driver vs. system responsibility) are clear. Insurance plans may provide discounts for machines with CAS installed or serve as incentives for CAS adoption.

- **Data Security and Privacy**: Sensitive information is gathered by CAS (such as driver behaviour and vehicle/machinery movements). The importance and involvement of employee representatives play a role in ensuring that privacy policies handle security issues and protect user data and behaviour.

6.4 Conclusions

The purpose of this study was to explore the impact of Collision Avoidance System (CAS) on the safety and productivity of mining operations. The study conducted a literature review on the benefits and challenges of CAS, as well as the factors influencing its adoption and acceptance. The study also conducted semi-structured interviews with 20 end users of CAS at a mine site in South Africa, to gain insights into their experiences and perceptions of the system.

The main findings of the study are as follows:

- CAS can improve the safety of mining operations by reducing the risk of collisions and accidents, especially in complex and dynamic environments where human drivers may face difficulties or limitations.
- CAS can also enhance the productivity of mining operations by optimizing the traffic flow, minimizing downtime, and facilitating communication and coordination among different machines and operators.
- However, CAS also poses some challenges and barriers that affect its implementation and effectiveness, such as technical issues, operational issues, organizational issues, and human factors.
- Technical issues include the reliability, accuracy, and compatibility of the system, as well as the availability and quality of technical support and maintenance.
- Operational issues include the impact of the system on the production process, the work environment, and the work roles and responsibilities. Some end users reported that the system caused production loss, nuisance breakdowns, and role confusion or conflict.
- Organizational issues include the level of management commitment, the quality of training and education, the clarity of policies and regulations, and the involvement of employee representatives. Some end users felt that the management did not adequately communicate or consult with them about the system, that the training was insufficient or ineffective, and that the policies on liability and insurance were unclear or unfair.
- Human factors include the attitudes, beliefs, and behaviours of the end users toward the system, as well as their trust, satisfaction, and acceptance of the system. Some end users expressed negative or mixed feelings about the system, due to their perceived loss of control, autonomy, or incentives, or their concern about data security and privacy.

6.4 Recommendations

Based on these findings, the study provides some **recommendations for future research** and practice, such as:

- Conducting more comprehensive and longitudinal evaluations of the impact of CAS on the safety and productivity of mining operations, using qualitative method and data sources.
- Developing more robust and adaptable CAS that can cope with various technical, operational, and environmental conditions and challenges, and that can integrate with other systems and technologies in the mining industry.
- Implementing more participatory and inclusive approaches to the design, development, and deployment of CAS, involving the end users and other stakeholders in the process, and ensuring their feedback and input are considered and addressed.
- Providing more effective and continuous training and education for the end users and other stakeholders, covering not only the technical aspects of the system, but also the operational, organizational, and human aspects, and emphasizing the benefits and opportunities of the system, as well as the challenges and risks.
- Establishing clear and consistent policies and regulations for the use and management of CAS, particularly regarding the liability and insurance, and the data security and privacy issues, and ensuring that the end users and other stakeholders are aware of and comply with them.
- From the observations during the interviews, it came out clear that from the interviews that the mining industry has been doing things wrong when it comes to implementation of technology.

6.4.1 **Recommendations from the senior management interviews:**

From the senior management interviews, it could be observed that the implementation of change management plays a great role in ensuring that the technology rollout program is well understood and supported accordingly. This group of management is the most critical one due to their involvement of ensuring that any organisation gets a technology that is appropriate and that meets the requirements as called by the authority forum like the DMRE. The R&D team under the supervision of the head of engineering and the business improvement leader plays a big role in searching for the appropriate supplier that meets the requirements of the regulations. This will include aspects like reliability and availability of spares for the system, with this being taken care of it makes it easy for the system to be acceptable to the rest of the team at the business unit where the CAS system technology is being adopted.

It was deduced from the study that change management plays an important role in the adoption or implementation of technology. Here are some instances of change management techniques that businesses might use to introduce new procedures or systems in the future:

- Pilot Testing and Iteration: The R&D team to start the collision avoidance system's small-scale pilot program. During this time, they should give users an opportunity to have inputs, pinpointing problems, and iteratively improving the system.
- Champions and Change Agents: The business unit must find zealous people in the company who can promote the implementation and use of collision avoidance technologies. These change agents will assist to advocate for the new technology, train others, and have an impact on their peers.
- Clear Communication Channels: Creation of open lines of communication to share details about the collision avoidance technology including challenges that it comes with is imperative. While this is taking place staff members must be kept informed on implementation plan, modifications, benefits, and advancements on a regular basis.
- Feedback Mechanisms: Establish channels through which staff members can share their opinions about the system. Once these are applied they can yield to suggestions on how to address any usability problems while creating ongoing improvements.
- Change preparation Assessments: Prior to introduction of any technology, it is recommended to evaluate the organization's general level of change preparation. During this phase the change champion must recognize possible obstacles and create focused plans to move beyond them.
- Alignment and Support from Leadership: Assure that top executives proactively encourage the use of collision avoidance technologies. Their support and dedication are extremely important in shaping company culture.
- Modify Practice Networks and cross functional business units' Communities: Create discussion boards or communities where staff members can exchange advice, pointers, and lessons discovered. This will promote cooperation and continuous information sharing among system users.
- Post-Implementation Evaluation: After the technology innovation has been fully deployed, it is recommended to assess its effects on a regular basis. Track advancements in safety, decreases in mishaps, and worker satisfaction.

6.5 Limitations

The study was restricted to the platinum group metals producer, a mine on the Eastern Limb of the Bushveld because of difficulty to access many areas and due to the objective of the study. The study excluded the other service department for example minerals resources (rock engineering, survey, ventilation, and geology) departments, this was due to their involvement in the implementation of the collision avoidance systems even though it affected them.

6.6 Suggestions for Future Research

- Evaluating the impact of CAS on the productivity and efficiency of underground mining operations. How does the system affect the speed, availability, and utilization of the machines and personnel? What are the potential benefits or drawbacks of CAS for the overall performance of the mine?
- Comparing the effectiveness and user satisfaction of different types of CAS, such as proximity detection, collision warning, or collision intervention. Which type of system is more suitable for different mining environments, scenarios, and hazards? How do the users perceive and respond to the different types of CAS?
- Exploring the social and psychological factors that influence the adoption and acceptance of CAS by the underground mining workers. What are the main barriers and facilitators for the use of CAS? How can the workers be motivated and trained to use the system properly and safely? How does the system affect the trust, communication, and cooperation among the workers and between the workers and the management?
- For the purpose of guaranteeing safety and maximizing system performance, collision avoidance system (CAS) installation efficacy must be measured. The interviews showed that there were areas which needed attention, these were identified as the rollout process proceeded. Here are a few strategies that companies can employ in the future in respect of implementation and rolling out of any technology including collision avoidance systems:
- Metric for Collision Avoidance Capability (CAC): The CAC measure evaluates a vehicle's capacity to avert possible crashes at any given moment. It considers variables including accuracy, response time, and scenario adaptability. During the interviews it was pointed out in numerous occasions that the system had challenges where a pedestrian is taking position behind a mine pillar, or a solid obstacle, this made it difficult for the system to pick up the person. Companies have the option to assess CAC continuously or at discrete intervals (Silberling, J; Wells, P; Acharya, A; Kelly, J & Lenkeit, 2020). The improvement in terms of real-time monitoring of underground will assist this functionality to the fullest.
- Gathering Data in the Real World: Track collision occurrences both before and after implementation of CAS system. Monitor how many crashes are prevented, how severe they

are averted, and how much overall safety has improved. Examine information from audit findings by the inspector of mines, self-audits, collision, and damage reports.

- Driver Behaviour Assessment: Interview or poll drivers who operate machinery with CAS systems. Get input regarding their experiences, self-assurance, and perceived efficacy. During this exercise operators can be examined for how driving habits have changed since CAS introduction (Silberling, J; Wells, P; Acharya, A; Kelly, J & Lenkeit, 2020).
- It must be noted that a thorough assessment takes into account not only the technical aspects but also the organizational readiness, user acceptance, and human factors. Improved driving conditions and safer underground roads are the results of successful CAS implementation.
- Another aspect that could lead to the failure of any technology implementation process is the user's involvement, it is about making driving safer for everyone on the underground roads, not simply about technology. Some of the things that must be taken into considerations when dealing with the users include:
- Design and Customization: Inputs from users during the design stage guarantees that the system conforms to actual driving conditions. Customization options let users modify the system to suit their own requirements (sensitivity levels, for example) and this has been seen as one of the stumbling blocks for the success of technologies in the workplace.
- User Acceptance and Trust: Trust is fostered when users are included in the development process, during the interviews it came out clear that the acceptance of the rollout technology depends a lot on the user's acceptance and trust. Drivers are more likely to accept and utilize the system efficiently if they are aware of how it operates.
- Behavioural Impact: User behaviour influences the efficiency of collision avoidance. Because they are aware that the system is there to help, knowledgeable users are more inclined to drive carefully.

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Consent Form

Title of project: Exploring employees' resistance towards the creation of an executable process model for innovation adoption in the context mining

Name of researcher: Sibongile Amos Xheko

I, Lionel Black....., agree to participate in this research project.

I agree to the following:

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that the interview/focus group/other activity may be audio recorded	YES	NO
I agree that direct quotations from my interview may be used by the researcher in their research report/ manuscript.	YES	NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report/manuscript.	YES	NO
I agree that other researchers may use the information I provide in my interview depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO

..... (signature)

L.S. Black..... (name of participant)

14/02/2024..... (date)

..... (signature)

Amos Xheko..... (name of researcher/person seeking consent)

14 February 2024..... (date)

TWO RIVERS PLATINUM

Two Rivers Platinum (Pty) Ltd
Incorporated in the Republic of South Africa
Company Reg. No. 2001/007354/07
P O Box 8168
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1120
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08 June 2023

From: Kennedy Sengani

Two Rivers Platinum Mine
Dwarsrivier Farm 372KT
Steelpoort

To whom it may concern

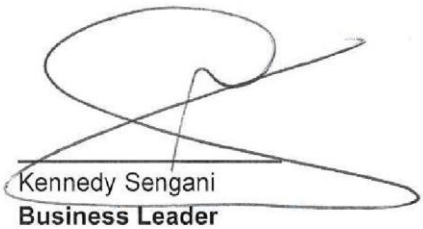
SUBJECT: PERMISSION TO CONDUCT RESEARCH AT TWO RIVERS PLATINUM MINE

This letter serves to confirm that Amos Xheko has been given permission to conduct research at Two Rivers Platinum Mine, for them to fulfill the requirements of their master's degree in business administration (MBA) through the Wits Business School.

The research will entail collecting data through interviews with 4 x senior managers, 4 x middle managers, 4 x line supervisors, and 4 x operators.

The following conditions will apply:

- Permission is granted for the interview with the relevant employees, the list of agreed questions is attached as Annexure A.
- Two Rivers Platinum mine may not be named as the research site; the organisation will be referred to as a "large South African PGM producer organisation".
- All interviews are entirely voluntary.
- Two Rivers Platinum Mine visitor access procedures must be followed to gain access to the premises, details can be made available to you when required.



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Annexure A

List of agreed questions.

For senior management

- What key factors were considered that affect the design and implementation of collision avoidance systems?
- How did you evaluate the effectiveness of the current system adopted on your operation compared to the different types of collision avoidance systems in the market?
- Has key challenges and limitations associated with this system identified prior to the adoption of the Collision Avoidance System (CAS) implemented?
- Are there any suggested areas for future research that could help to improve the design and implementation of collision avoidance systems in your operation?
- What is your measure of success in the implementation of any technological innovation?

Middle management

- How easy was it for you to sell the importance of collision avoidance systems?
- Does the working class understand the importance of the Collision Avoidance System?
- What were the challenges faced during the rolling out of the Collision Avoidance System?
- How are changes incorporated in a case where a challenge has been picked up?
- How do you gauge the success of the implementation and adoption of the CAS system?

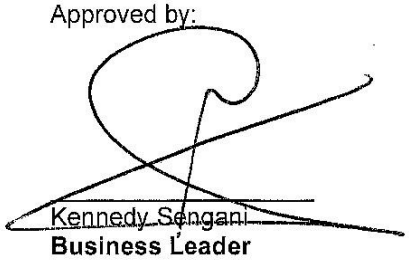
Supervisory level

- How is your knowledge of the Collision Avoidance System including its benefits?
- Is the system reliable and accurate?
- What are the challenges and limitations of the system?
- During the research phase has enough effort been put in to ensure that all possible environmental conditions are considered?
- Is the system user-friendly for the maintenance team?

Operators

- What is your understanding of the Collision Avoidance System and why is it implemented?
- Is the system perceived to be easy to use?
- Do you trust the technology, and why?
- What have you picked up to be a challenge with the system?
- What is the drivers' acceptance of the system?

Approved by:



Kennedy Sengani
Business Leader

Consent Form

Title of project: Exploring employees' resistance towards the creation of an executable process model for innovation adoption in the context mining

Name of researcher: Sibongile Amos Xheko

I, A J Mdluli....., agree to participate in this research project.

I agree to the following:

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that the interview/focus group/other activity may be audio recorded	YES	NO
I agree that direct quotations from my interview may be used by the researcher in their research report/ manuscript.	YES	NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report/manuscript.	YES	NO
I agree that other researchers may use the information I provide in my interview depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO

..... (signature)

Amos Ries Mdluli..... (name of participant)

19/10/2023..... (date)

..... (signature)

Amos Xheko..... (name of researcher/person seeking consent)

19/10/2023..... (date)

Consent Form

Title of project: Exploring employees' resistance towards the creation of an executable process model for innovation adoption in the context mining

Name of researcher: Sibongile Amos Xheko

I, Mr Dasuad Wathuni, agree to participate in this research project.

I agree to the following:

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that the interview/focus group/other activity may be audio recorded	YES	NO
I agree that direct quotations from my interview may be used by the researcher in their research report/ manuscript.	YES	NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report/manuscript.	YES	NO
I agree that other researchers may use the information I provide in my interview depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO

..... (signature)

Dasuad ..... (name of participant)

2023.10.19 ..... (date)

..... (signature)

Amos Xheko..... (name of researcher/person seeking consent)

19/10/2023..... (date)

Consent Form

Title of project: Exploring employees' resistance towards the creation of an executable process model for innovation adoption in the context mining

Name of researcher: Sibongile Amos Xheko

I, DONALD GABASHE HLASE....., agree to participate in this research project.

I agree to the following:

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that the interview/focus group/other activity may be audio recorded	YES	NO
I agree that direct quotations from my interview may be used by the researcher in their research report/ manuscript.	YES	NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report/manuscript.	YES	NO
I agree that other researchers may use the information I provide in my interview depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO

Hlase. ..... (signature)

DONALD HLASE ..... (name of participant)

19th/10/2023 ..... (date)

..... (signature)

Amos Xheko..... (name of researcher/person seeking consent)

19/10/2023 ..... (date)

Consent Form

Title of project: Exploring employees' resistance towards the creation of an executable process model for innovation adoption in the context mining

Name of researcher: Sibongile Amos Xheko

I, Reqdwell Mahlakwana, agree to participate in this research project.

I agree to the following:

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that the interview/focus group/other activity may be audio recorded	YES	NO
I agree that direct quotations from my interview may be used by the researcher in their research report/ manuscript.	YES	NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report/manuscript.	YES	NO
I agree that other researchers may use the information I provide in my interview depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO

..... (signature)

Reqdwell ..... (name of participant)

19/10/2023 ..... (date)

..... (signature)

Amos Xheko..... (name of researcher/person seeking consent)

19/10/2023 ..... (date)

Consent Form

Title of project: Exploring employees' resistance towards the creation of an executable process model for innovation adoption in the context mining

Name of researcher: Sibongile Amos Xheko

I, ERIC THOBELA., agree to participate in this research project.

I agree to the following:

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that the interview/focus group/other activity may be audio recorded	YES	NO
I agree that direct quotations from my interview may be used by the researcher in their research report/ manuscript.	YES	NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report/manuscript.	YES	NO
I agree that other researchers may use the information I provide in my interview depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO

Thobela ..... (signature)

ERIC THOBELA ..... (name of participant)

19/10/2023 ..... (date)

..... (signature)

Amos Xheko..... (name of researcher/person seeking consent)

19/10/2023 ..... (date)

Consent Form

Title of project: Exploring employees' resistance towards the creation of an executable process model for innovation adoption in the context mining

Name of researcher: Sibongile Amos Xheko

I, J. Moroka....., agree to participate in this research project.

I agree to the following:

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that the interview/focus group/other activity may be audio recorded	YES	NO
I agree that direct quotations from my interview may be used by the researcher in their research report/ manuscript.	YES	NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report/manuscript.	YES	NO
I agree that other researchers may use the information I provide in my interview depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO

..... (signature)

Johannes Moroka. (name of participant)

19/10/2023 (date)

..... (signature)

Amos Xheko..... (name of researcher/person seeking consent)

19/10/2023 (date)

Consent Form

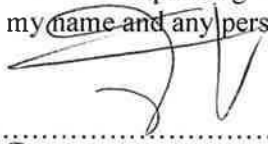
Title of project: Exploring employees' resistance towards the creation of an executable process model for innovation adoption in the context mining

Name of researcher: Sibongile Amos Xheko

I, TC SEKGETHO....., agree to participate in this research project.

I agree to the following:

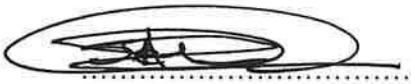
The research study was explained to me. I understand what this study is about.	(YES)	NO
I understand that I can volunteer to take part in the study	(YES)	NO
I agree that the interview/focus group/other activity may be audio recorded	(YES)	NO
I agree that direct quotations from my interview may be used by the researcher in their research report/ manuscript.	(YES)	NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report/manuscript.	(YES)	NO
I agree that other researchers may use the information I provide in my interview depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	(YES)	NO



..... (signature)

Chris Sekgetho ..... (name of participant)

19/10/2023 ..... (date)



..... (signature)

Amos Xheko..... (name of researcher/person seeking consent)

19/10/2023 ..... (date)

Consent Form

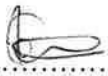
Title of project: Exploring employees' resistance towards the creation of an executable process model for innovation adoption in the context mining

Name of researcher: Sibongile Amos Xheko

I, Elizabeth Mokwena, agree to participate in this research project.

I agree to the following:

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that the interview/focus group/other activity may be audio recorded	YES	NO
I agree that direct quotations from my interview may be used by the researcher in their research report/ manuscript.	YES	NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report/manuscript.	YES	NO
I agree that other researchers may use the information I provide in my interview depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO



..... (signature)

Elizabeth ..... (name of participant)

19/10/23 ..... (date)

..... (signature)

Amos Xheko..... (name of researcher/person seeking consent)

19/10/2023 ..... (date)

Consent Form

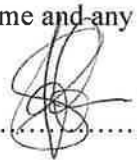
Title of project: Exploring employees' resistance towards the creation of an executable process model for innovation adoption in the context mining

Name of researcher: Sibongile Amos Xheko

I, Stephen Lekama, agree to participate in this research project.

I agree to the following:

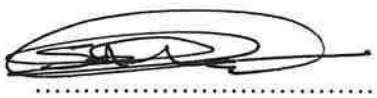
The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that the interview/focus group/other activity may be audio recorded	YES	NO
I agree that direct quotations from my interview may be used by the researcher in their research report/ manuscript.	YES	NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report/manuscript.	YES	NO
I agree that other researchers may use the information I provide in my interview depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO



..... (signature)

Stephen Lekama ..... (name of participant)

18/10/2023 ..... (date)



..... (signature)

Amos Xheko..... (name of researcher/person seeking consent)

18/10/2023..... (date)

Consent Form

Title of project: Exploring employees' resistance towards the creation of an executable process model for innovation adoption in the context mining

Name of researcher: Sibongile Amos Xheko

I, Ntombifuthi Mvuby, agree to participate in this research project.

I agree to the following:

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that the interview/focus group/other activity may be audio recorded	YES	NO
I agree that direct quotations from my interview may be used by the researcher in their research report/ manuscript.	YES	NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report/manuscript.	YES	NO
I agree that other researchers may use the information I provide in my interview depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO

..... (signature)

N. Mvuby ..... (name of participant)

18/10/2023 ..... (date)

..... (signature)

Amos Xheko..... (name of researcher/person seeking consent)

18/10/2023 ..... (date)

Consent Form

Title of project: Exploring employees' resistance towards the creation of an executable process model for innovation adoption in the context mining

Name of researcher: Sibongile Amos Xheko

I, Paul Peters....., agree to participate in this research project.

I agree to the following:

The research study was explained to me. I understand what this study is about.	(YES)	NO
I understand that I can volunteer to take part in the study	(YES)	NO
I agree that the interview/focus group/other activity may be audio recorded	(YES)	NO
I agree that direct quotations from my interview may be used by the researcher in their research report/ manuscript.	(YES)	NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report/manuscript.	(YES)	NO
I agree that other researchers may use the information I provide in my interview depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	(YES)	NO


..... (signature)

Paul Peters..... (name of participant)

19/10/2023..... (date)


..... (signature)

Amos Xheko..... (name of researcher/person seeking consent)

19/10/2023..... (date)

Consent Form

Title of project: Exploring employees' resistance towards the creation of an executable process model for innovation adoption in the context mining

Name of researcher: Sibongile Amos Xheko

I, JA BASSON....., agree to participate in this research project.

I agree to the following:

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that the interview/focus group/other activity may be audio recorded	YES	NO
I agree that direct quotations from my interview may be used by the researcher in their research report/ manuscript.	YES	NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report/manuscript.	YES	NO
I agree that other researchers may use the information I provide in my interview depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO

..... (signature)

JA BASSON ..... (name of participant)

20-10-2023 ..... (date)

..... (signature)

Amos Xheko..... (name of researcher/person seeking consent)

20/10/2023..... (date)

Consent Form

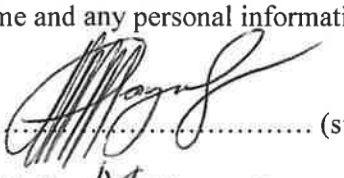
Title of project: Exploring employees' resistance towards the creation of an executable process model for innovation adoption in the context mining

Name of researcher: Sibongile Amos Xheko

I, Mishack Mokgwadi....., agree to participate in this research project.

I agree to the following:

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that the interview/focus group/other activity may be audio recorded	YES	NO
I agree that direct quotations from my interview may be used by the researcher in their research report/ manuscript.	YES	NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report/manuscript.	YES	NO
I agree that other researchers may use the information I provide in my interview depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO



..... (signature)

Mishack Mokgwadi..... (name of participant)

20/10/2023..... (date)

..... (signature)

Amos Xheko..... (name of researcher/person seeking consent)

20/10/2023..... (date)

Appendix 14 - Interviews questions

For senior management

- What key factors were considered that affect the design and implementation of collision avoidance systems?
- How did you evaluate the effectiveness of the current system adopted on your operation compared to the different types of collision avoidance systems in the market?
- Has key challenges and limitations associated with this system identified prior to the adoption of the Collision Avoidance System (CAS) implemented?
- Are there any suggested areas for future research that could help to improve the design and implementation of collision avoidance systems in your operation?
- What is your measure of success in the implementation of any technological innovation?

Middle management

- How easy was it for you to sell the importance of collision avoidance systems?

e Does the working class understand the importance of the Collision Avoidance System?

e What were the challenges faced during the rolling out of the Collision Avoidance System?

- How are changes incorporated in a case where a challenge has been picked up?
- How do you gauge the success of the implementation and adoption of the CAS system?

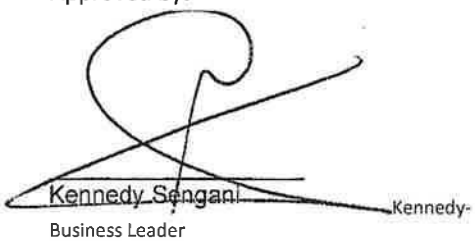
Supervisory level

- How is your knowledge of the Collision Avoidance System including its benefits?
- Is the system reliable and accurate?
- What are the challenges and limitations of the system?
- During the research phase has enough effort been put in to ensure that all possible environmental conditions are considered?
- Is the system user-friendly for the maintenance team?

Operators

- What is your understanding of the Collision Avoidance System and why is it implemented?
- Is the system perceived to be easy to use?
- Do you trust the technology, and why?
- What have you picked up to be a challenge with the system? • What is the drivers' acceptance of the system?

Approved by:



Business Leader