Organisational culture, safety climate, supervisory accountability and engagement as drivers of safety behaviour in a platinum mining organisation

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ABSTRACT

The mining industry plays a significant role in the South African economy. In 2019, the sector contributed R360.9 billion (8.1%) to the total gross domestic product (Minerals Council South Africa, 2020). With almost half a million employees reporting to work in the South African mining industry each day, a relentless commitment to safety and health compliance is required to manage the inherent risks and hazards associated with the sector.

Previous research has shown that frontline supervisors have a direct impact on the safety behaviour of individuals and that their leadership significantly influences team safety performance. The objectives of this study sought to contribute to the body of research on organisational culture, frontline supervisory engagement and accountability as levers for enhancing organisational performance and creating sustainable competitive advantage through resilient safety behaviour.

Quantitative, confirmatory research methods were used to gain insights into the effect of organisational culture and safety climate on safety behaviour, while examining the influencing effects of frontline supervisory engagement and accountability on safety behaviour in the process division of a single platinum mining organisation in South Africa. A total of 104 survey based responses from frontline supervisors were analysed using factor analysis and multiple regression tactics.

The key findings indicate that the tendency of a supervisor to hold herself and her team accountable is positively correlated to good safety behaviour, and is the strongest predictor of safety behaviour when considering safety climate and supervisory engagement and supervisory accountability. Furthermore, safety climate was found to be a significant contributor to safety behaviour. All three organisational culture factors – organisational practices, supervisory support and work attributes – were found to be strong predictors of safety climate, with only work attributes contributing to predicting supervisory accountability. These results indicate a significant influence between organisational culture, safety climate, supervisory accountability and safety behaviour. Supervisory engagement, although found to be positively correlated, was not a statistically significant predictor of safety behaviour. The findings from this research add to the literature on safety behaviour, frontline supervisory behaviours and organisational culture.

KEYWORDS

Safety behaviour, organisational culture, frontline supervision, accountability, engagement, safety climate

DECLARATION

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

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1 INTRODUCTION TO THE RESEARCH PROBLEM

1.1 Description of the problem

South Africa is known for its wealth of mineral resources, but industry leaders trying to create sustainable value and competitive advantage face a number of challenges as a result of today's rapidly changing and dynamic business environment (Cao & Ramesh, 2008). To remain competitive, many firms have been forced to prioritise operational efficiencies, which often results in leaner labour forces and additional productivity pressures on employees and organisations (Hakanen, Schaufeli & Ahola, 2008). As a result, safety processes in South Africa's mining environment may have been compromised (Hlatywayo, 2013). Within these constraints, firms are required to create and manage safe, secure and sustainable work environments (Cummings *et al*., 2010), and any failure to do so will have an adverse effect on organisational performance (Schaufeli, Taris & Van Rhenen, 2008).

The mining industry plays a significant role in the South African economy. In 2019, the sector contributed R360.9 billion (8.1%) to the total gross domestic product (Minerals Council South Africa, 2020). In the same year, the sector represented 6.2% of all private non-agricultural employment, accounting for an estimated 456 000 jobs (Minerals Council South Africa, 2020). With almost half a million employees reporting to work in the South African mining industry each day, a relentless commitment to safety and health compliance is required to manage the inherent risks and hazards associated with the sector. In 2019, 51 fatalities were recorded in the sector, of which 19 were attributed to the platinum mining sector. This reflects an increase of 58% from 2018 (Department of Mineral Resources and Energy, 2020).

The performance of mining companies varies widely. Organisations that consistently and systematically outperform their competitors have a fundamental appreciation for the key drivers of value creation, often determined by complex economic and social factors. In mining, the health and safety of employees is of utmost importance for the competitive functioning of organisations (Jarosławska-Sobór, 2015; Bini, Bellucci & Giunta, 2018). Corporate social responsibility is fundamental to any firm's strategic direction, and by addressing issues pertaining to employee health and safety, businesses create sustainable value and competitive advantage (Chandler, 2016). It

is apparent, then, that drivers to improve health and safety in mines are important if organisations are to compete. Organisational culture is an important feature in creating a safe and effective workforce (Baker, 1980). Furthermore, engagement and accountability have been shown to increase productivity and performance (Barbars, 2015; Gelfand, Lim & Raver, 2004; Shaufeli & Salanova, 2011; Schneider, Yost, Kropp, Kind & Lam, 2018).

Frontline supervision is fundamental to the management of risk in a mining environment (Yang, Zheng, Liu, Lu & Schaubroeck, 2019). When investigating accidents in the South African railway industry, Tau (2017) found that 71% of all accidents were attributed to “the human factor”, and that 32% of these were either directly or indirectly a result of inadequate supervision. The report indicates that despite procedures and policies for the adequate management of safety being available and in place, these systems were not well implemented because of a lack of supervision (Tau, 2017). These findings were corroborated by the Inspector of Mines, who, in 2017, under the auspices of the Mine Health and Safety Act (1996), issued partial and complete closure instructions necessary to protect the health and safety of workers at specific mines. This forced employers to take the necessary steps to rectify substandard conditions, occurrences or practices. Of all closure instructions issued, general and poor supervision accounted for 34% (Department of Mineral Resources and Energy, 2018).

Previous research has revealed that frontline leaders have a direct influence on the safety behaviour of individuals and that their leadership significantly influences team safety performance (Fang & Wu 2015; Lingard, Cooke & Blismas, 2012). By virtue of their proximity to the workforce, frontline leaders provide the first line of defence in managing risk, communicating organisational priorities and values, and building relationships with individual team members (Delbridge & Lowe, 1997; Weick & Sutcliffe, 1997). Effective supervision sets and maintains high standards of performance and the physical aspects of the work environment, and is critical to achieving and maintaining the desired safety culture (Delbridge & Lowe, 1997; Weick & Sutcliffe, 1997). Michael, Wiedenbach & Ray (2006) emphasise that because workers rely significantly on frontline leaders to delegate tasks, and to support and guide the execution of complex work in a dynamic environment, frontline leaders can have a direct and substantial impact on a team’s safety behaviour and performance.

However, it is important to understand what aspects of frontline leadership make it effective in driving progressive safety behaviour and the successful management of risk.

The engagement of frontline leaders is considered one of the sources of increased commitment and performance in the workplace (Barbars, 2015, Schneider, Yost, Kropp, Kind & Lam, 2018). But job engagement can be created and sustained only if it is supported by organisational culture (Barbars, 2015; Schneider *et al*, 2018). Furthermore, individual-level accountability, or felt accountability, has been found to influence performance and job engagement (Hall, Frink & Buckley, 2017; Hochwarter, Ferris, Gavin, Perrewé, Hall & Frink, 2007).

1.2 Purpose of the research

It is pertinent to understand the relationship between the engagement and accountability of frontline supervisors and their impact on safety behaviour. It is also pertinent to understand how organisational culture would need to support these dynamics for an industry-wide improvement in safety management to be sustainably achieved.

This study seeks to contribute to the body of research on organisational culture, frontline supervisory engagement and accountability as levers in enhancing organisational performance and creating sustainable competitive advantage through resilient safety behaviour. The purpose of the research is to investigate the effect of organisational culture on safety behaviour, while examining the mediating or moderating effects of frontline supervisory engagement and accountability on safety behaviour. Although these subjects have been comprehensively researched, they have not been thoroughly applied to frontline supervision and safety behaviour in the mining industry. These relationships remain important to business and academics alike as they affect both employee and organisational performance.

1.2.1 The business need for the study

The wellbeing of employees and organisations is of major concern for all stakeholders. Consequently, workplace safety is of fundamental importance to the creation of a profitable and sustainable business. By ensuring the workplace is a safe

and healthy professional environment, the business not only protects its workforce from injury and illness, but also improves employee morale, reduces absenteeism, and increases productivity, efficiency and quality while contributing to the sustainability and resilience of the business (Minerals Council South Africa, 2020). The South African mining industry is legally regulated by the Mine Health and Safety Act (1996), and any contraventions of this act can result in significant loss of life and financial instability. It can thus be said that a safe workplace is good for business. By furthering the knowledge into how organisational culture, supervisory job engagement and felt accountability affect safety behaviour, organisational leadership will have a better understanding of how these levers can be manipulated to optimise behaviours that lead to safe workplace, and in so doing, drive improved safety performance and better business results.

1.2.2 The theoretical need for the study

Barbars (2015) investigates the relationship between organisational culture and job engagement between various teams within an IT department, and finds a positive correlation between organisational culture and work engagement. Similar findings are put forth by Schneider *et al* (2018), who posit a positive relationship between employee behaviour, work engagement and aspects of organisational culture, and that this correlation is a predictor for future organisational success. Both of these studies call for further research into the nature and direction of the relationship between organisational culture and work engagement using larger sample sizes and across other industries. Schneider *et al* (2018) specifically call for further research into the mediating antecedents to work engagement that may affect business performance or outcomes. In addition, there is a growing body of knowledge on the aspects and consequences of individual accountability within organisations as a result of the demand by business, society and academic literature for greater understanding of this elusive concept (Pearson & Sutherland, 2016). It is known that accountability positively correlates with behaviour and performance, but the extent of felt accountability as a mediating effect on safety-specific behaviours is not well researched.

2 LITERATURE REVIEW

2.1 Introduction

The mining industry plays a significant role in the South African economy. In 2019, the sector contributed R360.9 billion (8.1%) to the total gross domestic product (Minerals Council South Africa, 2020). In the same year, the sector represented 6.2% of all private non-agricultural employment, accounting for an estimated 456 000 jobs (Minerals Council South Africa, 2020). With almost half a million employees reporting to work in the South African mining industry each day, a relentless commitment to safety and health compliance is required to manage the inherent risks and hazards associated with the sector. In 2019, 51 fatalities were recorded in the sector, of which 19 were attributed to the platinum mining sector. This reflects an increase of 58% from 2018 (Department of Mineral Resources and Energy, 2020).

The performance of mining companies varies widely. Organisations that consistently and systematically outperform their competitors have a fundamental appreciation for the key drivers of value creation, often determined by complex economic and social factors. In mining, the health and safety of employees is of utmost importance for the competitive functioning of organisations (Jarosławska-Sobór, 2015; Bini, Bellucci & Giunta, 2018). Corporate social responsibility is fundamental to any firm's strategic direction, and by addressing issues pertaining to employee health and safety, businesses create sustainable value and competitive advantage (Chandler, 2016). It is apparent, then, that drivers to improve health and safety in mines are important if organisations are to compete. Organisational culture is an important feature in creating a safe and effective workforce (Baker, 1980). Furthermore, engagement and accountability have been shown to increase productivity and performance (Barbars, 2015; Gelfand, Lim & Raver, 2004; Shaufeli & Salanova, 2011; Schneider, Yost, Kropp, Kind & Lam, 2018).

The main purpose of this research is to analyse the effect of organisational culture on the safety climate and behaviour of frontline supervisors within a South African platinum mining organisation. Supervisory engagement and accountability were investigated as additional factors within the context of organisational culture and safety practices. The constructs reviewed include organisational culture, safety

climate, safety behaviour, and the accountability and engagement of frontline supervision.

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2.2 Safety climate and behaviour

Safety is a significant area of concern for the wellbeing of employees and the organisations in which they work (Yang, Zheng, Liu, Lu & Schaubroeck, 2020). Workplace safety is also the source of significant direct and indirect costs, making safety performance a major contributor to organisational success and competitive advantage (Neal & Griffin, 2006). Organisations are therefore required to create and manage safe, secure and sustainable work environments (Cummings *et al*., 2010), and failure to do so adversely affects organisational performance (Schaufeli, Taris & Van Rhenen, 2008). Workplace safety can be defined by whether and how frequently employees, or others associated with the workplace, come into contact with hazards, as well as what efforts are made to reduce or eliminate accidents or injuries as a result of these interactions (Yang *et al*, 2020). Safety performance refers to the number of workplace accidents, injuries or errors that occur due to hazardous interactions (Christian, Bradley, Wallace & Burke, 2009).

To ensure a safe workplace, the antecedents to safety performance need to be well understood. Yang *et al* (2020) propose that individual safety behaviour is “the most proximal antecedent of safety performance”. Neal & Griffin (2006) define safety behaviour as “the set of individual actions that meet or exceed particular role requirements in order to ensure workplace safety and reduced harm”. Furthermore, safety behaviour can be categorised into both participation and compliance behaviours (Neal & Griffin, 2006, Yang *et al*, 2020). Participatory safety behaviours include taking personal initiative to ensure personal safety and the safety of others, whereas safety compliance refers to adherence to procedures, instructions and rules

designed to improve safety (Yang *et al*, 2020). Despite there being theoretical difference between safety compliance and safety participation, research on safety performance indicates that both are influenced by an employee's willingness to exert extra effort to behave safely, and this is in turn influenced by organisational culture (Neal & Griffin, 2000).

Although significant research has been conducted on understanding job performance as a dimension of safety performance, there has been far less research on understanding how safety behaviour affects the number of incidents and accidents in the workplace (Yang *et al*, 2020; Neal & Griffin, 2006), or on the impact of safety climate on individual safety behaviour. Furthermore, theoretical models and frameworks in safety literature do not adequately address why some individuals engage in more safety behaviours than others (Yang *et al*, 2020). It was thus suggested that the safety climate of an organisation can have an independent effect on individual safety behaviour. This would give organisations the ability to target specific interventions related to an individual's compliance with, motivation to participate and participation in organisational safety practices.

- H1: Aggregate employee perceptions of safety culture are significantly related to safety behaviour.

2.3 Organisational culture and safety climate

In recent research, the emphasis of safety literature has shifted from a focus on the individual – such as noncompliance and human error – towards organisational factors such as the safety climate. Despite the assumption of large parts of this research that the relationship between safety climate and performance is dependent on safety behaviour, there is little known about the mechanisms that can be leveraged to influence individual safety behaviour. Furthermore, little is known about the organisational factors that affect safety climate and how these influence the safety knowledge, motivation and performance of individuals in an organisation (Neal, Griffin & Hart, 2000).

Organisational culture has for many years been studied as a driver of organisational performance and there is substantial evidence of the relationship between organisational culture and performance. Hartnell, Ou & Kinicki (2011), as well as

Sackmann (2011), find that certain characteristic organisational culture factors can be correlated with a number of characteristics to determine work performance. A number of studies have tried to identify the antecedents to safety behaviour in the mining industry. Al Mazrouei, Khalid, Davidson & Abdallah (2019) find that safety behaviour in the oil and gas industry is dependent on elements of the firms' organisational culture after Clarke (1999) described safety as a subclass of organisational culture. Stemn, Bofinger, Cliff & Hassall (2019) define safety in the mining industry as a reflection of perceptions, values, behaviours, attitudes and values concerning safety that are shared by employees. From research conducted in the nuclear industry, Pidgeon (1991) describes safety as "a set of roles, norms, technical, social, attitudes and belief practices intended to minimise the exposure of the public, managers, employees and customers to injurious or dangerous conditions". For Beus, Payne, Arthur & Munoz (2019), safety is a "conceptual ambiguity" that includes the attitudes, behaviours and beliefs of an organisation as can be found in the procedures, policies and actions that have an impact on the safety performance of the firm. Lee & Harrison (2000) define safety culture as the perceptions of risk, behaviours, values and beliefs that employees hold with regards to their safety in the organisation. This implies that the concept of safety behaviour cannot be researched in isolation, and consideration must be given to organisational culture (Al Mazrouei *et al*, 2019).

In more recent literature, organisational culture is described as a set of values or behaviours practiced and shared by the employees of an organisation (Barbars, 2015). These behaviours have an effect on how decisions are made and how work is done. Hofstede (1994) defines organisational culture as "deeply rooted values or shared norms, moral or aesthetic principles that guide action and serve as standards to evaluate one's own and others' behaviours". Hofstede (1994) also emphasises that organisational culture pivots around a set of values that have a special meaning to the organisation or individual, and that these values set the tone for expectations around relationships, as well as how people think feel, act and behave. According to Barbars (2015), the foundations of any organisational culture are the underlying values that define how the members of that organisation behave. He postulates that it is possible to determine the values required to drive a particular culture. Baker (1980) is of the opinion that "good" cultures are characterised by "good" values that support performance and excellence by leveraging teamwork, honesty, integrity,

commitment to the organisation, pride in one's work, and adaptability. We can thus identify a set of values that may have a positive effect on what the organisation is trying to achieve and how it is trying to achieve those things by reinforcing the its vision, mission and purpose (Baker, 1980). If we extrapolate this concept, we might say that safe organisational cultures can be characterised by a set of values that encourage safe behaviour and performance.

Brown & Leigh (1996) find that organisational climate significantly influences individual motivation to perform, while Morrison, Upton & Cordery (1997) establish that organisational culture also affects participation in organisational programmes. Safety climate describes how individuals within an organisation perceive how safe the work environment is, and this is influenced by a number of factors. These include supervisory support or management values such as how concerned management are with the wellbeing of their employees; and organisational practices and work attributes such as access to training, safety system quality, communication, the provision of equipment, and employee involvement in workplace safety. Whereas a range of studies have established sound predictive relationships between these factors and safety-related incidents such as accidents (Zohar, 2010; Brown & Leigh, 1996), few studies have established links between specific organisational culture factors and safety climate. This study proposes that factors such as supervisory support, organisational practices and the work attributes of an organisation inform the formation of specific perceptions of or on safety, and thus should predict safety culture.

Hopkins (2006), in an effort to clarify the difference between organisational culture and safety culture, states that every organisation has a culture and that this culture can be assumed to influence safety. Wiegmann, Zhang, von Thaden, Sharma & Gibbons (2004) studied safety culture and developed a summary of definitions for safety culture emanating from literature. Wiegmann et al. (2004) conclude that, regardless of the industry being investigated, all safety culture definitions contain commonalities with reference to shared values, management and supervisory systems, safety behaviour and an organisations growth mindset and ability and willingness to learn and adapt. Furthermore, Wiegmann et al. (2004) describe at least five organisational antecedents to safety culture. These include employee engagement (in the form of organisational commitment), supervisory support,

employee empowerment, and systems of accountability and reporting. These indicators are crucial to this study, as they form the basis of the research methodology, as discussed in Chapter 3.

Zohar (2010) contends that a comprehensive understanding of the influence organisational culture has on safety climate must include knowledge of how safety procedures and policies are prioritised by frontline supervisors, and how these policies are relayed to frontline employees. On this point, Zohar & Luria (2005) find that supervisors play a fundamental role in implementing safety procedures and policies by "turning them into predictable, situation-specific action directives" that ultimately improve safety behaviour and prevent accidents and injuries.

Because the supervisory group of employees plays an important role in modelling safety behaviour and priorities during their interactions with frontline employees, Zohar & Luria (2005) postulate that supervisory support for appropriate safety behaviour is informed by organisational culture, and that this manifests in organisation-wide safety behaviour. Furthermore, even though supervisors may have some discretion in how procedures are executed within their work groups, Zohar & Luria (2005) show a positive relationship between organisational culture and work team safety climates. This suggests that a strong organisational safety culture should influence frontline supervisors to engage in behaviours that support workplace safety.

In this light, this study hypothesises that a positive relationship exists between supervisory support, organisational practices, work attributes and safety climate.

- H2: Aggregate employee perceptions of organisational practices are a significant predictor of safety climate;

- H3: Aggregate employee perceptions of supervisory support are a significant predictor of safety climate;

- H4: Aggregate employee perceptions of work attributes that are meaningful and empowering are a significant predictor of safety climate.

2.4 Frontline supervision and safety behaviour

The South African mining industry is characterised by several hazardous features that converge to create the potential to cause major accidents. These features include the falling of ground, fires, excavations, explosions, occupational hygiene emissions and the presence of moving machinery. With almost half a million employees reporting to work in the South African mining industry each day, a relentless commitment to safety and health compliance is required to manage the inherent risks and hazards associated with the sector. In 2019, 51 fatalities were recorded in the sector, of which 19 were attributed to the platinum mining sector. This reflects an increase of 58% from 2018 (Department of Mineral Resources and Energy, 2020). Safety behaviour offers an interesting opportunity for research for academics and practitioners alike because, contrary to Maslow's (1970) hierarchy of needs, in which self-preservation overrides other motivations, careless behaviour, a lack of adherence to rules and noncompliance with safety procedures are all too common in the execution of routine work (Zohar & Luria, 2003). This makes safe behaviour a challenge for supervisors.

To address the issue of poor safety performance within the mining industry, academics and practitioners have researched safety supervision as a possible way to improve the safety behaviour of employees, and, consequently, reduce the number of accidents, injuries and fatalities. This emphasis on safety supervision is aligned with research that indicates that safety initiatives directed at supervisors are more effective at improving safety performance than initiatives directed at frontline employees (Zohar & Luria, 2004), as well as research that finds that supervisors have a greater influence over the safety attitudes of employees than co-workers do (Dingsdag, Biggs & Sheahan, 2008). These results are consistent with studies that indicate a positive relationship between the safety leadership behaviours of supervisors and the safety leadership behaviours of employees (Barling, Loughlin & Kelloway, 2002; Conchie & Donald, 2009; Conchie, Taylor & Donald, 2012; Kelloway, Mullen & Francis, 2006; Mullen & Kelloway, 2009; Törner & Pousette, 2009).

Frontline supervisors have a direct impact on the safety behaviour of individuals. Their leadership significantly influences team safety performance (Fang & Wu 2015; Lingard, Cooke & Blismas, 2012). By virtue of their proximity to the workforce,

frontline supervisors provide the first line of defence in managing risk, communicating organisational priorities and values, and building relationships with individual team members (Delbridge & Lowe, 1997; Weick & Sutcliffe, 1997). Effective supervision sets and maintains high standards of performance and the physical aspects of the work environment, and is critical to achieving and maintaining the desired safety culture (Delbridge & Lowe, 1997; Weick & Sutcliffe, 1997). Michael, Wiedenbach & Ray (2006) emphasise that because workers rely significantly on their frontline supervisors to delegate tasks, and to support and guide the execution of complex work in a dynamic environment, frontline supervisors can have a direct and substantial impact on the safety behaviour and performance of the team.

A number of studies have investigated the impact of frontline supervision on safety behaviour and performance. Hofmann & Morgeson (1999) find that the relationship between a supervisor and her team had an influence on their commitment to safety and safety-related communication, and where a positive relationship was observed, a decreased number of workplace accidents occurred. Other studies showed that specific aspects of the type of leadership practised by leaders affected the safety behaviours of team members and reduced workplace incidents (Kelloway, Mullen & Francis, 2006; Martínez-Córcoles & Stephanou, 2017; Smith, Eldridge & DeJoy, 2016). Chughtai (2015) proves that by leveraging ethical leadership styles, leaders are able to improve the safety behaviours of their teams by improving the efficiency with which work is done and self-regulated. Furthermore, it is shown that exposing supervisors to safety-related programmes and courses leads to an improvement in the safety behaviours and performance of their teams (Zohar & Polachek, 2014). Most recently, Yuan, Xu & Li (2018) show a link between abusive supervision and a deterioration in the safety behaviour and performance of a team. Conchie, Moon & Duncan (2013) find that role overload, production pressure and certain workplace characteristics hinder a supervisor's safety leadership behaviours.

Griffin & Neal (2000) argue that the perceived safety climate is an antecedent of safety behaviour. They recommend a model of safety performance based on three distinguishing dimensions of safety behaviour – compliance, participation and motivation. Safety compliance involves adhering to safety procedures and carrying out work in a safe manner. Safety participation describes actions or behaviours that do not directly influence an individual's personal safety but contribute to a safer work

environment. Examples of safety participation include helping co-workers, promoting workplace safety programmes, demonstrating initiative, and putting effort into improving safety in the workplace. Safety motivation describes an individual's enthusiasm to behave in a safe manner by complying with safety regulations and participating safely in the work environment.

2.5 Safety compliance and supervisory accountability

Many researchers agree that safety participation can be encouraged by exhibiting transformational leadership behaviours that encourage relationships built on cooperation and trust. However, less research is available on how leaders can motivate employees towards more compliance-orientated behaviours.

Accountability is a central component in all organisations, societies and communities. Without it, there would no regard for consequences (Hall, Frink & Buckley, 2017; Hochwarter, Ferris, Gavin, Perrewé, Hall & Frink, 2007). Without accountability, coordinated undertakings would be difficult, and organisations would find it challenging to operate efficiently (Frink & Klimoski, 1998). Although accountability has clear benefits in relation to performance and efficiency, there are also negative consequences associated with heightened levels of accountability that contribute to job-induced tension, cognitive biases and job dissatisfaction (Hall, Frink & Buckley, 2017; Hochwarter, Ferris, Gavin, Perrewé, Hall & Frink, 2007; Frink & Klimoski, 1998). More recently, however, research has emphasised a positive correlation between performance, behaviour and accountability (Patterson, 2013; Mero, Guidice & Werner, 2012).

2.5.1 Types of accountability

2.5.1.1 Perceived accountability

Perceived accountability is a person's subjective understanding of the accountability environment (Laird, Harvey, & Lancaster, 2015). Individuals may perceive accountability differently which leads to inconsistency in results. Perceptions of accountability are influenced by environmental aspects such as work attributes, organisational practices, and intra-personal characteristics. In other words, just because organisations have formal accountability systems in place, it does not

automatically evoke feelings of remorse or answerability from individuals who do not comply (Royle, 2017). Formal accountability relationships can be limited as the perceived significance of the accountability relationship, from both the account-holder and the account-giver, are not considered.

Steinbauer, Renn, Taylor & Njoroge (2014) discuss how a leader's influence can be supported by various mechanisms to hold individuals to account for performance, while Ferrell & Ferrell (2011) emphasise how ethical leaders can enhance performance by creating a culture of accountability. This finding is supported by Steinbauer *et al* (2014), who find a positive relationship between ethical leadership and an accountability culture that drives individual performance.

2.5.1.2 Self-accountability

It has been generally accepted that self-accountability is a prerequisite for organisations to operate effectively (Hall and Ferris, 2011). Individuals may feel accountable based on the motivation to do their jobs well. However, no empirical evidence has been gathered to explain the extent to which motivation related constructs have on the level to which an individual feels accountable (Hall and Ferris, 2011, Roch and McNall, 2007).

McKernan (2012) argues that responsibility forms the foundation of self-accountability. People acceptance of responsibility for their actions and outcomes can vary. Motivating factors such as personal values and professional ethics are said to form the basis of an individual's sense of responsibility (Mansouri and Rowney, 2014; Roch and McNall, 2007). It has been suggested that individuals are self-accountable due to their motivation to achieve and gain intrinsic satisfaction (Mansouri & Rowney, 2014). An individual's sense of accountability theorized to be based on personal values and professional ethics.

Self-accountability is central to managing safety in the mining environment, whereby accountability must be effectively managed to be able to identify and address at risk behaviour before an injury occurs (Goulart, 2016). This is done by analysing leading indicators which requires inputs from all employees on being able to self-report failures or shortcomings (Goulart, 2016) .Review of failures requires all responsible

parties to be able to give an account of the events and decisions made to prevent similar incidents occurring in future (Goulart, 2016)

Pearson & Sutherland (2017) identified that the role of the individual employee was crucial to drive accountability in the workplace. The individual self is considered a source of accountability since the individual could “choose to hold themselves accountable” (Pearson & Sutherland, 2017, p 429). Without this ability, any supporting mechanism used to drive accountability would be ineffective (Pearson & Sutherland, 2017). Organizations could benefit from focusing on leveraging these individuals’ self-accountability rather than monitoring and control (Mansouri & Rowney, 2014).

2.5.2 Sources of accountability

The definition and theory of accountability presented highlight that an individual is perceived accountability influences behaviour. However, an individual’s perception of accountability can be affected by certain elements of the work environment (Hall et al., 2007). One of these elements is the accountability source that is defined as the source to whom an individual feels accountable (Hall et al., 2017). McCall & Pruchnicki (2017) state that there are “fluid boundaries created by the different accountability relationships” (p 149). Managers and employees have to move between these different relationships daily and negotiate how to best meet their individual needs, the needs of various team and the organisation (McCall & Pruchnicki, 2017).

Understanding these different accountability relationships are important as conflicts between them could either result in safe operations or be the cause of the next accident (McCall & Pruchnicki, 2017). Creating a safety culture with shared accountability requires a deeper understanding of how work is conducted within the boundaries of these relationships and how accountability sources are prioritised (McCall & Pruchnicki, 2017).

In an evaluation of the empirical and theoretical literature on felt accountability to date, Hall et al. (2017) highlight the need to investigate the degree to which employees prioritize different accountability sources (Hall et al. 2017). Hall et al

(2007) suggest that individual's feelings of accountability might differ depending on the source.

2.5.3 Supervisory accountability

Hierarchical accountability is common in high-risk industries where relationships are based on supervisors holding power over an employee, due to their position or rank (McCall & Pruchnicki, 2017). It exists when there is a contractual agreement existing between a superior and a subordinate, whereby the subordinates are expected to deliver on their accepted responsibilities and provide an account for their performance (Cordery, et al., 2010). Hierarchical accountability is concerned with ensuring the expectations of the superior is met and is a form of control over the subordinates; limiting their power (Cordery et al., 2010). (Cordery et al., 2010).

Managers are considered to have a high degree of influence in the system of accountability, as individuals are expected to give an account to a higher authority (Joannides, 2012; Mero et al, 2014). Accountability for specific outcomes are a result of managers monitoring employee's behaviour and communicating the desired outcome (Mero et al., 2014). Often, an increased demand for accountability gets translated into a need for added managerial controls (Messner, 2009). Control can be directed by issuing clear orders or having formalized laws and regulations in place (Mansouri & Rowney, 2014). Employee's roles and responsibilities are defined within these hierarchical types of relationships through rules, policies and procedures. This approach is used to try standardizing processes and to achieve efficiency (McCall & Pruchnicki, 2017).

In such industries, it is common to find managers trying to exercise control by expressing the desire to "hold someone accountable" for errors (McCall & Pruchnicki, 2017, p1). However, accountability extends beyond control; it involves a "sense of individual responsibility, professional and personal accountability" (Mansouri & Rowney, 2014, p 50). Mansouri & Rowney (2014) suggest that hierarchical accountability and the exercise of too much control can damage professional accountability and restrict the advancement of safety in the workplace (McCall & Pruchnicki, 2017).

Empirical evidence suggests that people in powerful positions, required to make difficult decisions with far-reaching consequences, may often discard the advice of others (De Wit, Scheepers, Ellemers, Sassenberg, & Scholl, 2017). Therefore, making these perceptions susceptible to suboptimal decision making. It has been found that persons in a position of power are more likely to take advice if they perceive their power in terms of responsibilities (De Wit, et al., 2017).

Accountability is context driven and in unsafe conditions it might require a shift from the standard hierarchy (McCall & Pruchnicki, 2017) Employees might be required to take instructions and be accountable to more knowledgeable personnel (McCall & Pruchnicki, 2017). It has been suggested that in high consequence industries, a shift in focus to shared accountability may be required, where employees are empowered to play an active role in risk mitigation (McCall & Pruchnicki, 2017).

This approach would require employees to be self-accountable and accountable to their peers. An empirical study by Pearson & Sutherland (2017) suggests that managers might not be as influential in driving accountability as some researchers might suggest. A manager's influence in driving accountability could be restricted to the implementation of systems and culture within organization. The impact of managers as a factor was not ranked highly, therefore bringing into question their priority as an identified accountability source (Pearson & Sutherland, 2017).

Although studies have emphasized the role of accountability to top management, Hall et al (2017) recommend further investigation in employee's responsibility to immediate supervisors, managers and other stakeholders. Given the effect perceived accountability has on behaviour and performance, consideration should be given to the nature of the relationship between the employee and her supervisor. It is important to establish the whether a manager is considered a source of accountability due to the position they hold or due to the relationship with the individual (Mero et al., 2014).

2.5.4 Legal accountability

The mining industry has a legal accountability to ensure all regulations are adhered to. Legal accountability is based on formal specific responsibilities that have punitive measures if not complied with (McCall & Pruchnicki, 2017). Most organizations have

some form of formal mechanism in place to drive accountability (Hall & Ferris, 2011). Dynamic high consequence industries such as mining make use of scheduled inspections; audits and standardized operating procedures to promote safety and monitor compliance (McCall & Pruchnicki, 2017). These serve as evidence of legal compliance and used to deter any punitive measures. Accountability systems allows acceptable performance standards to be set and prescribe the reward or penalty associated with compliance to those standards.

The use of formalized systems to drive accountability is often favoured as it can remove ambiguity. Therefore, making it difficult for individuals to pass blame for failure or accept unwarranted responsibility for success (Laird et al., 2015). However, formalized systems also have the potential of hindering performance as employees could “feel policed, undermined and caught out” (Pearson & Sutherland, 2017). In the case where the consequences of contraventions are high, the risk for employees to cover their mistakes is high. (Pearson & Sutherland, 2017).

This negatively impacts the safety culture within an organization since all parties are required to give an accurate account of events to prevent similar occurrences in future (Goulart, 2016). An organization’s resilience to safety incidents is dependent on creating an environment that promotes reporting and learning from incidents and is free of reprisal. Hall & Ferris (2017) highlight the need to establish the appropriate forms of accountability that organizations should impose to try limit negative consequences.

Accountability for safety compliance refers to how diligently frontline supervisors observe whether employees are working safely and whether they make individuals aware, and responsible for, the discrepancy between the current state and desired state. This accountability should encourage employees to become more aware of their noncompliant or unsafe behaviours, and motivate them to improve.

It is clear that accountability is an important but complex construct that requires further research (Pearson & Sutherland, 2016). In particular, theory on the accountability of frontline supervisors and the consequences for safety performance in a mining environment has not been well understood. Given the work linking accountability and work performance, it is hypothesised that a frontline supervisor’s

ability to hold team members and herself accountable is an important factor when motivating employee safety compliance.

- H5: The ability of frontline supervisors to hold employees and themselves accountable has a positive influence on safety behaviour.

More recent research into accountability recognises that the subjective and individualised nature of accountability is often based on perceptions of the external environment such as organisational norms, culture, practices and procedures. Hall (2005) calls for a better understanding of these relationships in order to develop a more robust view on accountability. In this light, it is hypothesised that organisational culture factors will offer insights into the degree to which frontline supervisors experience and exercise accountability to encourage safety behaviour.

- H6: Aggregate employee perceptions of organisational practices are a significant predictor of supervisory accountability.

- H7: Aggregate employee perceptions of supervisory support are a significant predictor of supervisory accountability.

- H8: Aggregate employee perceptions of work attributes that are meaningful and empowering are a significant predictor of supervisory accountability.

2.6 Safety motivation and supervisory work engagement

Safety motivation is defined as an employee's inclination to exert extra effort to behave in a safe manner and the extent to which employees are enthusiastic about enacting these safety behaviours (Neal & Griffin, 2006). Probst & Baker (2001) establish a significant, although lagged, relationship between safety motivation and safety compliance. The definition of safety motivation can be compared to the definition of employee engagement. Schaufeli & Baker (2004) define engagement as the amount of energy, enthusiasm and inspiration that employees feel and give to their role as safety leaders. Their findings suggest that one way for organisations to promote the safety leadership of supervisors is to lower expectations for them. Conchie, Moon & Duncan (2013) suggest that increasing support and training for those in supervisory roles may decrease the negative effects of expectation. By doing

this, organisations should expect to see an increase in supervisory engagement and safety leadership behaviours (Conchie *et al*, 2013). Despite the continuing interest in supervisory safety behaviours, there has been relatively little research on factors that influence supervisors' engagement in their role of safety leadership.

Engagement is a well-researched concept. The first literature and definitions date back to 1990, when Kahn motivated for the idea of work to include the entire person executing the task. He developed this idea by saying: "We believe that people are engaged when we see them working hard, putting in effort, staying involved. They truly show up for work. They remain focused on what they are doing. They strive to move their work ahead" (Kahn, 2010). One of the reasons engagement has received so much attention among business leaders and researchers is because of the focus on human capital as a source of competitive advantage (Barbars, 2015).

Engagement has been defined as a "goal-oriented psychological state in which a person is fully focused on the task at hand", considers it "necessary to reach the organisational goals" (Barbars, 2015), and has found work to be a source of increased commitment, performance and satisfaction (Barbars, 2015; Schnieder, Yost, Kropp, Kind & Lam, 2017; Bryne, Peters & Weston, 2016). The creation of a culture of engaged employees enables an organisation to sustain high performance over time (Barbars, 2015; Rich LePine & Crawford, 2012; Rice, Marlow & Masarech, 2021; Macey, Schneider, Barbera & Young, 2009).

Engagement can be sustainably generated only if the organisational culture supports it (Macey *et al*., 2009). Although some organisations create performance by leveraging short, intense bursts of energy through strategies other than employee engagement, these are not sustainable. An organisational culture that supports engagement is required. However, the establishment of a culture that fosters sustainable, beneficial engagement takes effort. If leaders are to enhance performance, they need to understand which organisational culture factors encourage engagement (Barbars, 2015).

Organisational performance can be positively influenced by engaged employees and negatively impacted by actively disengaged employees. (Hewitt, 2013). Muthuveloo et al., (2013) suggested that employees who work in environments which require

physical work, such as mining, may be resentful or unhappy leading to disengagement at work. It is thus important for platinum mining organisations to understand the key drivers of employee engagement as this could affect, and improve, organisational performance.

2.6.1 Antecedents of engagement

Sahoo and Mishra (2012) found that when positively engaged, employees can form an emotional connection to an organisation, thus driving increased effort and individual performance. Subrahmanin (2014) went on to classify antecedents to employee engagement to include organisational practices, job satisfaction and attributes and supportive, collaborative teams and supervision. Cardus (2013) added to this list of antecedents by specifying competent and supportive supervision, an overarching vision and mission for the organisation, employee empowerment and autonomy and necessary resources as being important to increase employee engagement. These characteristics were supported by Schaufeli, Martínez, Marques-Pinto, Salanova & Bakker (2002) who suggested a framework for measuring engagement based on job attributes, supervisory support and organisational practices such as a safe and supportive workplace.

2.6.1.1 Job attributes as an antecedent to engagement

Work attributes are described as job related characteristics that relate to the design or nature of the job, its challenges, required skill set, environment, safety and security, performance, remuneration and interpersonal relationships (Chen & Chiu, 2016). Most platinum mining operations in South Africa are conventional mines, implying labour and heavy machinery intensive environments (Kunda, Frantz, & Karachi, 2013). Historically mineworkers from this industry have been clear about these unfavourable conditions, demanding decent living wages and benefits in compensation for their work environment. Employees tend to be more engaged when they are properly compensated for meaningful and challenging work (Schaufeli et al, 2020). Furthermore, when employees are encouraged to contribute to the decision making process within their work environment, they are more likely to invest more time and effort into their work (Schaufeli et al, 2020). Research completed by Farlie (2011) found a strong association between meaningful job attributes and employee performance and that those work attributes predicted an employee's engagement. Farlie (2001) furthers this idea by showing that when an employee believes her job

is fundamental, with a sense of meaning and purpose, it results in higher levels of engagement and interest in the work.

Mining is a tough working environment with strenuous conditions (Kunda, Frantz, & Karachi, 2013) and these job pressures and poor working conditions can hinder employees from performing optimally. There is significant pressure on mineworkers to deliver not only on safety requirements, but on production targets as well. These these factors most certainly impact the level of engagement of workers in a mine (Oldfield & Mostert, 2007).

2.6.1.2 Supervisory support as an antecedent to employee engagement

One of the key drivers of employee engagement suggested by Schaufeli et al (2020) is autonomy and an environment in which an employee understands that she choice and control over the decisions she makes and takes full responsibility for these actions. Employees who experience high levels of micromanagement, exhibit active disengagement and an attitude of “I just do what I’m told and it is not my fault if anything goes wrong” (Cardus, 2013). In South Africa, mining organisations are still very hierarchical, authoritative and autocratic and as such, it is most likely that employees, particularly supervision and frontline workers experience micromanagement during their daily routines

Welch (2011) suggested that manager and supervisors the world over acknowledge that employee engagement is an important, if not critical, factor affecting performance, organisational effectiveness and competitive advantage. As such, strong and wilful leadership is essential if the notoriously difficult mining industry is to achieve positive performance. In a study completed on a South African coal mine, Mclaggan ,Botha and Bezuidenhout (2013) found that employees were positively influenced by supportive supervisors who displayed behaviours indicative of genuine care and concern for their personal wellbeing and development and adopted a model which included supportive supervisory relationships as a precursor for employee engagement. Mclaggan et al (2013) described a supportive supervisory relationship as including employee coaching, work planning assistance, emotional support and work advice as factors for promoting employee engagement. Positive supervisory behaviours are likely to give meaning and purpose to work, while providing adequate resources to deliver on task (Schaufeli et al, 2020). Conversely, poor supervisory

behaviours that lead to unfaourable working conditions are shown to increase unhappiness, frustration and active disengagement (Schaufeli et al, 2020). The platinum mining industry is known for its hostile work environments and has been marred by violent strikes and other work stoppages, which would contribute to further disengagement, placing further importance on the role of supportive supervisory practices to improve employee engagement levels.

2.6.1.3 Organisational practices as an antecedent to engagement

Schaufeli et al (2020) defined factors such as work environment, team collaboration, leadership, inter personal relationship with colleagues, career progression and training and development, organisational procedures and policies, compensation and safe and healthy workplaces as being key factors for employee engagement. Organisations are encouraged to create a working environment based on practices which contribute to employee engagement in order to achieve competitive advantage through extraordinary performance and outcomes. Mine employees are typically exposed to difficult and uncomfortable working conditions, long hours, treacherous conditions often with radical unionised environments, and with extreme pressure to perform safely and productively. Such conditions will affect an employee's level of engagement and it is thus imperative that business leadership create organisational practices which contribute to a safe and meaningful work environment in which employee engagement can be prioritised (Oldfield & Mostert, 2007). The findings from Schaufeli et al (2020) highlighted the importance of positive organisational practices which contribute to organisational and, possibly, the safety culture, by leveraging levels of engagement amongst the workforce.

The arguments presented linking organisational culture with an engaged workforce and improved, sustainable performance can be extrapolated to link safety climate with safety motivation and behaviours. Zohar (2000) finds that safety climate is an antecedent to safety motivation as it portrays the desired state of behaviours and subsequently moulds the expectations and enthusiasm associated with safe or unsafe behaviours (Zohar, 2000). A healthy and positive safety climate may engender an implied responsibility to behave safely, and this suggests that employees working in a positive safety climate will be more motivated to engage in positive safety behaviours (Zohar, 2000). Given that the direction of causation was

found to be from climate to motivation and from motivation to behaviour, the following predictions were made:

- H9: Aggregate frontline supervisor perceptions of engagement are significantly related to safety behaviour;

- H10: Aggregate frontline supervisor perceptions of organisational practices are a significant predictor of supervisory engagement;

- H11: Aggregate frontline supervisor perceptions of supervisory support are a significant predictor of supervisory engagement;

- H12: Aggregate frontline supervisor perceptions of work attributes that are meaningful and empowering are a significant predictor of supervisory engagement.

2.7 Conclusion

Although previous research has added greatly to the body of knowledge on the impact of leaders on safety behaviour, few studies have explored how safety behaviour is affected by work engagement and the felt accountability of frontline leaders. Furthermore, few studies have researched which organisational culture values have the greatest impact on work engagement and individual accountability.

The hypothetical model illustrated in Figure 1 is derived from the literature reviewed. It illustrates that, if one is to sustainably grow an organisational culture that supports engaged, accountable and safe behaviour, particularly in high-risk work environments, a number of interdependent and complex causal relationships must be understood.

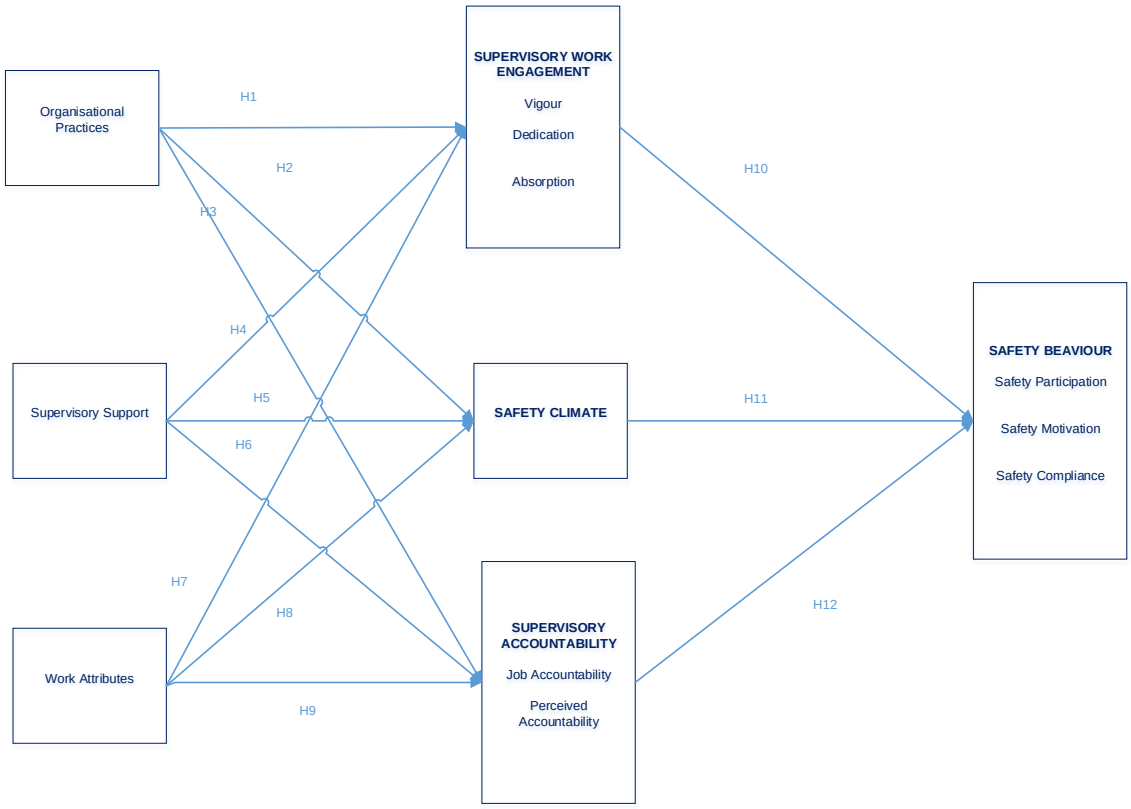

Figure 1: Hypothetical model derived from literature review to illustrate the complex and interrelated causal relationships between organisational culture, safety climate, supervisory behaviour and safety performance.

3 RESEARCH HYPOTHESES

3.1 Purpose

The purpose of the research was to understand and quantify the impact that higher levels of supervisory work engagement and accountability have on safety climate and behaviour in a mining environment. A further objective was to find a relationship between specific organisational culture values and the engagement and accountability of frontline supervisors in an effort to drive sustainable improvement in safety performance across the mining industry in South Africa. The research was descripto-exploratory in nature, and was intended to identify the extent and nature of cause-and-effect relationships between supervisory work engagement, felt accountability and safety performance, while providing a possible explanation for the quantified results by considering organisational culture and values (Saunders & Lewis, 2012).

3.2 Hypotheses

The research aimed to address the following hypotheses, also depicted as a structural model in Figure 1:

- H1: Aggregate employee perceptions of organisational practices are a significant predictor of safety climate

- H2: Aggregate employee perceptions of supervisory support are a significant predictor of safety climate.

- H3: Aggregate employee perceptions of work attributes that are meaningful and empowering are a significant predictor of safety climate.

- H4: Aggregate employee perceptions of safety culture are significantly related to safety behaviour.

- H5: The ability of frontline supervisors to hold employees and themselves accountable has a positive influence on safety behaviour.

- H6: Aggregate employee perceptions of organisational practices are a significant predictor of supervisory accountability.

- H7: Aggregate employee perceptions of supervisory support are a significant predictor of supervisory accountability.

- H8: Aggregate employee perceptions of work attributes that are meaningful and empowering are a significant predictor of supervisory accountability.

- H9: Aggregate frontline supervisor perceptions of engagement are significantly related to safety behaviour.

- H10: Aggregate frontline supervisor perceptions of organisational practices are a significant predictor of supervisory engagement.

- H11: Aggregate frontline supervisor perceptions of supervisory support are a significant predictor of supervisory engagement.

- H12: Aggregate frontline supervisor perceptions of work attributes that are meaningful and empowering are a significant predictor of supervisory engagement.

4 RESEARCH METHODOLOGY AND DESIGN

4.1 Introduction

The objective of this research was to evaluate the impact that organisational culture factors had on supervisory engagement, accountability and safety climate, and how these in turn influence safety behaviour. In Chapter 2, a review of recent literature predicted that safety behaviour was an antecedent to safety performance, and provided a measure for safety behaviour based on employees' compliance with, participation in and motivation to participate in safety programmes. This review also predicted a strong and positive relationship between an organisation's safety climate and safety behaviour, and the subsequent research seeks to confirm this relationship within the South African mining context. Furthermore, a review of existing literature on frontline supervision indicated that by virtue of the proximity of frontline supervisors to the workforce, frontline supervisory practices and support affects the behaviour and performance of frontline workers. The researcher predicted that the level of supervisory work engagement and supervisory accountability could be measured and used as predictors of safety behaviour to identify interventions to improve these supervisory features and ultimately safety behaviour. Research on organisational culture factors influencing work engagement established a measure to determine the impact of three broad scale organisational culture factors on work engagement. The researcher predicted that these factors would also affect safety climate and supervisory accountability. The literature review resulted in the development of 12 hypotheses with a view of understanding specific organisational practices and supervisory features that could be used to influence safety behaviour.

This chapter provides a description of the research methodology and design that was used to address each hypothesis. It outlines the design, sample population, data collection methods, unit of analysis and data analysis techniques employed to evaluate each hypothesis.

4.2 Research design

This study was quantitative, allowing for both descriptive and confirmatory work to be done with the aim of making inferences about the findings related to a particular subject (Saunders & Lewis, 2018).

4.2.1 Philosophy

Saunders & Lewis (2012) explain that research philosophy refers to “a system of beliefs and assumptions about the development and nature of knowledge”. This study used a positivist philosophical stance to gain insight into the nature of the research problem. Social realities, in particular those pertaining to organisations and people, were observed in an effort to produce generalisations and unambiguous knowledge.

4.2.2 Approach

This research followed a descriptive approach to theory development, stemming from the hypotheses formulated from existing theory on safety behaviours, organisational factors, the engagement of frontline supervision, and felt accountability. The approach was adopted from a recent study by Barbars (2015) that compared organisational culture and employee engagement in two departments within a financial institution. The key features of a deductive approach to research are: to attempt to explain the causal relationship between the variables of interest; to operationalise these relationships into testable hypotheses that can be proved or rejected; and to collect and analyse data in order to reject or accept the proposed hypotheses.

4.2.3 Methodological choices

This study used a mono quantitative method as the data collected was in numerical form. Data was analysed using quantitative analysis techniques such as descriptive statistics, confirmatory factor analysis for parametric testing, and multiple linear regression analysis (Saunders & Lewis, 2012).

4.2.4 Strategy

A survey was conducted using questionnaires developed from quality academic journals. Surveys are useful in describing the characteristics of a large population, thus providing broad capability to ensure a more accurate sample from which to gather targeted results, draw conclusions and make important decisions (Saunders & Lewis, 2012).

4.2.5 Time

This study used a cross-sectional research design. The defining feature of a cross-sectional study is that it can compare different population groups at a single point in time, enabling the comparison of many different variables at the same time (Saunders & Lewis, 2012).

4.2.6 Techniques and procedures

Questionnaires were used to answer specific research questions. Questionnaires are a cost- and time-efficient way of obtaining large amounts of data from a large sample of people. The data was analysed using statistical analysis techniques such as descriptive statistics, confirmatory factor analysis for parametric testing, and multiple linear regression analysis (Saunders & Lewis, 2012). Table 1 provides a summary of the research design.

Table 1: Summarised approach to research design

Topic	**Approach**	**Explanation**
Philosophy	Positivism	The use of theory to develop hypotheses and the use of structured methods to facilitate replication
Approach	Descriptive	Hypotheses developed from theory
Strategy	Survey using questionnaires tested in literature	Aim to generate findings that can be generalised across a population
Methodological choice	Mono quantitative method	Descriptive statistics, confirmatory factor analysis and multiple linear regression
Time horizon	Cross sectional	One-off data collection
Techniques and procedures	Descriptive statistics, parametric testing, multiple linear regression	Underlying factor structure validated through confirmatory factor analysis (maximum likelihood estimation and Yuan-Bentler correction method) prior to a multiple linear regression model

4.3 Research methodology

4.3.1 Population

Frontline supervision is fundamental to the management of risk in a mining environment. By virtue of their proximity to the workforce, frontline supervisors provide the first line of defence in managing risk, communicating organisational

priorities and values, and building relationships with individual team members (Delbridge & Lowe, 1997; Weick & Sutcliffe, 1997). Effective supervision sets and maintains high standards of performance, particularly within the physical aspects of the work environment, and is critical to achieving and maintaining the desired safety culture (Delbridge & Lowe, 1997; Weick & Sutcliffe, 1997). Thus, the target population comprised frontline supervisors within the processing division of a large platinum mining organisation in South Africa. A full list of all frontline supervisors was made available through the payroll system and consisted of 157 employees across five operations.

4.3.2 Unit of analysis

During data analysis, it was established that the first unit of analysis would be the individual perceptions of frontline supervisors surveyed. These individuals provided data on their level of safety behaviour, supervisory engagement and accountability, and the perceived safety climate. This data was then correlated to their individual safety behaviour.

The second unit of analysis was the individual responses to specific factors related to organisational culture. During data analysis, these factors were compared to assess how predominant organisational culture values influence safety climate, supervisor engagement and accountability, and, subsequently, how these affect safety behaviour (Barbars, 2015).

These units of analysis related specifically to the research objectives identified in Chapter 1, and allowed for the identification of organisational factors that influence supervisory behaviours and safety climate, and considerations of the extent to which these factors influence safety behaviour.

4.3.3 Sampling method and size

As the researcher had a list of all frontline supervisors in the organisation, probability sampling was applied. This sampling technique enabled the researcher to make statistical inferences about the population (Saunders & Lewis, 2012). In particular, a simple random sample method was followed using the MS Excel random function, and a response rate of 80% was assumed. The required sample size, for a 95% confidence level with a 5% margin for error, was 108 (Saunders & Lewis, 2012). This

is based on a total population of 157 frontline supervisors across the organisation's process division operations. Given the confidence requirements and the size of the population, the sample size was determined to be 135.

4.3.4 Data collection

Saunders & Lewis (2012) suggest that the survey strategy is popular and particularly useful when conducting business and management studies. Survey are easy to administer and allow for the collection of data across a wide range of variables and people in a cost-effective manner. Furthermore, the ability to analyse survey data makes it appropriate for descriptive research. The use of a questionnaire is the most common method for collecting data using a survey strategy. However, Saunders & Lewis (2012) recommend that, when using questionnaires, content and construct validity must be considered to ensure that the data collected measures the correct constructs. For purposes of this research, questionnaires from other research studies were used to measure the constructs identified. These questionnaires were found to produce accurate and reliable results when measuring safety behaviour and climate, engagement, accountability and organisational culture. In terms of ensuring validity and reliability, the researcher relied on previous research conducted in the same field of study to ensure validity and confirmed validity using appropriate parametric testing. The researcher relied on Cronbach's alpha to establish the reliability of the instruments. According to Bonett & Wright (2015), "Cronbach's alpha is one of the most widely used measures of reliability in the social and organisational sciences".

4.3.4.1 Measurement instruments

Surveys such as those used in Barbars (2015), Hochwarter *et al.* (2007) and Yang *et al*. (2019) were be considered as the main instruments of measurement.

The following instruments were used:

- Safety climate and safety behaviour

Participants rated their safety behaviour using an established 12-item scale proposed by Neal & Griffin (2006) and used in Yang, Zheng, Liu, Lu & Schaubroeck (2019). The scale consists of four subscales measuring safety climate, safety motivation, safety compliance and safety participation. To assess the discriminant validity of these four dimensions, a confirmatory factor analysis using the maximum

likelihood estimation (MLE) method was considered, and factors that were loaded incorrectly were removed. The discriminant validity between safety compliance and safety participation was not supported. This was consistent with the Yang *et al*. (2019) study, and safety behaviour was collapsed to consist only of participation and motivation. A sample item from this instrument is, “I voluntarily carry out tasks or activities that help to improve workplace safety”, measured on a five-point Likert scale (*1 = Never to 5 = Always*). The items included in the scale are found in Appendix A, Table A1.

- Supervisory work engagement

Participants rated their engagement using the Ultricht work engagement scale as proposed by Schaufeli, Martínez, Marques-Pinto, Salanova & Bakker (2002). The scale consists of three subscales measuring vigour, dedication and absorption. To assess the discriminant validity of these dimensions, a confirmatory factor analysis using the MLE method was considered, and factors that were loaded incorrectly were removed. The discriminant validity of all factors was supported, consistent with results in extensive literature. A sample item from this instrument is, “I find the work that I do full of meaning and purpose”, measured on a five-point Likert scale (1 = Never to 5 = Always). The items included in the scale are found in Appendix A, Table A2.

- Organisational culture factors

Participants rated factors of their organisational culture using the tested profile proposed in Schneider, Yost, Kropp, Kind & Lam’s (2017) study of the organisational antecedents to workforce engagement. The scale consists of three subscales measuring organisational practices, supervisory support and work attributes. To assess the discriminant validity of these three dimensions, a confirmatory factor analysis using the MLE method was considered. The discriminant validity of all factors was supported, consistent with the results in Schneider *et al*. (2017). A sample item from this instrument is, “Senior leadership provides a clear direction for my company”, measured on a five-point Likert scale (*1 = Never to 5 = Always*). The items included in the scale are found in Appendix A, Table A3

- Supervisory accountability

Participants rated their experience with accountability using the eight-item scale proposed by Hochwater, Kacmar & Ferris (2003). The scale consists of two subscales measuring job accountability and perceived accountability. To assess the discriminant validity of these dimensions, a confirmatory factor analysis using the MLE method was considered. The discriminant validity of both factors was supported. A sample item from this instrument is, “I am required to justify or explain my performance in terms of achieving unit goals”, measured on a five-point Likert scale (1 = Never to 5 = Always). The items included in the scale are found in Appendix A, Table A4

4.3.5 Data gathering process

Creswell (2014) associates data collection for quantitative research with both experimental and non-experimental methods. A survey strategy is considered a non-experimental method.

Data was collected through the distribution of surveys to identified frontline supervisors within the organisation. Two distribution channels were used. Where easy access to the employees was available, fieldworkers distributed printed copies of the questionnaires to identified employees and assisted with the accurate completion of the surveys. Where access to employees was inconvenient due to constraints of distance, web-based surveys were emailed to the identified respondents. The structured questionnaire was used as the single data collection tool for this study.

The advantage of using data collected through a survey is that it is generally faster, particularly if it is online as this enables it to be distributed widely, and is associated with improved turnaround time and increased flexibility (Zikmund, Babin, Carr & Griffin, 2009). Furthermore, web-based surveys allow candidates to analyse the questions further before submitting an answer if they feel they need to.

The risks associated with survey responses include possible misunderstanding of the questions by respondents. However, with web-based surveys, participants are unable to ask clarifying questions. To mitigate this risk, a sample of eight surveys was sent to easily accessible people who met the population criteria with the

objective of identifying and rectifying any issues prior to administering the survey to a wider population. Questions such as, “Did you experience any difficulty understanding the questions?” were asked, and where the same concern was expressed by two or more of the trial respondents, the wording was changed to enhance understanding.

A further risk with this type of data collection is a low response rate. This study was no different. As the respondents were all professional people, with many working shift schedules, it was often difficult to reach them to follow up on completion. Two weeks after distributing the survey online, only four responses had been received. This poor response rate was mitigated by following up with a face-to-face discussion – either in person or on a virtual platform – or where this was not possible, via email, to discuss the objective of the research and the perceived benefits of their participation. Concerns over confidentiality or anonymity were purposefully addressed and an offer was made to distribute the final findings. A total of 104 responses were collected, reflecting a response rate of 77%. Of these 104 responses, 97% were included in the analysis, and the small number of responses excluded was due to them being incomplete or incorrect. This was largely managed by programming the web-based survey to flag incomplete questions. Furthermore, fieldworkers were coached to ensure all questions were completed.

4.3.6 Analysis approach

The analysis approach was based on ranked data obtained from the measurement instruments using a Likert scale. This data was analysed using the EQS 6 for Windows and SPSS software. As the data collection, in numerical format, facilitated the answering of the hypotheses, the use of MS Excel, SPSS and EQS 6 for Windows was appropriate. Descriptive statistics were used to explain the data collected and inferential statistical methods were used to test the significance of differences or relationships between responses. Furthermore, a confirmatory factor analysis (CFA) was used to investigate the underlying factor structure prior to investigating the nature and extent of the relationships between measures through correlation and regression techniques. A summary of the steps taken in the data analysis approach follows.

- Data summary and coding

Data collected through the online survey was exported to MS Excel in tabular format. The spreadsheet gave an indication of participant responses per question. The response rate per question ranged from 101 to 104 completions.

To be input into the statistical software, the raw data needed to be coded. This was done by converting it to numerical values. Each survey was assigned a letter to designate the it, with each item in the survey identified by number. The Likert scale was used to enable each response to be replaced with an associated number – for example, “never” was assigned a 1 and “always” was assigned a 5. Frequency tables, charts and demographic analysis was carried out to assist in understanding representation of the data and whether any bias existed within the various demographic statistics.

- Validity and reliability

Validity and reliability are two important characteristics for assessing the quality of a measurement (Saunders & Lewis, 2012). Reliability is referred to in the context of consistency, and implores the importance of results being reliable from use to the next (Gao, Mokhtarian & Johnston, 2008). Gao *et al*. (2008) discusses the concept of validity as being representative of the precision and accuracy with which a measurement assesses a construct or variable. It is important that measurements are both reliable and accurate. Cronbach’s alpha was used to test for reliability in the research. It is a statistical measure to test for reliability, and ranges from 0 to 1. Discriminant validity was considered for ensuring all measures were measuring what they were supposed to.

- Descriptive statistics

Descriptive statistics were completed for each item assessed using the Likert scale, to understand the distribution of responses per construct. The following descriptive statistics were considered:

- Mean: The average of the responses was calculated for each item. This statistic gives an understanding of the central tendency of the data per item.
- Minimum: The minimum value was used to understand the lowest score obtained in the response rates per item.

- Maximum: The maximum value was used to understand the highest score obtained in the response rates per item.
- Standard deviation: This statistic was used to understand how far away from the mean the responses were per item.

- Confirmatory factor analysis

CFA is a powerful statistical tool for examining the nature of relationships between various constructs. It is often the analytical tool of choice for refining measurement instruments, identifying influence and effects, and evaluating variance across factors, times and groups (Jackson, Gillaspy & Purc-Stephenson, 2009). CFA refers to a set of statistical techniques used to confirm the underlying structure among a set of factors. The CFA employed seeks to validate the hypothesised structure shown in Figure 1. Compared to the analytic method of exploratory factor analysis, CFA directly tests hypotheses for relationships and influences between observed variables – such as survey scores or Likert scale ratings – and underlying variables or factors.

- Correlation and regression techniques

Methods of correlation and regression were used to analyse and quantify the extent and nature of relationships between the different variables (Barbars, 2015; Hochwarter *et al*., 2007; Schnieder *et al*., 2018). Correlation analysis is used to understand the nature of relationships such as strength and direction between different variables. Correlation analysis provides a number of advantages, such as data analysis from many subjects simultaneously, and correlations can interpret a broad range of variables and their relationships. However. correlations are unable to determine causality.

- Testing the hypotheses

The hypotheses generated were specifically related to the nature and direction of the relationship between the constructs. Two variables were considered in this analysis. The correlation coefficient would give an indication of the direction of the relationship (positive direction with positive relationship, negative direction with negative relationship). The probability of these coefficients in the ANOVA were considered when making a determination on the significance of the predictability. The hypothesis would be accepted as significant if it yielded a p value of less than 0.05.

4.3.7 Quality controls

Quality control refers to the efforts and procedures that researchers put in place to ensure the quality and accuracy of data being collected using the methodologies chosen for a particular study. Assessment of the knowledge gained and retained by interviewers is also a part of survey quality control (Saunders & Lewis, 2012). Rigorous data collection methods using tested and reliable measurement instruments were adopted and accompanied by the well-defined and strict application of data quality norms (Barbars, 2015; Hochwarter *et al*., 2007; Schnieder *et al*., 2018). Where necessary, efforts were made to ensure individuals completing the surveys fully understood the questions being asked, as well as the nature of the responses available.

The questionnaires were designed to be simple and contained minimal free text fields in an effort to avoid mistakes. *Better Thesis* (Syddansk University, 2020) recommends that 25% of the recorded data must first be reviewed in an effort to establish whether there is a high rate of error. In the event of an unacceptable error rate, all forms would be reviewed. This process was followed after 25 electronic responses had been received prior to conducting the written surveys. The survey was in English and an interpreter was available if required. Because data transfer may also result in input errors, outliers were double checked for incorrect inputs and duplication errors, and free text was scrutinised.

4.3.8 Limitations

A limitation of the research methodology is the sample size. Despite the total population being small, a sample size of just more than 100 is lower than ideal for completing confirmatory analysis.

The population consists of individuals whose home language might not be English, and whose level of education might be limited. These factors might limit the findings of the research due to interpretation of certain constructs.

The study is a static, cross-sectional survey, and as such, the results are limited to a static view. This implies that responses to the constructs may be dependent on the

mood of the participant. A supervisor who has just be held accountable by her manager may see the organisational culture more negatively than if she had experienced a more positive interaction.

The use of Likert scale responses limits the amount of detail included, and as a result, it is improbable that sufficient data will be collected to offer explanatory answers to the associations identified. Furthermore, the survey was long and it was noted that respondents were fatigued by the end of it, possible resulting in a rush to finish.

5 RESULTS

5.1 Introduction

The focus of this chapter is to present the findings from data gathered through online or hard-copy surveys, and facilitates an understanding of the data and the analysis that was completed in order to test the hypotheses. Demographic and descriptive statistics using the mean score were used to describe the composition of the sample.

5.2 Response rate

A complete list of frontline supervisors within the processing division of a large South African platinum mining organisation was obtained through the company's payroll system. Electronic surveys were emailed to each of the 147 potential respondents. Where electronic responses were not received within two weeks of distribution, identified respondents were contacted and asked to complete the online survey, or arrangements were made to complete a hand-written survey with the help of a translator. Not all identified respondents consented to taking part in the survey, or were unreachable through the contact details provided. A total of 104 responses were received, reflecting a 70.7% response rate, providing a 95% confidence limit with a confidence interval of 5.22%.

5.3 Demographics and descriptive statistics

The participants in this research constituted 104 frontline supervisors within the processing division of a large platinum mining organisation in South Africa. Of these 104 participants, 87.1% were men, 11.9% were women and 1% preferred not to say what their gender was. These statistics compare well with reports from 2018 and 2019, which found inclusion rates of between 11% and 12% for women in the platinum mining sector (Minerals Council South Africa, 2020).

The age and level of education for the sample, shown in figures 2 and 3, reflect that 49.8% of respondents were older than 40 and 52% of respondents had completed primary or secondary schooling. These results compare well with the South African population upper secondary school completion rate of 55% (Statistics South Africa, 2020). The remaining 48% of respondents indicated that they had tertiary or

postgraduate education. Given the nature and requirements of frontline supervisors within the mining industry, this was a higher proportion than the researcher was expecting. It is proposed that these respondents were newly qualified employees in frontline supervision roles as part of their career development paths. Alternatively, it may be that these respondent incorrectly assumed technical qualifications completed after secondary schooling, such as trade qualifications, to be tertiary qualifications.

Of the 104 responses received, all participants indicated that they had supervised or currently were supervising a team of employees. This result is unsurprising due to the targeted nature of the survey respondents, which required frontline supervision experience to be mandatory. Furthermore, 67% of respondents indicated that they had more than 10 years of supervisory experience (Figure 4). This result was in line with the age group demographic as 89.7% of respondents were older than 30.

Almost a quarter (22%) of respondents indicated that they had been injured at their workplace and 58.3% of respondents indicated that a member of a team that they supervised had been injured at work.

Most (86%) respondents indicated that they were the primary breadwinner in their families and 96.2% of respondents had between 1 and 15 dependents. A large number of respondents (61%) indicated that they had between 1 and 4 dependents.

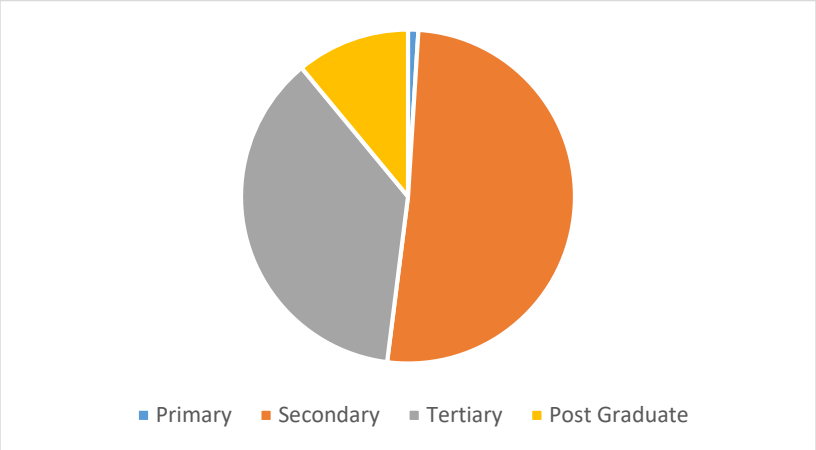

Figure 2: Level of education

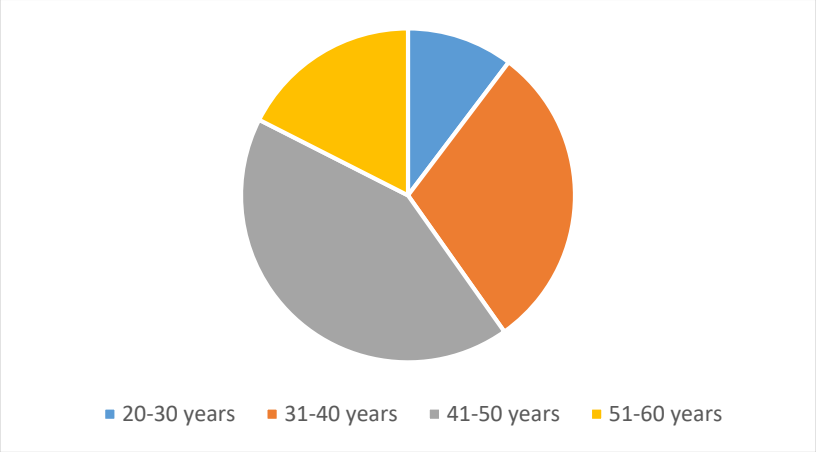

Figure 3: Age distribution

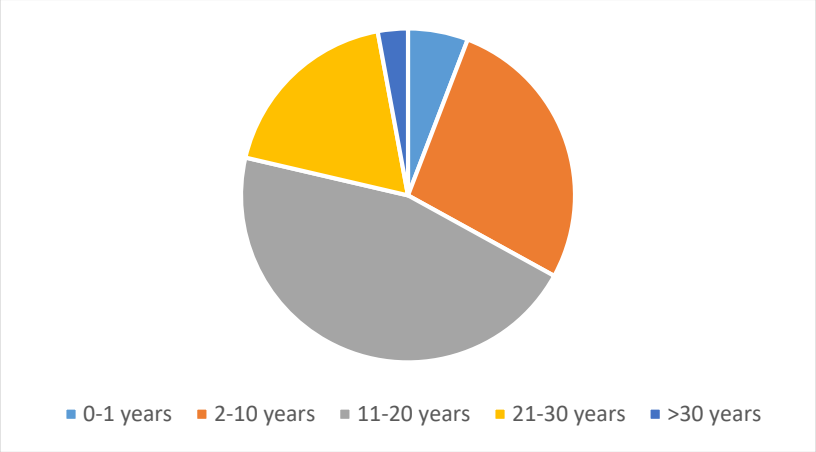

Figure 4: Supervisory experience

A summary of the descriptive statistics per measurement instrument is shown in Table 2. These statistics include the means, medians, modes, standard deviations, minimum and maximum values for each instrument. The safety behaviour instrument showed the highest mean, indicating that the perceived safety behaviour was almost always positive. The organisational practice factor from the organisational culture profile showed the lowest mean, and also indicated the greatest variance and standard deviation. This shows that the actions and behaviours of leaders and employees that translate organisational values into practice were observed only occasionally.

Table 2: Summary of descriptives on scales

	Valid responses	Missing responses	Mean	Median	Mode	Std. dev	Min	Max
Safety climate	104	0	4.43	4.67	5.00	0.67	2.67	5.00
Safety behaviour	104	0	4.57	4.71	5.00	0.47	3.14	5.00
Organisational practices	103	1	3.37	3.33	3.00	0.91	1.40	5.00
Supervisory support	103	1	3.69	3.86	5.00	0.99	1.29	5.00
Work attributes	103	1	3.75	3.83	3.00	0.79	1.00	5.00
Work engagement	102	2	3.81	3.75	3.33	0.69	1.92	5.00
Accountability	103	1	3.99	4.00	3.60	0.66	1.00	5.00

Table A5 in Appendix A give the detailed descriptive statistics for each instrument investigated.

In terms of safety climate and behaviour, items with the highest means included responses believing “that it is important to reduce the risk of accidents and incidents in the workplace”, feeling “that it is important to maintain safety at all times”, and feeling “that it is worthwhile to put in effort to maintain or improve my personal safety”. Items with the lowest means included being “satisfied that the systems in place at my company are good enough to eliminate all injuries”, voluntarily “carrying out tasks or activities that help to improve workplace safety”, and spending “most of my time supervising work to ensure safety compliance”. These results indicate that frontline supervisors were strongly motivated to practice good safety behaviour, but felt that compliance to organisational practices was less important. This may be explained by the fact that they also felt that the organisational procedures in place were not necessarily good enough to prevent all injuries, thus raising questions about the benefit of compliance.

For organisational culture, items with the highest means included “understanding my company's goals and objectives”, “my company is making the changes necessary to compete effectively”, and “my company is always moving towards improved ways of doing things”. Those with the lowest means included being “satisfied with the feedback I receive when I raise concerns to my organisation’s leadership”, “my immediate supervisor takes an active interest in my growth and development”, and “when I do an excellent job, my accomplishments are recognised”. Preliminary analysis of these results indicated that organisational practices ensuring effective

performance and healthy competitive advantage were perceived to be prominent and well communicated, but that aspects of supervisory support and feedback on performance and personal development were less well established.

In terms of accountability, the items with the highest means included items from the perceived accountability scale. In particular, “I take full responsibility for the completion and success of tasks that I am involved in at work” and “I am held accountable for the work that I am assigned” give an indication that there are frontline supervisors within the organisation who appear to take accountability for, and are held accountable for, work assigned to them. Those items with the lowest means included “in my organisation, achieving unit goals is directly attributed to an individual’s personal actions” and “I am required to justify or explain my performance in terms of helping and cooperating with colleagues”. These items, although from separate scales within the measurement instrument, indicate that those aspects of job accountability and collaboration may be deemed less influential within the organisational culture. In terms of standard deviation, these two items also showed the highest standard deviations, indicating larger variances in these answers, perhaps due to the more subjective nature of these items.

Finally, in terms of work engagement, items such as “I am proud of the work that I do” and “at my work, I always persevere, even when things do not go well” showed the highest mean scores. These items were extracted from the vigour and dedication subscales of the engagement tool and indicated a sense of personal pride in work completed, as well as a noticeable culture of resilience within the organisation. Items on the lower end of this scale included items attributable to the absorption subscale, such as “it is difficult to detach myself from my job” and “I get carried away when I’m working”. This could imply that although employees were dedicated to and energetic about their work, their absorption, concentration or immersion in their tasks were less noticeable.

5.4 Confirmatory factor analysis

To confirm the empirical uniqueness of the measures of the focal constructs, a CFA was performed using EQS 6 for Windows. Because validated instruments were applied, it was required to confirm the factor structure of these instruments on the

sample population of frontline supervisors. Furthermore, given the sample size requirement of five times the number of items in any measurement instrument considered, the sample size of 104 was considered a good opportunity for CFA as the tool with the highest number of items was the safety behaviour instrument, which had 21 items. Given the differences in samples, populations and research methods, CFA is considered a powerful analytical tool for the development and refinement of measurement instruments when assessing construct validity, method effect and evaluation factors (Jackson, Gillaspy & Purc-Stephenson, 2009). Although there is considerable consistency in literature on how a CFA report should be structured, there is no universal standard (Jackson, 2009).

A significant characteristic of CFA is that it allows the researcher to postulate very precise and complex hypotheses. However, to test these ideas, it is recommended that they be converted into a model (Jackson, Gillaspy & Purc-Stephenson, 2009). An assessment of the reliability and credibility of the observed measures used to identify the underlying factor structure must be completed. Furthermore, because a common application of CFA is to develop or validate scales, it is recommended that a greater amount of detail be reported on the results of the CFA to support the measurements used.

Some challenges were experienced with the CFA – specifically collinearity concerns, where subscales, or items within subscales, correlated too highly to other subscales or items within other subscales, indicating the duplicate measurement of the same variable. Despite these challenges, a final CFA was arrived at, with recommendations for each of the measurement instruments. Furthermore, the CFA was able to provide a robust structure for the subsequent regression analysis and model recommendations as the analysis determined that the measurement instruments used were accurate and reliable measures for the hypothesised structural model (Jackson, Gillaspy & Purc-Stephenson, 2009).

5.4.1 Multivariate normality

In CFA, it is important to address multivariate normality as this will determine the estimation methods that should be employed (Gao, Mokhtarian & Johnston, 2008)

and how trustworthy the results from these methods will be. Multivariate normal distributions suggest that each variable within a scale has a univariate normal distribution. Univariate normality defines the distribution of a single variable in the sample, whereas multivariate normality describes the combined distribution of all variables (Gao *et al*., 2008).

Generally, real-life data such as the kind obtained from a Likert scale do not have univariate normality, let alone multivariate normal distributions and in such an instance, the application of a normal theory-based estimation method will result in questionable outcomes (Gao *et al*., 2008). In this study, Mardia's coefficient was used to evaluate the multivariate normality by considering the skewness and kurtosis. The choice of coefficient was based on the software package used for statistical analysis. The expected value for the Mardia's coefficient of a normally distributed multivariate sample is zero, with higher values indicating a larger deviation from normality. Even small departures from multivariate normality can lead to great variances in the chi-square test, undermining its effectiveness. In general, violation of this assumption inflates chi-square, but may also deflate it under certain circumstances. For the purposes of this study, a normalised estimate of greater than 5 indicated non-normal multivariate data. The multivariate kurtosis normalised estimates for each factor analysis can be found in tables 2, 4, 6 and 8. Unsurprisingly, none of the distributions were found to be normally distributed. To bring a sample closer to compliance with the Mardia's coefficient for multivariate normality, researchers may transform the raw data by deleting outliers that contribute most strongly to a distorted normal distribution.

5.4.2 Validity and reliability

Even if a researcher chooses to transform or delete data to improve multivariate normality, it is unlikely that a fully normalised dataset will be achieved without compromising the underlying factor structure (Gao *et al*., 2008). Furthermore, the proposed model will also often be assessed by estimate goodness-of-fit parameters. It is thus more important to have data that can provide accurate and reliable parameter estimates, even under non-normal conditions, than it is to have normally distributed data.

- Validity

Validity is a statistical idea used to measure the quality of a quantitative study. It is described as the degree to which a factor or variable is accurately measured. Convergent and discriminant validity are two subtypes of validity and, for purposes of this CFA, these measures were considered when measuring the independence of factors within the underlying model structure. This test for validity estimated the correlation coefficient to determine whether the theoretical constructs that should not be related to one another were in fact not related (discriminant validity), or whether the measures of constructs that theoretically should be related to one another were, in fact, observed to be related (convergent validity). Correlations between theoretically similar measures should be closer to 1, whereas correlations between theoretically dissimilar measures should be closer to 0. For the purposes of this study, a correlation coefficient of less than 0.3 was required to prove discriminant validity between the factors being analysed. Values of greater than 0.7 indicated convergent validity. The correlation coefficient for each of the variables and factors considered in the CFA can be found in tables 3, 5, 7 and 9.

- Reliability

The second measure of quality in a quantitative study is reliability. This is described as the accuracy of an instrument or the degree to which the instrument consistently reports the same results on repeated occasions. Cronbach's alpha, developed in 1951 by Lee Cronbach, is a statistical measure to test for reliability and ranges from 0 to 1. The higher Cronbach's alpha, the more reliable the instrument. Typically, values greater than 0.8 indicate excellent reliability (Jackson, Gillaspy & Purc-Stephenson, 2009). The Cronbach alpha values for each CFA iteration can be found in tables 3, 5, 7 and 9.

5.4.3 Estimation method and goodness-of-fit

Once the data had been analysed for normality, validity and reliability, a parameter estimation and goodness-of-fit analysis was conducted. In CFA modelling, the goodness-of-fit indexes establish whether the overall model that has been uncovered is acceptable and which of the proposed model paths are significant (Moss, 2009). The default choice for this type of analysis tends to be the use of a variance-

covariance matrix with the MLE method, which assumes normality. As the sample indicated non-normal multivariance, the Yuan-Bentler correction method for non-normal multivariate samples was also considered (Jackson, Gillaspy & Purc-Stephenson, 2009).

Many of the fit parameters used in the MLE and Yuan-Bentler methods are derived from the chi-square value, which in this context represents the difference between the observed and predicted covariance matrix (Moss, 2009). Many researchers recommend the use of multiple fit indices when computing a model fit as this will assist in overcoming the limitations associated with each parameter (Moss, 2009; Marsh, Balla & Hau, 1996; Jaccard & Wan, 1996). The criteria used to determine whether the model fit was adequate were as follows:

- The comparative fit index exceeds 0.93 (Byrne, 1994).
- The relative chi-square should be less than 2 or 3 (Kline, 1998; Ullman, 2001), with relative chi-square being the chi-square divided by the degrees of freedom.
- The standardised root mean square residual (SRMSR) and the root mean square error of approximation (RMSEA) is less than 0.08 (Browne & Cudeck, 1993).
- 90% confidence limit for the RMSEA is less than 0.05 (Browne & Cudeck, 1993).

Table 3, 5, 7 and 9 summarises these fit indices for each CFA iteration. The results obtained from the MLE are indicated first, with the results of the more robust Yuan-Bentler correction method indicated in brackets.

5.4.3.1 Safety behaviour

In an effort to reach an analysis with adequate model-fit parameters, the researcher compared the results for four different factor structures using EQS 6 for Windows. Factor analysis was run on the variables measuring safety climate (B1-B6), safety motivation (B7-B10), safety compliance (B11-B17) and safety participation (B18-B21). Seven iterations were required to achieve convergence. The factor analysis found that items B3, B5, B6, B10, B11, B12, B13, B14, B15, B16 and B17 had to be dropped from the structure as these items were loaded with factors they were not supposed to measure. The resultant fit indices from each iteration can be found in

Table 3, with Yuan-Bentler correction results indicated in brackets. Final factor values can be found in Table 4.

The final structure remained non-normally distributed with a Mardia's coefficient of greater than 5. This supported the use of the Yuan-Bentler correction method and a Cronbach alpha 0.792, which is deemed acceptable for model validity. Although the relative chi-square value of 1.66 was slightly lower than recommended due to the use of the Yuan-Bentler correction method, which accounts for an overestimated chi-square, this is not unusual and was not deemed a concern (Jackson, Gillaspy & Purc-Stephenson, 2009; Gao *et al*., 2008). A CFI of 0.77 and an RMSEA of 0.08 (Yuan-Bentler correction) along the 90% lower confidence limit of 0.038 (< 0.05) indicated an adequate model fit. The final factor loadings for all items were between 0.363 and 0.914, indicating discriminant validity between items and factors.

Table 3: Normalised estimates, reliability estimate and fit indices for factor analysis: safety behaviour. Values in brackets and italics indicate Yuan-Bentler correction method values. All other values are for the MLE.

	Mardia's co-eff	α	χ2/df	SRMR	CFI	RMSEA	90% CL
CFA1.1	33.85	0.908	3.11 *(1.8)*	0.15	0.70 *(0.83)*	0.14 *(0.09)*	0.129; 0.156 *(0.074; 0.104)*
CFA1.2	35.37	0.898	3.14 *(1.81)*	0.11	0.76 *(0.87)*	0.06 *(0.09)*	0.128; 0.159 *(0.070; 0.106)*
CFA1.3	32.1063	0.836	2.76 *(1.58)*	0.105	0.86 *(0.94)*	0.06 *(0.08)*	(0.105; 0.156) *(0.042; 0.105)*
CFA1.4	31.707	0.792	2.80 *(1.66)*	0.10	0.77 *(0.93)*	0.13 *(0.08)*	(0.100; 0.164) *(0.038; 0.117)*

Table 4: Pattern matrix for final CFA for safety behaviour. Extracted using MLE. Seven iterations were required for convergence.

	Safety culture	Safety motivation	Safety participation
B1	0.710		
B2	0.914		
B4	0.363		
B7		0.706	
B8		0.379	
B9		0.499	
B18			0.491
B19			0.743
B20			0.472
B21			0.407

5.4.3.2 Organisational culture: Organisational practices

In an effort to reach an analysis with adequate model-fit parameters, the researcher compared the results for three different factor structures using EQS 6 for Windows. Factor analysis was run on the variables measuring organisational practices (C1-C13). Seven iterations were required to achieve convergence. The factor analysis found that items C1, C2, C3, C4, C5, C6 and C10 had to be dropped from the structure as these items were loaded with factors they were not supposed to measure. The resultant fit indexes from each iteration can be found in Table 5, with Yuan-Bentler correction results indicated in brackets. Final factor loadings are shown in Table 8.

The final structure was found to be normally distributed with a Mardia's coefficient of less than 5, supporting the use of MLE with a Cronbach alpha of 0.896, which is deemed acceptable for model validity. A relative chi-square value of 4.52, along with a CFI of 0.91, indicated adequate model fit. An RMSEA of 0.186 and a 90% lower confidence limit of 0.13 (> 0.05) indicated an acceptable model fit as the other parameters were well within recommended limits. The final factor loadings for all items were between 0.522 and 0.794, indicating discriminant validity between items.

Table 5: Normalised estimates, reliability estimate and fit indexes for factor analysis: Organisational culture (organisational practices). Values in brackets and italics indicate Yuan-Bentler correction method values. All other values are for the MLE.

	Mardia's co-eff	**α**	**χ2/df**	**SRMR**	**CFI**	**RMSEA**	**90% CL**
CFA2.1.1	8.3409	0.895	4.72 *(1.1)*	0.12	0.66 *(0.78)*	0.019 *(0.16)*	0.169; 0.212 *(0.133; 0.177)*
CFA2.1.2	7.8911	0.890	3.39 *(2.09)*	0.08	0.83 *(0.91)*	0.015 *(0.12)*	0.123; 0.83 *(0.083; 0.147)*
CFA2.1.3	4.0552	0.896	4.52 *(3.07)*	0.06	0.91 *(0.95)*	0.186 *(0.14)*	(0.130; 0.244) *(0.084; 0.204)*

5.4.3.3 Organisational culture: Supervisory support

In an effort to reach an analysis with adequate model-fit parameters, the researcher compared the results for a single factor structure using EQS 6 for Windows. Factor analysis was run on the variables measuring organisational practices (C14-C20). Four iterations were required to achieve convergence. The factor analysis found that all items were adequately loaded with factors they were supposed to measure. Thus, no items were recommended to be dropped from supervisory support subscale. The

resultant fit indexes from each iteration can be found in Table 6, with Yuan-Bentler correction results indicated in brackets. Final factor loadings are shown in Table 8.

The final structure remained non-normally distributed with a Mardia's coefficient of greater than 5, supporting the use of the Yuan-Bentler correction method with a Cronbach alpha 0.952, which is deemed acceptable for model validity. A relative chi-square value of 3.343 indicated adequate model fit. A CFI of 0.95 and an RMSEA of 0.087 (Yuan-Bentler correction), along with the 90% lower confidence limit of 0.021 (< 0.05), indicated an adequate model fit. The final factor loadings for all items were between 0.470 and 0.832, indicating discriminant validity between items.

Table 6: Normalised estimates, reliability estimate and fit indices for factor analysis: Organisational culture (supervisory support). Values in brackets and italics indicate Yuan-Bentler correction method values. All other values are for the MLE.

	Mardia's co-eff	**α**	**χ2/df**	**SRMR**	**CFI**	**RMSEA**	**90% CL**
CFA2.2.1	18.0093	0.952	3.343 *(1.8)*	0.035	0.950 *(0.98)*	0.152 *(0.087)*	0.104; 0.200 *(0.021; 0.141)*

5.4.3.4 Organisational culture: Work attributes

In an effort to reach an analysis with adequate model-fit parameters, the researcher compared the results for two different factor structures using EQS 6 for Windows. Factor analysis was run on the variables measuring organisational practices (C21-C28). Six iterations were required to achieve convergence. The factor analysis found that items C26 and C27 had to be dropped from the structure as these items were loaded with factors that they were not supposed to measure. The resultant fit indexes from each iteration of the process can be found in Table 7, with Yuan-Bentler correction results indicated in brackets. Final factor loadings are shown in Table 8.

The final structure remained non-normally distributed, with a Mardia's coefficient of greater than 5, supporting the use of the Yuan-Bentler correction method and a Cronbach alpha of 0.881, which is deemed acceptable for model validity. A relative chi-square value of 4.132 indicated adequate model fit. A CFI of 0.869 and an RMSEA of 0.087 (Yuan-Bentler correction), along with a 90% lower confidence limit of 0.021 (< 0.05) indicated an adequate model fit. The final factor loadings for all items were between 0.47 and 0.832, indicating discriminant validity between items and factors.

Table 7: Normalised estimates, reliability estimate and fit indexes for factor analysis: Organisational culture (work attributes). Values in brackets and italics indicate Yuan-Bentler correction method values. All other values are for the MLE.

	Mardia's co-eff	α	χ2/df	SRMR	CFI	RMSEA	90% CL
CFA2.3.1	9.8675	0.880	7.38 *(3.9)*	0.138	0.738 *(0.819)*	0.250 *(0.171)*	0.212; 0.287 *(0.132; 0.210)*
CFA2.3.2	9.9259	0.881	6.37 *(4.1)*	0.084	0.869 *(0.874)*	0.229 *(0.175)*	0.173; 0.285 *(0.118; 0.234)*

Table 8: Pattern matrix for final CFA for organisational culture, extracted using MLE. Six iterations were required for convergence.

	Organisational practices	Supervisory support	Work attributes
C7	0.522		
C8	0.501		
C9	0.794		
C11	0.700		
C12	0.703		
C13	0.639		
C14		0.827	
C15		0.830	
C16		0.832	
C17		0.699	
C18		0.737	
C19		0.565	
C20		0.470	
C21			0.450
C22			0.308
C23			0.786
C24			0.752
C25			0.779
C28			0.317

5.4.3.5 Supervisory work engagement

In an effort to reach an analysis with adequate model-fit parameters, the researcher compared the results for four different factor structures using EQS 6 for Windows. Factor analysis was run on the variables measuring supervisory work engagement (D1-D17). Five iterations were required to achieve convergence. The factor analysis found that items D6, D11, D13, D16 and D17 had to be dropped from the structure as these items were loaded with factors that they were not supposed to measure. The resultant fit indexes from each iteration can be found in Table 9, with Yuan-Bentler correction results indicated in brackets. Final factor loadings are shown in Table 10.

The final structure remained non-normally distributed with a Mardia's coefficient of greater than 5, supporting the use of the Yuan-Bentler correction method and a Cronbach alpha 0.917, which is deemed acceptable for model validity. A relative chi-square value of 2.53 indicated adequate model fit. A CFI of 0.943 and an RMSEA of 0.082 (Yuan-Bentler correction), along with a 90% lower confidence limit of 0.049 (< 0.05) indicated an adequate model fit. The final factor loadings for all items were between 0.304 and 0.733, indicating discriminant validity between items.

Table 9: Normalised estimates, reliability estimate and fit indexes for factor analysis: supervisory engagement. Values in brackets and italics indicate Yuan-Bentler correction method values. All other values are for the MLE.

	Mardia's co-eff	**α**	**χ2/df**	**SRMR**	**CFI**	**RMSEA**	**90% CL**
CFA3.1	10.7964	0.914	2.32 *(1.72)*	0.085	0.828 *(0.895)*	0.114 *(0.084)*	0.096; 0.131 *(0.064; 0.103)*
CFA3.2	9.0665	0.914	2.33 *(1.73)*	0.072	0.873 *(0.924)*	0.114 *(0.084)*	0.092; 0.136 *(0.059; 0.108)*
CFA3.3	8.9445	0.915	2.28 *(1.61)*	0.061	0.891 *(0.943)*	0.112 *(0.077)*	0.087; 0.136 *(0.047; 0.104)*
CFA3.4	9.7790	0.917	2.53 *(1.68)*	0.060	0.889 *(0.942)*	0.123 *(0.082)*	0.096; 0.149 *(0.050; 0.111)*

Table 10: Pattern matrix for final CFA for supervisory engagement, extracted using MLE. Five iterations were required for convergence.

	Vigour	**Dedication**	**Absorption**
D1	0.733		
D2	0.646		
D3	0.568		
D4	0.307		
D5	0.457		
D7		0.614	
D8		0.742	
D9		0.693	
D10		0.486	
D12			0.304
D14			0.642
D15			0.558

5.4.3.6 Supervisory accountability

In an effort to reach an analysis with adequate model-fit parameters, the researcher compared the results for two different factor structures using EQS 6 for Windows. Factor analysis was run on the variables measuring organisational practices (E1-

E12). Five iterations were required to achieve convergence. The factor analysis found that items E8 and E10 had to be dropped from the structure as these items were loaded with factors they were not supposed to measure. The resultant fit indexes from each iteration of the process can be found in Table 11, with Yuan-Bentler correction results indicated in brackets. Final factor loadings are shown in Table 12.

The final structure remained non-normally distributed with a Mardia's coefficient of greater than 5, supporting the use of the Yuan-Bentler correction method and a Cronbach alpha 0.899, which is deemed acceptable for model validity. A relative chi-square value of 2.19 and a CFI of 0.852 indicated adequate model fit. Although an RMSEA of 0.108 (Yuan-Bentler correction) and a 90% lower confidence limit of 0.0074 (> 0.05) are outside of the recommended limits, the good fit of values for the other parameters indicated an acceptable model fit overall. The final factor loadings for all items were between 0.402 and 0.941, indicating discriminant validity between items.

Table 11: Normalised estimates, reliability estimate and fit indexes for factor analysis: supervisory accountability. Values in brackets and italics indicate Yuan-Bentler correction method values. All other values are for the MLE.

	Mardia's co-eff	**α**	**χ2/df**	**SRMR**	**CFI**	**RMSEA**	**90% CL**
CFA4.1	11.6835	0.906	2.43 *(2.65)*	0.120	0.820 *(0.764)*	0.155 *(0.127)*	0.130; 0.179 *(0.101; 0.152)*
CFA4.2	9.7666	0.899	3.00 *(2.19)*	0.120	0.887 *(0.852)*	0.140 *(0.108)*	0.108; 0.170 *(0.074; 0.140)*

Table 12: Pattern matrix for final CFA for supervisory accountability, extracted using MLE. Five iterations were required for convergence.

	Job accountability	**Perceived accountability**
E1	0.402	
E2	0.579	
E3	0.653	
E4	0.536	
E5	0.638	
E6	0.508	
E7	0.410	
E9		0.332
E11		0.941
E12		0.816

Figures 5 and 6 show a comparison of the initial underlying factor structure used for the CFA and the final structure on which the regression analysis was based.

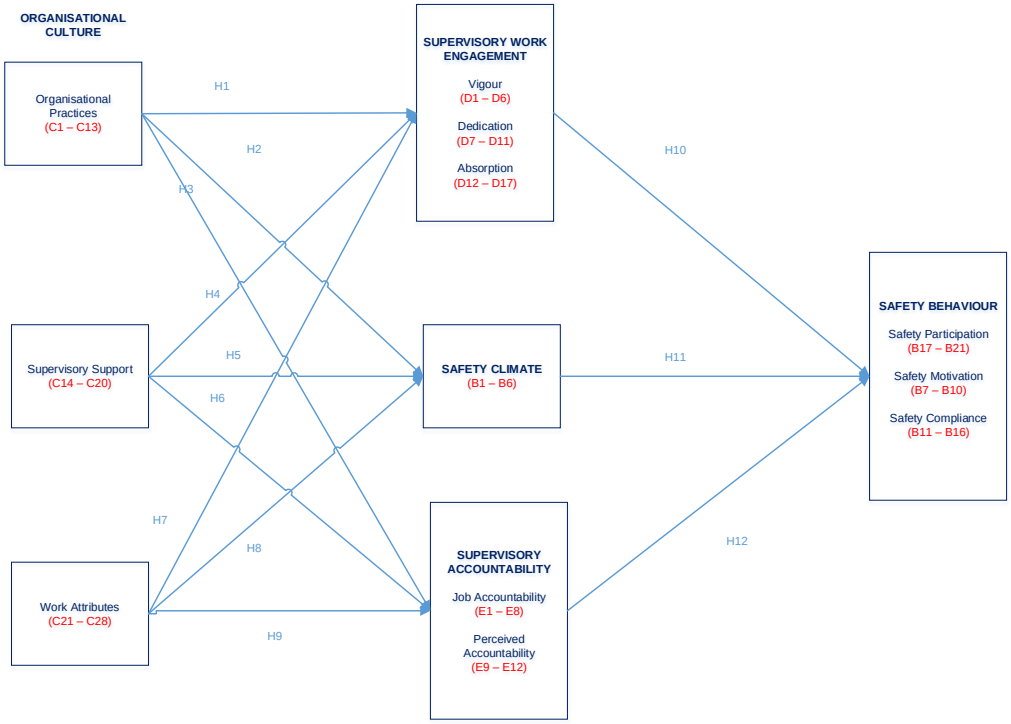

Figure 5: Underlying structure for initial CFA. Detail on items proposed for initial measurement as per data coding and measurement instruments.

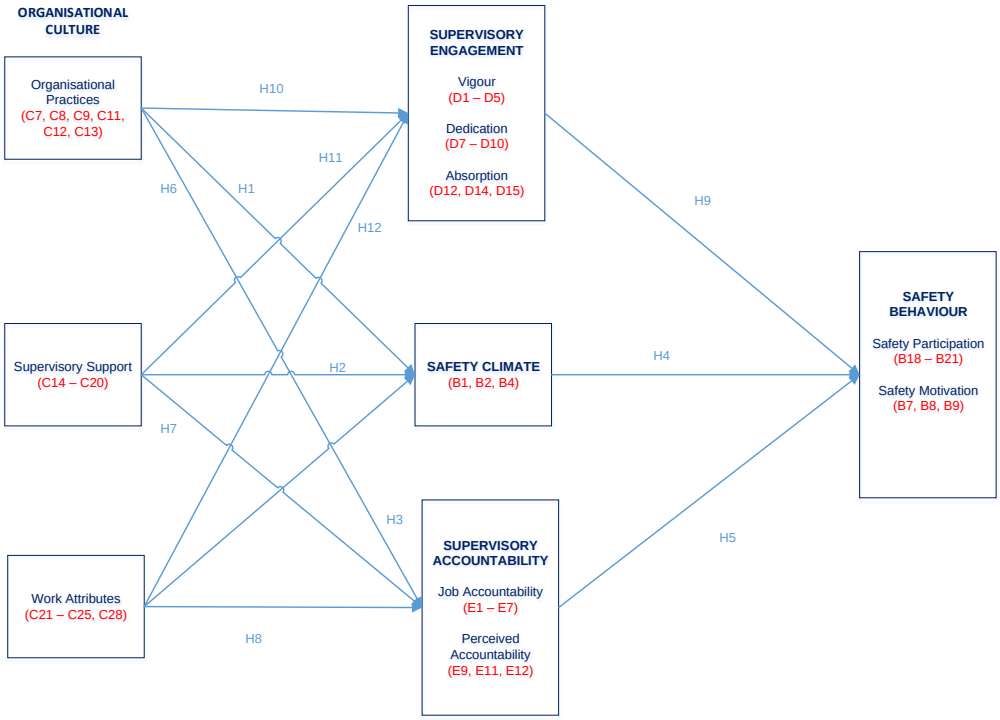

Figure 6: Finalised structure after CFA. Items used for final regression analysis updated as recommended by CFA.

5.5 Regression analysis

Correlation analysis is used to describe the strength and direction of a linear relationship between variables. Multiple regression is a family of techniques able to describe the relationship between multiple independent variables and a single dependent variable. Regression analysis uses correlation methods, and allows for the analysis of complex, real-life scenarios.

For the purposes of this research, the dependent variables considered, and thus modelled, were supervisory engagement, safety climate, supervisory accountability and safety behaviour. Independent variables for supervisory engagement, safety climate and supervisory accountability included the factors associated with organisational culture –, organisational practices, supervisory support and work attributes. The independent variables considered for safety behaviour included supervisory engagement, safety climate and supervisory accountability. Regression techniques were used to assess how well the set of independent variables predicted the associated dependent variable, which independent variable best predicted the dependent variable outcome, and the extent to which a particular independent variable contributed to a particular prediction where the effects of a different variable were controlled.

Multiple regression is one of the stricter statistical techniques in that it makes use of a number of fundamental assumptions. If these assumptions are not true, they lead to incorrect results. The assumptions considered – and corrected for where required – as part of the research included sample size, multiple collinearity and singularity, outliers, and normality.

5.5.1 Safety climate

The hypotheses associated with safety climate as the dependent variable included:

- H1: Aggregate employee perceptions of organisational practices are a significant predictor of safety climate.
- H2: Aggregate employee perceptions of supervisory support are a significant predictor of safety climate.
- H3: Aggregate employee perceptions of work attributes that are meaningful and empowering are a significant predictor of safety climate.

The regression descriptive statistics shown in Table 13 considered 103 responses. The safety climate mean indicated an “always” Likert rating, suggesting a positive safety climate, whereas the factors measuring organisational culture appeared to be closer to the “sometimes” or “almost always” Likert ratings. These factors also indicated the largest standard deviations for the analysis.

Table 13: Regression descriptives for analysis of safety climate as a function of organisational culture factors: organisational practices, supervisory support and work attributes.

	Mean	**Standard deviation**	**N**
Safety climate	4.43	0.671	103
Organisational practices	3.37	0.914	103
Supervisory support	3.69	0.990	103
Work attributes	3.75	0.786	103

The relationship between safety climate and each of the independent variables was investigated using the Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and outliers. The data was compliant with all assumptions. There were strong and statistically significant positive correlations between all independent variables and safety climate, with correlation coefficients ranging from 0.429 to 0.674. These results indicated a correlation between higher levels of safety climate and higher levels of organisational practices, work attributes and supervisory support. Table 14 supports these findings and shows the regression output.

The model was summarised with an r-squared value of 0.373, indicating that 37% of the safety climate was attributed to the organisational culture factors of organisational practices, supervisory support and work attributes. The model summary is shown in Table 15.

An ANOVA analysis indicated that all independent variables correlated to safety climate were statistically significantly, but only organisational practices and work attributes were found to be significant predictors of safety climate. The influence of work attributes on safety climate was found to be higher than that of organisational practices. The output of this analysis is shown in tables 16 and 17.

Table 14: Correlation output for the analysis of safety behaviour as the dependent variable with organisational culture factors as the independent variable.

		Safety climate	Organisational practices	Supervisory support	Work attributes
Pearson correlation	**Safety climate**	1.000	0.527	0.574	0.429
	Organisational practices	0.527	1.000	0.637	0.565
	Supervisory support	0.574	0.637	1.000	0.674
	Work attributes	0.429	0.565	0.674	1.000
Sig. (1-tailed)	**Safety climate**		0.000	0.000	0.000
	Organisational practices	0.000		0.000	0.000
	Supervisory support	0.000	0.000		0.000
	Work attributes	0.000	0.000	0.000	

Table 15: Model summary for analysis of relationship between safety climate and organisational culture factors.

Safety climate and organisational culture	R	r-square	Adjusted r-square	Standard error of estimate
	0.611	0.373	0.354	0.539

Table 16: ANOVA analysis for organisational culture factors as statistically significant predictors of safety climate.

	Sum of squares	df	Mean square	F	Sig.
Regression	17.100	3	5.700	19.613	0.000
Residual	28.771	99	0.291		
Total	45.871	102			

Table 17: Coefficient analysis for safety climate ANOVA output.

	Beta	Std. error	Beta	t	Sig	90% low	90% upper	Tolerance	VIF
(Constant)	2.740	0.268		10.212	**0.000**	2.208	3.273		
Organisational practices	0.197	0.078	0.269	2.528	**0.013**	0.042	0.352	0.561	1.784
Supervisory support	0.267	0.080	0.395	3.323	**0.001**	0.108	0.427	0.449	2.228
Work attributes	0.010	0.095	0.011	0.101	0.920	-0.178	0.197	0.514	1.944

Using regression analysis, it was concluded that organisational practices and supervisory support are significant predictors of safety climate, and thus hypotheses 1 (H1) and 2 (H2) are accepted. As work attributes are not a statistically significant predictor of safety climate, hypothesis 3 (H3) is rejected.

5.5.2 Supervisory accountability

The hypotheses associated with supervisory accountability as the dependent variable included:

- H6: Aggregate employees perceptions of organisational practices are a significant predictor of supervisory accountability.
- H7: Aggregate employee perceptions of supervisory support are a significant predictor of supervisory accountability.
- H8: Aggregate employee perceptions of work attributes that are meaningful and empowering are a significant predictor of supervisory accountability.

The regression descriptive statistics shown in Table 18 considered 102 responses. The accountability mean indicated an “almost always” Likert rating, suggesting a positive climate for accountability. The factors measuring organisational culture appeared to be closer to the “sometimes” and “almost always” Likert ratings. These factors also indicated the largest standard deviations for the analysis.

Table 18: Regression descriptives for analysis of supervisory accountability as a function of organisational culture factors: organisational practices, supervisory support and work attributes.

	Mean	**Standard deviation**	**N**
Accountability	4.02	0.588	102
Work attributes	3.76	0.789	102

The relationship between supervisory accountability and each of the independent variables was investigated using Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and outliers. In completing these preliminary tests, it was found that organisational practices were not statistically significantly correlated to supervisory accountability. This would result in collinearity concerns if it were included in the regression. Furthermore, supervisory support was identified as an outlier and removed from the regression analysis. There was, however, a moderately strong yet statistically significant positive correlation between work attributes and

supervisory accountability, with a correlation coefficient of 0.325. This indicates that higher levels of work attributes result in higher levels of supervisory accountability. Table 19 supports these findings and shows the regression output.

Table 19: Correlation output for the analysis of safety behaviour as the dependent variable, with organisational culture factors as the independent variable.

		Supervisory accountability	**Work attributes**
Pearson correlation	**Supervisory accountability**	1.000	0.325
	Work attributes	0.325	1.000
Sig. (1-tailed)	**Supervisory accountability**		0.000
	Work attributes	0.000	

The model was summarised with an r-squared value of 0.105, indicating that 10.5% of supervisory accountability is attributed to the organisational culture factor of work attributes. The model summary is shown in table 20.

Table 20: Model summary for analysis of relationship between safety climate and organisational culture factors.

Safety climate and organisational culture	**R**	**r-square**	**Adjusted r-square**	**Standard error of estimate**
	0.325	0.105	0.096	0.559

An ANOVA analysis indicated that the independent variable of work attributes – the only variable considered in the regression due to the aforementioned assumption violations – was a statistically significant predictor of supervisory accountability. The output of this analysis is shown in tables 21 and 22.

Using, regression analysis, the researcher concluded that the organisational culture factor of work attributes is a significant predictor of supervisory accountability. Organisational practices and supervisory support are not significant predictors of supervisory accountability. Thus, hypotheses 6 (H6) and 7 (H7) are rejected, and hypothesis 8 (H8) is accepted.

Table 21: ANOVA analysis for organisational culture factors as statistically significant predictors of safety climate.

	Sum of squares	df	Mean square	F	Sig.
Regression	3.685	1	3.685	11.782	0.001
Residual	31.276	100	0.313		
Total	34.961	101			

Table 22: Coefficient analysis for safety climate ANOVA output.

	Beta	Standard error	Beta	t	Sig	90% low	90% upper
(Constant)	3.111	0.271		11.489	**0.000**	2.574	3.648
Work attributes	0.242	0.071	0.325	3.433	**0.001**	0.102	0.382

5.5.3 Supervisory engagement

The hypotheses associated with supervisory engagement as the dependent variable included:

- H10: Aggregate frontline supervisor perceptions of organisational practices are a significant predictor of supervisory engagement.
- H11: Aggregate frontline supervisor perceptions of supervisory support are a significant predictor of supervisory engagement.
- H12: Aggregate frontline supervisor perceptions of work attributes that are meaningful and empowering are a significant predictor of supervisory engagement.

The regression descriptive statistics shown in Table 23 considered 102 responses. The supervisory engagement mean indicated an “almost always” Likert rating, suggesting an engaged supervisory workforce. The factors measuring organisational culture appeared to be closer to the “sometimes” and “almost always” Likert ratings. These factors also indicated the largest standard deviations for the analysis.

The relationship between supervisory engagement and each of the independent variables was investigated using Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and outliers. The data was compliant with all assumptions. There were strong and statistically significant positive correlations between all independent variables and safety climate, with correlation coefficients ranging from 0.473 to

0.674. This indicated a correlation between higher levels of supervisory engagement and higher levels of organisational practices, work attributes and supervisory support. Table 24 supports these findings and shows the regression output.

Table 23: Regression descriptives for analysis of safety climate as a function of organisational culture factors: organisational practices, supervisory support and work attributes.

	Mean	**Standard deviation**	**N**
Supervisory engagement	3.81	0.686	102
Organisational practices	3.37	0.917	102
Supervisory support	3.68	0.994	102
Work attributes	3.75	0.790	102

Table 24: Correlation output for the analysis of safety behaviour as the dependent variable with organisational culture factors as the independent variable.

		Supervisory engagement	**Organisational practices**	**Supervisory support**	**Work attributes**
Pearson correlation	**Supervisory engagement**	1.000	0.473	0.552	0.577
	Organisational practices	0.473	1.000	0.637	0.564
	Supervisory support	0.552	0.637	1.000	0.674
	Work attributes	0.577	0.564	0.674	1.000
Sig. (1-tailed)	**Supervisory engagement**		0.000	0.000	0.000
	Organisational practices	0.000		0.000	0.000
	Supervisory support	0.000	0.000		0.000
	Work attributes	0.000	0.000	0.000	

The model was summarised with an r-squared value of 0.390, indicating that 39% of supervisory engagement was attributed to the organisational culture factors of organisational practices, supervisory support and work attributes. The model summary is shown in Table 25.

An ANOVA analysis indicated that all independent variables were statistically significantly correlated to supervisory engagement, but only supervisory support and work attributes were found to be significant predictors of safety climate. The influence of work attributes on supervisory engagement was found to be higher than that of supervisory support. The output of this analysis is shown in tables 26 and 27.

Using regression analysis, the researcher concluded that supervisory support and work attributes are significant predictors of supervisory engagement, and thus hypotheses 11 (H11) and 12 (H12) are accepted. As organisational practices are not a statistically significant predictor of supervisory engagement, hypothesis 10 (H10) is rejected.

Table 25: Model summary for analysis of relationship between safety climate and organisational culture factors.

Supervisory engagement and organisational culture	R	r-square	Adjusted r-square	Standard error of estimate
	0.625	0.390	0.372	0.544

Table 26: ANOVA analysis for organisational culture factors as statistically significant predictors of supervisory engagement.

	Sum of squares	df	Mean square	F	Sig.
Regression	18.559	3	6.186	20.915	0.000
Residual	28.987	98	0.296		
Total	47.546	101			

Table 27: Coefficient analysis for safety climate ANOVA output.

	Beta	Standard error	Beta	t	Sig	90% low	90% upper
(Constant)	1.757	0.271		6.490	0.000	1.220	2.295
Organisational practices	0.094	0.079	0.126	1.193	0.236	-0.062	0.250
Supervisory support	0.166	0.081	0.241	2.046	0.043	0.005	0.327
Work attributes	0.298	0.096	0.343	3.124	0.002	0.109	0.488

5.5.4 Safety behaviour

The hypotheses associated with safety behaviour as the dependent variable included:

- H4: Aggregate employee perceptions of safety culture are a significant predictor of safety behaviour.
- H5: The ability of frontline supervisors to hold employees and themselves accountable has a positive influence on safety behaviour.
- H9: Aggregate frontline supervisor perceptions of engagement are a significant predictor of safety behaviour.

The regression descriptive statistics shown in Table 28 considered 102 responses. The safety behaviour mean indicated an “always” Likert rating, suggesting a supervisory workforce that behave in a safe manner. The supervisory engagement factor and supervisory accountability factors appeared to be closer to the “sometimes” or “almost always” Likert ratings, whereas safety climate was closer to the safety behaviour mean. The independent variables indicated the largest standard deviations.

Table 28: Regression descriptives for analysis of safety behaviour as a function of safety climate, supervisory engagement and supervisory accountability.

	Mean	**Standard deviation**	**N**
Safety behaviour	4.57	0.470	102
Supervisory engagement	3.81	0.686	102
Safety climate	4.43	0.670	102
Accountability	4.00	0.656	102

The relationship between safety behaviour and each of the independent variables was investigated using the Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and outliers. The data was compliant with all assumptions. There were strong to moderately strong and statistically significant positive correlations between all independent variables and safety behaviour, with correlation coefficients ranging from 0.344 to 0.554. This indicated a correlation between higher levels of safety behaviour and higher levels of safety climate, supervisory engagement and supervisory accountability. Table 29 supports these findings and shows the regression output.

The model was summarised with an r-squared value of 0.384, indicating that 38% of safety behaviour was attributed to safety climate and levels of supervisory engagement and accountability. The model summary is shown in table 30.

An ANOVA analysis indicated that all independent variables were statistically significantly correlated to supervisory engagement, but only safety climate and supervisory accountability were found to be significant predictors of safety behaviour. The influence of supervisory accountability on safety behaviour was found to be

higher than that of safety climate. The output of this analysis is shown in tables 31 and 32.

Using regression analysis, the researcher concluded that safety climate and supervisory accountability are significant predictors of safety behaviour, and thus hypotheses 4 (H4) and 5 (H5) are accepted. As supervisory engagement is not a statistically significant predictor of safety behaviour, hypothesis 9 (H9) is rejected.

Table 29: Correlation output for the analysis of safety behaviour as the dependent variable with organisational culture factors as the independent variables.

		Safety behaviour	Supervisory engagement	Safety climate	Supervisory accountability
Pearson correlation	**Safety behaviour**	1.000	0.347	0.377	0.554
	Supervisory engagement	0.347	1.000	0.352	0.344
	Safety climate	0.377	0.352	1.000	0.221
	Supervisory accountability	0.554	0.344	0.221	1.000
Sig. (1-tailed)	**Safety behaviour**		0.000	0.000	0.000
	Supervisory engagement	0.000		0.000	0.000
	Safety climate	0.000	0.000		0.000
	Supervisory accountability	0.000	0.000	0.000	

Table 30: Model summary for analysis of relationship between safety climate and organisational culture factors.

Supervisory engagement and organisational culture	R	r-square	Adjusted r-square	Standard error of estimate
	0.620	0.384	0.365	0.374

Table 31: ANOVA analysis for organisational culture factors as statistically significant predictors of supervisory engagement.

	Sum of squares	df	Mean square	F	Sig.
Regression	8.549	3	2.850	203.55	.000[b]
Residual	13.720	98	0.140		
Total	22.269	101			

Table 32: Coefficient analysis for safety climate ANOVA output.

	Beta	Standard error	Beta	t	Sig	90% low	90% upper
(Constant)	2.233	0.316		7.073	0.000	1.607	2.860
Supervisory engagement	0.070	0.061	0.103	1.159	0.249	-0.050	0.191
Safety climate	0.167	0.060	0.238	2.793	0.006	0.048	0.286
Supervisory accountability	0.334	0.061	0.466	5.485	0.000	0.213	0.454

5.6 Conclusion

After presenting the descriptive statistics and demographic profile for the sample, the results of a confirmatory factor analysis were presented to prove the reliability and validity of the underlying structure. The validated model was used to test the identified hypotheses using multiple regression analysis in an effort to determine the nature – strength, direction and significance – of the relationship between the independent and dependent variables. Of the 12 hypotheses proposed, five were rejected because the independent variable was not a statistically significant predictor of the dependent variable. The validated model, updated with only accepted hypotheses and their correlation coefficients, is shown in Figure 7.

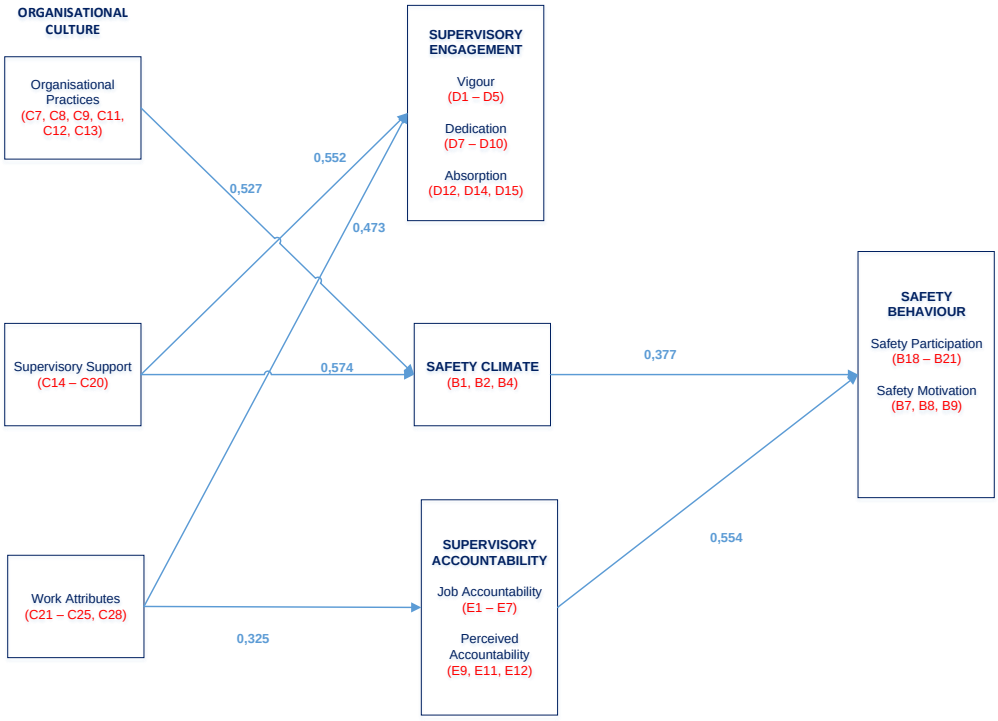

Figure 7: Proposed model using validated factor structure and indicating accepted hypotheses with associated correlation coefficients.

6 DISCUSSION OF RESULTS

This chapter discusses the research findings and results in detail, using the literature review as the context. In an attempt to understand and explain the hypothesis outcomes, the insights obtained from the results discussed in Chapter 4 are deliberated, compared and juxtaposed to the constructs and concepts available in recent literature and research. The research findings contribute to a better understanding of the organisational culture and supervisory conduct factors that influence safety climate and behaviour, and provide new insights that are not yet charted in the reviewed literature. The relevance of the results and literature associated with this research is addressed in the following sections.

6.1 Safety climate

The first objective of the research was to address the relationship between organisational factors and safety climate. Although a range of studies have established sound predictive relationships between safety climate and safety-related incidents such as accidents (Zohar, 2010; Brown & Leigh, 1996), few have established links between specific organisational culture factors and safety climate. It was proposed that factors such as supervisory support, organisational practices and work attributes within an organisation provide the context for the formation of specific safety perceptions, and thus should predict safety climate.

The three independent variables of organisational practices, supervisory support and work attributes were considered as factors of organisational culture, and were analysed in a model for variance. Based on the adjusted r^2-value, 37.3% of the variance in safety climate could be attributed to organisational culture. Considering the range of other organisational culture factors not considered in this research, a 37.3% variance was considered significant and thus a strong factor that organisational leadership should consider leveraging in an attempt to create a positive and resilient safety climate. This result confirms the findings of Wiegmann *et al*. (2004) and adds to the body of research required by Zohar (2010).

6.1.1 Aggregate employee perceptions of organisational practices are a significant predictor of safety climate (H1)

Hypothesis 1 aimed to establish whether employee perceptions of organisational practices could be used to predict the safety culture of an organisation. A multiple linear regression analysis between safety climate (dependent variable) and organisational practices (independent variable) illustrated a positive, moderately strong relationship, with a correlation coefficient of 0.527 across 103 participants. For the purposes of this research, examples of organisational practices included effective communication from senior leadership, transparent and fair recognition, compensation and opportunity for promotion, goal clarity, and employee wellbeing. This result indicates that organisational practices that positively enhance employee perceptions of their organisation also positively influences the safety climate of the organisation. An analysis of variance indicated a significant correlation between organisational practices and safety climate when keeping all other independent variables stable, with a relative 0.970 improvement in safety climate for every movement in organisational practices.

6.1.2 Aggregate employee perceptions of supervisory support are a significant predictor of safety climate (H2)

Hypothesis 2 aimed to establish whether employee perceptions of supervisory support could be used to predict the safety climate of an organisation. A multiple linear regression analysis between safety climate (dependent variable) and supervisory support (independent variable) illustrated a positive, moderately strong to strong relationship, with a correlation coefficient of 0.637 across 103 participants. For the purposes of this research, examples of supervisory support included active interest in growth and development; care and respect; encouragement for a fair, inclusive and diverse environment; and useful communication. This result indicates that supervisory support that positively enhances employee perceptions of their organisation also positively influences the safety climate of the organisation. An analysis of variance indicated a significant correlation between supervisory support and safety climate when keeping all other independent variables stable, with a relative 0.268 improvement in safety climate for every movement in supervisory support. This result suggests that supervisory support is the strongest predictor of safety climate when considering the organisational culture factors analysed.

6.1.3 Aggregate employee perceptions of work attributes are a significant predictor of safety climate (H3)

Hypothesis 3 aimed to establish whether employee perceptions of work attributes could be used to predict the safety climate of an organisation. A multiple linear regression analysis between safety climate (dependent variable) and supervisory support (independent variable) illustrated a positive, moderately strong relationship, with a correlation coefficient of 0.565 across 103 participants. For the purposes of this research, examples of work attributes included personal accomplishment, autonomy to make decisions, transparent communication and feedback, and the proper use of skills and abilities. This result indicates that work attributes that positively enhance employee perceptions of their organisation also positively influence the safety climate of the organisation. However, an analysis of variance indicated that work attributes were not significantly correlated to safety climate when keeping all other independent variables stable, with a relative 0.01 improvement in safety climate for every movement in work attributes. This result suggests that work attributes is an inadequate predictor of an organisation's safety climate, despite a positive correlation between the two variables.

An organisational culture that encourages safety is necessary for resilient safety performance. Although organisational practices and supportive supervisory routines can provide an effective safety framework, it is ultimately the employee's perception of the importance of safety to the organisation that governs safety behaviour. These results contribute to literature on safety by confirming that for resilient safety behaviour, an organisation requires both safety systems and an organisational culture that is able to support those systems.

6.2 Safety behaviour

A further objective of the research sought to determine the strength and direction of the relationship between safety climate and safety behaviour. Although significant research has been completed in understanding job performance as a dimension of safety performance, far less research has been conducted on how safety behaviour affects the number of incidents and accidents in the workplace (Yang *et al*., 2020; Neal & Griffin, 2006), or the impact of safety climate on individual safety behaviour. Safety climate is defined by Neal & Griffin (2006) as a collective concept resulting from individuals' collective insights into the several ways that safety is lived in the

work environment. Research has shown that safety climate is an important predictor of safety behaviour, and safety outcomes such as accidents and injury (Yang *et al*., 2020, Neal & Griffin, 2006). This information is important as it empowers organisations to target specific interventions related to an individual's compliance to, motivation to participate and participation in organisational safety practices in an effort to improve safety performance.

The three independent variables of safety climate, supervisory accountability and supervisory engagement were considered as factors of safety behaviour, and were analysed for variance. Based on the adjusted r^2-value, 38.4% of the variance in safety behaviour could be attributed to climate and supervisory routines. Considering the range of other factors not considered in this research, 38.4% variance was considered significant, and thus a strong factor that organisational leadership should consider leveraging to create a positive and resilient safety climate.

6.2.1 Aggregate employee perceptions of safety climate are significantly related to safety behaviour (H4)

Hypothesis 4 aimed to establish whether employee perceptions of safety climate could be used to predict the safety behaviour of employees within the organisation. A multiple linear regression analysis between safety climate (independent variable) and safety behaviour (dependent variable) illustrated a positive, moderately weak relationship, with a correlation coefficient of 0.377 across 102 participants. An analysis of variance indicated a significant correlation between safety climate and safety behaviour when keeping all other independent variables stable, with a relative 0.167 improvement in safety climate for every movement in safety behaviour. These results are compliant with literature (Neal & Griffin, 2006; Christian, Bradley, Wallace & Burke, 2009; Yang *et al*., 2020), although the strength of the relationship is less robust and suggests that possible extrinsic factors such as supervisory accountability or engagement may be more important determinants of change in safety behaviour. This complements research suggesting a positive and resilient relationship between a supervisor's behaviours and safety performance (Barling, Loughlin & Kelloway, 2002; Conchie & Donald, 2009, Conchie; Taylor & Donald, 2012; Kelloway, Mullen & Francis, 2006; Mullen & Kelloway, 2009; Törner & Pousette, 2009). Moreover, these results further motivate the critical and direct influence that frontline

supervisors have on the safety behaviour of individuals within their teams (Fang & Wu, 2015; Lingard, Cooke & Blismas, 2012).

6.3 Supervisory accountability

Literature reveals that positive safety behaviour can be instilled by exhibiting transformational leadership behaviours that encourage relationships built on cooperation and trust. However, less research is available on how leaders can motivate employees towards more compliance-orientated behaviours. Accountability is a central component in all organisations, societies and communities; without it, there would be no regard for the consequences imposed by others (Hall, Frink & Buckley, 2017; Hochwarter, Ferris, Gavin, Perrewé, Hall & Frink, 2007). A further objective of the research was therefore to understand how accountability for safety compliance influences safety behaviour.

6.3.1 The ability of frontline supervisors to hold employees and themselves accountable has a positive influence on safety behaviour (H5)

Hypothesis 5 aimed to establish whether supervisory perceptions of accountability could be used to predict the safety behaviour of employees. A multiple linear regression analysis between safety behaviour (dependent variable) and supervisory accountability (independent variable) illustrated a positive, moderately strong relationship, with a correlation coefficient of 0.554 across 103 participants. An analysis of variance indicated a significant correlation between supervisory accountability and safety behaviour when keeping all other independent variables stable, with a relative 0.334 improvement in safety behaviour for every movement in supervisory accountability. This result suggests that supervisory accountability is the strongest predictor of an employee's safety behaviour, confirming that accountability has implications for all levels within an organisation or society (Hall, Frink & Buckley, 2017; Hochwarter, Ferris, Gavin, Perrewé, Hall & Frink, 2007, Frink & Klimoski, 1998). More recently, research has emphasised a positive correlation between performance, behaviour and accountability (Patterson, 2013; Mero, Guidice & Werner, 2012). These results support these findings, contributing to safety literature and research by specifying the behaviour as safety related.

Pearson & Sutherland (2017) identify the five primary antecedents of accountability as: systems, the culture of an organisation, clarity of role and tasks, strategic

leadership, and the individual. In this light, it is hypothesised that organisational culture factors offer insights into the degree to which frontline supervisors experience and exercise accountability for safety behaviour. Steinbauer, Renn, Taylor & Njoroge (2014) discuss how a leader's influence can be supported by various mechanisms to hold individuals to account for performance, while Ferrell & Ferrell (2011) emphasise how leaders create an organisational culture of accountability for performance.

The three independent variables of organisational practices, supervisory support and work attributes were considered as factors of supervisory accountability, and were analysed for variance. Neither organisational practices nor supervisory support were found to be statistically significant, nor correlated with supervisory accountability. Based on the adjusted r^2-value of the model, only 9.6% of the variance in supervisory accountability could be attributed to the work attributes of an organisational culture. Pearson & Sutherland (2017) support the notion of a relationship between accountability and responsibility, and that a large portion of accountability entails the individual having a clear sense of responsibility for a particular outcome. This construct complements the finding that only 10% of supervisory accountability is attributed to organisational culture, and more specifically the perception that work is meaningful, stimulating and recognised, and that accountability is more dependent on an individual's understanding and ownership of responsibility. This emphasis on the individual again brings to the fore the importance of a single frontline supervisor and her proximity to job performance and safety behaviour.

6.3.2 Aggregate employees perceptions of organisational practices are a significant predictor of supervisory accountability (H6)

Hypothesis 6 aimed to establish whether employee perceptions of organisational practices could be used to predict supervisory accountability. A multiple linear regression analysis between supervisory accountability (dependent variable) and work attributes (independent variable) illustrated no significant correlation between the variables. This finding is aligned with antecedents to the accountability model developed by Pearson & Sutherland (2017), which did not find the meaning of work to be a factor considered in understanding an employee's tendency to experience or exercise accountability. This finding adds to literature on accountability by suggesting that interventions based on improving an employee's perception of the attributes of

their work will in no way influence their tendency to be accountable for their performance, or more specifically, practise positive safety behaviours.

6.3.3 Aggregate employee perceptions of supervisory support are a significant predictor of supervisory accountability (H7)

Hypothesis 7 aimed to establish whether employee perceptions of supervisory support could be used to predict supervisory accountability. A multiple linear regression analysis between supervisory accountability (dependent variable) and supervisory support (independent variable) illustrated no significant correlation between the variables. Pearson & Sutherland (2017) find that clarity of role influences accountability. Although one would be inclined to consider the supervisor to be responsible for role clarity, for purposes of this research, role clarity was not included as a construct in supervisory support. This finding adds to literature on accountability by suggesting that interventions based on improving a supervisor's tendency to value, care for, respect and grow her team would not increase her tendency to exercise accountability, nor would it encourage a greater sense of perceived accountability.

6.3.4 Aggregate employee perceptions of work attributes that are meaningful and empowering are a significant predictor of supervisory accountability (H8)

Hypothesis 8 aimed to establish whether employee perceptions of work attributes could be used to predict the supervisory accountability within the organisation. A multiple linear regression analysis between work attributes (dependent variable) and supervisory accountability (independent variable) illustrated a positive, moderate relationship, with a correlation coefficient of 0.325 across 102 participants. This result indicates that work attributes can positively influence supervisory accountability, which will in turn has an impact on safety behaviour. An analysis of variance indicated a significant correlation between supervisory accountability and the work attributes of an organisational culture when keeping all other independent variables stable, with a relative 0.242 improvement in safety behaviour for every movement in accountability. This result also suggests that work attributes is the only predictor of supervisory accountability within the model for organisational culture considered.

6.4 Supervisory engagement

Safety motivation is defined as an employee's inclination to exert extra effort to behave in a safe manner, as well as the extent to which employees are enthusiastic about enacting safety behaviours (Neal & Griffin, 2006). The definition of safety motivation can be compared to the definition of employee engagement, and Conchie, Moon & Duncan (2013) expect to see an increase in safety leadership behaviours with an increase in supervisory engagement. Despite the continuing interest in supervisory safety behaviours, there has been relatively little research on factors that influence supervisors' engagement in their role of safety leadership. These results contribute to this field of research by describing the strength and direction of the relationship between supervisory engagement and safety behaviours, and by providing a quantification for influential relationships between organisational culture factors and supervisory engagement in order to improve safety behaviours.

6.4.1 Aggregate frontline supervisor perceptions of engagement are a significant predictor of safety behaviour (H9)

Hypothesis 9 aimed to establish whether supervisory engagement could be used to predict safety behaviour within an organisation. A multiple linear regression analysis between safety behaviour (dependent variable) and supervisory engagement (independent variable) illustrated a positive, moderate relationship, with a correlation coefficient of 0.347 across 102 participants. For the purposes of this research, examples of supervisory engagement included the vigour, dedication and motivation with which supervisors approached their work. This result indicates that higher levels of supervisory engagement positively influence safety behaviour within an organisation. However, an analysis of variance indicated no significant correlation between supervisory engagement and safety behaviour when keeping all other independent variables stable, with a relative 0.07 improvement in safety behaviour for every movement in supervisory engagement. This result suggests that supervisory engagement is an inadequate predictor of an organisation's safety behaviour, despite a positive correlation between the two variables. These outcomes contribute to literature on engagement, which has extensively drawn a connection between higher levels of engagement and improved job performance. Extrapolating this performance to safety behaviour, however, does not produce the same result, and interventions related to improving engagement do not positively influence safety behaviour.

The objective of the research was to investigate the relationship between factors of organisational culture and supervisory engagement. The three independent variables of organisational practices, supervisory support and work attributes were considered as factors of organisational culture, and were analysed for variance with supervisory engagement as the dependent variable. Based on the adjusted r^2-value, 37.2% of the variance in supervisory engagement can be attributed to organisational culture. Considering the range of other organisational culture factors not considered in this research, a 37.3% variance was considered significant, and thus a strong factor that organisational leadership should consider leveraging to create a more engaged supervisory workforce. Sahoo & Mishra (2012) identify career development, communication, empowerment, fair treatment and equal opportunities, cooperation, constructive performance feedback, salary and benefits, image, health and safety, and overall employee wellbeing as being key drivers of employee engagement. These constructs were all included in the model for organisational culture. It is therefore unsurprising that the results confirm Sahoo & Mishra's findings.

6.4.2 Aggregate frontline supervisor of organisational practices are a significant predictor of supervisory engagement (H10)

Hypothesis 10 aimed to establish whether perceptions of organisational practices could be used to predict the supervisory engagement levels within an organisation. A multiple linear regression analysis between supervisory engagement (dependent variable) and organisational practices (independent variable) illustrated a positive, moderate relationship, with a correlation coefficient of 0.473 across 102 participants. This result indicates that although organisational practices can positively influence supervisory engagement, they do not influence the safety behaviour of an organisation. An analysis of variance indicated no significant correlation between supervisory engagement and organisational practices when keeping all other independent variables stable, and thus organisational practices cannot be considered to accurately predict the level of supervisory engagement. This finding directly contradicts Schneider *et al*. (2017), who found that organisational practices were the strongest correlate for workforce engagement. Given that this research was conducted on only one organisation, it may not be that organisational practices are not significant predictors of supervisory engagement, but perhaps that these practices are to tangible enough for employees at the organisation in question,

leading to an insignificant influence on supervisory engagement (Schneider *et al*., 2017).

6.4.3 Aggregate frontline supervisor perceptions of supervisory support are a significant predictor of supervisory engagement (H11)

Hypothesis 11 aimed to establish whether perceptions of supervisory support could be used to predict the supervisory engagement levels within the organisation. A multiple linear regression analysis between supervisory engagement (dependent variable) and supervisory support (independent variable) illustrated a positive, moderately strong relationship, with a correlation coefficient of 0.552 across 102 participants. Although this result indicates that supervisory support can positively influence supervisory engagement, it does not influence safety behaviour in the organisation. An analysis of variance indicated a significant correlation between supervisory engagement and levels of supervisory support in an organisational culture when keeping all other independent variables stable, and thus can be seen to accurately predict the level of supervisory engagement. This finding is in agreement with Schneider *et al*. (2017), who found supervisory support to be strong correlate for workforce engagement.

6.4.4 Aggregate frontline supervisor perceptions of work attributes that are meaningful and empowering are a significant predictor of supervisory engagement (H12)

Hypothesis 12 aimed to establish whether perceptions of work attributes could be used to predict supervisory engagement levels within the organisation. A multiple linear regression analysis between work attributes (dependent variable) and supervisory support (independent variable) illustrated a positive, moderately strong relationship, with a correlation coefficient of 0.557 across 102 participants. Although this result indicates that work attributes can positively influence supervisory engagement, they do not influence safety behaviour in an organisation. An analysis of variance indicated a significant correlation between supervisory engagement and the levels of work attributes in an organisational culture when keeping all other independent variables stable, and thus can be seen to accurately predict the level of supervisory engagement, with a relative 0.298 improvement in supervisory engagement for every movement in work attributes. This result also suggests that

work attributes are the strongest predictor of supervisory engagement within the model for organisational culture considered.

6.5 Conclusion

The results indicate that the tendency of a supervisor to hold herself and her team accountable is positively correlated to good safety behaviour, and is the strongest predictor of safety behaviour when considering safety climate and supervisory engagement and supervisory accountability. Despite significant positive correlations existing between supervisory engagement, safety climate and safety behaviour, of the two independent variables, only safety climate was found to be a significant predictor of safety behaviour. These results indicate that to improve safety behaviour, mining leaders need to focus on capacitating and empowering supervisors to hold their teams accountable and be accountable themselves. This should be followed by initiatives to improve the safety climate.

Safety climate was found to be a significant contributor to safety behaviour. All three organisational culture factors – organisational practices, supervisory support and work attributes – were found to be strong predictors, indicating a significant influence between organisational culture and safety climate. To increase safety climate, and subsequent safety behaviour, leaders should focus on leveraging these characteristics to effect safety performance.

The only significant organisational culture factor predictor for supervisory accountability was found to be work attributes. Organisational practices and supervisory support were not found to contribute to supervisory accountability. The strongest organisational culture factor predictor of safety climate was supervisory support. It thus seems prudent for organisational leaders to focus their efforts on increasing supervisory support behaviours and the work attributes of supervisors. Such a focus is likely to result in the greatest indirect increase in safety behaviour and subsequent safety performance.

Although supervisory engagement was found to positively correlate with safety behaviour, it was not found to be a strong or significant predictor. Efforts to increase the engagement levels of supervisors would not go amiss, but the contribution of these efforts to safety behaviour and subsequent safety performance would not likely

be substantial in the short to medium term. Should initiatives be undertaken to increase supervisory engagement, the organisational culture factors that will produce the most significant contributions are, again, supervisory support and work attributes.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

The objectives of this study sought to contribute to the body of research on organisational culture, frontline supervisory engagement and accountability as levers for enhancing organisational performance and creating sustainable competitive advantage through resilient safety behaviour. The purpose of the research was to investigate the effect of organisational culture on safety behaviour, while examining the influencing effects of frontline supervisory engagement and accountability on safety behaviour. Although these subjects are comprehensively researched, they have not been specifically applied to frontline supervision and safety behaviour in the mining industry. This chapter discusses the factor model created as a measurement tool for safety behaviour within a platinum mining company. The implications of organisational culture on supervisory accountability and engagement as predictors of safety behaviour are explored with recommendations for business and managers responsible for managing safety at platinum mining operations. Some of the shortcomings of the study as well as suggestions for future work are discussed.

7.2 Key findings

The first objective of the research was to address the relationship between organisational factors, safety climate, supervisory engagement and accountability. Three independent variables of organisational practices, supervisory support and work attributes were considered as factors of organisational culture, and were analysed in a model for variance. The second objective of the study was to establish the nature of the relationship between safety climate, supervisory engagement, supervisory accountability and safety behaviour in an effort to understand the antecedents to a resilient safety environment and safety performance.

7.2.1 Safety climate

Although significant research has been completed in understanding job performance as a dimension of safety performance, far less research has been conducted on the impact of safety climate on individual safety behaviour. As a sound forecaster of safety climate, organisational culture should be a priority factor for leadership to consider leveraging in an attempt to create a positive and resilient safety climate. It

was established that the relative influence that organisational culture has on the safety climate is significant and strong. All three organisational culture factors analysed were found to be positively correlated with the safety climate, although only supervisory support and organisational practices were proved statistically significant predictors of the safety climate. The strongest organisational culture factor predictor of safety climate was supervisory support. It thus seems prudent for organisational leaders to focus their efforts on increasing supervisory support behaviours. Such a focus is likely to result in the greatest indirect increase in safety behaviour and subsequent safety performance. The result also indicates that organisational practices that positively enhance employee perceptions of their organisation can positively influence the safety climate of the organisation

7.2.2 Safety behaviour

A positive, moderately weak yet statistically significant relationship was found between safety climate and safety behaviour. The strength of this relationship was less robust than literature would have predicted due to the extrinsic factor of supervisory accountability that was found to be a far stronger determinant of change in safety behaviour. This complements research suggesting a positive and resilient relationship between a supervisor's behaviours and safety performance. These results further motivate the critical and direct influence that frontline supervisors have on the safety behaviour of individuals within their teams. Supervisory engagement was found to be positively correlated to safety behaviour, however, it was not a statistically significant predictor and thus not a robust factor in the determination of safety behaviour.

7.2.3 Supervisory accountability

Accountability for safety behaviour refers to how diligently frontline supervisors observe whether employees are working safely and whether they make individuals aware, and responsible for, the discrepancy between the current state and desired state. This accountability should encourage employees to become more aware of their noncompliant or unsafe behaviours, and motivate them to improve. Theory on the accountability of frontline supervisors and the consequences for safety performance in a mining environment has not been well understood and provided the work linking accountability and work performance, it was hypothesised that a

frontline supervisor's ability to hold team members and herself accountable is an important factor when motivating employee safety compliance.

A strong, positive and statistically significant relationship was found between supervisory accountability and safety behaviour. The only significant organisational culture factor predictor for supervisory accountability was found to be work attributes. Organisational practices and supervisory support were not found to contribute to supervisory accountability. It thus seems prudent for organisational leaders to focus their efforts on increasing the perceptions and understandings of the work attributes of supervisors. Such a focus is likely to result in the greatest indirect increase in safety behaviour and subsequent safety performance.

The result suggest that supervisory accountability is the strongest predictor of an employee's safety behaviour, confirming that accountability has implications for all levels within an organisation or society.

7.2.4 Supervisory engagement

Despite the continuing interest in supervisory safety behaviours, there has been relatively little research on factors that influence supervisors' engagement in their role of safety leadership and this study aimed to address this gap. Although supervisory engagement was found to positively correlate with safety behaviour, it was not found to be a strong or significant predictor. An analysis of variance indicated no significant correlation between supervisory engagement and safety behaviour. This result suggests that supervisory engagement is an inadequate predictor of an organisation's safety behaviour, despite a positive correlation between the two variables. These outcomes contribute to literature on engagement, which has extensively drawn a connection between higher levels of engagement and improved job performance. Extrapolating this performance to safety behaviour, however, does not produce the same result, and interventions related to improving engagement do not positively influence safety behaviour.

Efforts to increase the engagement levels of supervisors would not go amiss, but the contribution of these efforts to safety behaviour and subsequent safety performance would not likely be substantial in the short to medium term. Should initiatives be undertaken to increase supervisory engagement, the organisational culture factors

that will produce the most significant contributions were found to be supervisory support and work attributes.

7.3 Implications for business

The study indicates opportunities for platinum mine leadership, and in particular, those responsible for employee health and safety at mines to tie together supervisory behaviour and organisational culture tools to address safety behaviour and performance. By creating a robust safety climate, mine leadership may not be addressing the inherent safety hazards associated with mining, but rather, they would be focussing on the human behaviour, attitudes and reactions to the work environment.

The hypotheses results indicate that the some of the traditional understanding of supervisory engagement and its positive effect on organisational performance may not be accurately extrapolated to influencing safety behaviour. However, increasing supervisory accountability and safety climate by leveraging organisational culture is becoming more and more apparent in the quest to develop anti fragile and robust safety behavioural patterns amongst frontline employees in the platinum mining environment. While it is important for front line supervisors and managers to acknowledge the important role they play in enforcing accountability within their teams, it is also imperative for them to recognise other organisational influences – such as supervisory support, work attributes and organisational practices – that affect safety behaviour.

While the factor based model derived was somewhat complex, the strong relationships between organisational culture and safety climate and behaviour, as well as supervisory accountability and safety behaviour create a number of opportunities for managers and business to analyse.

The research specifically identified the strong and positive relationship between supervisory accountability and safety behaviour while identifying work attributes as the strongest organisational culture factor in trying to influence supervisory accountability. Managers should thus ensure that frontline supervisors are equipped and comfortable enacting on an accountability framework and that all employees experience this accountability consistently:

- Supervisors should take the time to understand the organisational culture of the work place to promote the development of positive safety behaviour amongst their teams. This includes building social capital with their teams that can be interpreted as supervisory support, in promotion of the organisational vision, purpose and values of the firm;
- When administering a formal accountability framework, supervisors should use a combination of positive reinforcement and support systems that contribute to a better understanding of the work attributes and how these influence organisational effectiveness. Consideration should be given to recognising positive safety behaviour through leading indicators as much as identifying detrimental safety behaviours, and accountability in the form of rewards and recognition, incentives and remuneration can be used to create effective work management systems;
- Of critical importance is the promotion and hiring of frontline supervision. Managers should ensure that the correct type of employee is promoted or hired into frontline supervisory positions. These employees should have a strong personal tendency to hold themselves and others accountable for poor safety performance and non-delivery, and their personal values and ethical conduct should be strongly aligned with the organisational culture. Developing a custom-made recruitment and selection process to ensure compliance with the culture will be helpful, as well as intentional training and development programmes which capacitate and support frontline supervisors to execute on the accountability framework of the organisation.
- Frontline supervisors should put the required effort into ensuring that the role or task attributed to an employee is well articulated and understood through the use of simple and clear communication, instructions, performance measurement and consequence management. By eliminating ambiguity and by ensuring employees are adequately versed on the attributes of their task, individuals cannot claim that they did not know or understand and thus cannot be held accountable.

It is well known that people who find purpose and meaning in their work are more engaged, happier and more productive. These employees are more likely to accept challenging or unpopular jobs, to work harder and collaborate more effectively. Results from this research indicate that by attributing meaning to work and tasks at

hand result in higher levels of perceived and work accountability, which in turn predicts improved safety behaviour. It is thus prudent for managers and supervisors alike to create an environment in which frontline employees are able to find true meaning in the daily tasks:

- By initiating connection between frontline employees and their customers – which in the mining environment can be the market, downstream process operations or suppliers and distributors – employees are given an opportunity to learn who is impacted by their work and how the daily decision affect others;
- Rewarding and recognising good work assists in creating further meaning for employees as they get the sense that their work is noticed and valued. Given the cost driver strategy of mining companies, these organisations will need to come up with innovative ways of noticing and rewarding good work without relying on monetary bonuses and salary increases;
- Managers and supervisors should attempt to tie the work of their employees to a higher purpose or a larger goal than themselves. Business can do this by regularly communicating the organisations vision or purpose. Of importance is that these messages are not imposed onto employees, since such communication is not taken to heart. Employees should be encouraged to make a personal connection with the work they do and their organisations vision. A practical suggestion would be to encourage employees to think about their work as a series of “whys” for their most important tasks at work. Research has indicated that the practicing of consecutive “whys” will motivate employees to focus on why they are doing something and not on what they are doing, building persistence and better performance.

The study also highlights the critical importance of an effective and well functionary frontline supervisory workforce. Effective supervisors apply themselves not only physically, but cognitively and emotionally too, and given their proximity to the workforce, inadequate engagement or ineffective supervisory behaviours will inhibit how successfully an organisations strategy is operationalised:

- The hierarchical nature of mining organisations within South Africa allows for safety interventions at the supervisory level, just above the level where most workplace injuries occur. Thus, if the organisational culture can be put into context at this level by introducing better integrated training and supervisory

behaviour modification programmes, it is expected that the benefits will be greater than worker targeted behaviour modification programmes;

- An important aspect of effective supervision is the ability to juggle multiple and completing priorities. Interventions which focus on providing regular feedback on performance, specifically safety behaviour and safety related decision making, will allow for supervisors to change their safety supervisory practices and improve perceptions on safety climate and behaviour
- For business leadership, it will be important that adequate investment is made in training and development of supervision. Organisational practices such as performance management, regular feedback and communication, fair and transparent succession planning, reward and recognition programmes were found to be strongly correlated with an improved supervisory safety climate and thus, targeted interventions which capacitate supervisors with this knowledge and ability will allow for positive safety behavioural changes
- Work attributes, or characteristics, such as compensation and the nature of the work itself was found to strongly influence the tendency of the supervisor to exhibit accountable behaviour or management styles. Mining working conditions are far from ideal and involve difficult, harsh and uncomfortable conditions that can negatively affect the perception of work attributes associated with mining supervision. Business leadership will need to develop intentional strategies to combat these negative mediating effects on perceptions of work characteristics if supervisory accountability is to be prioritised and utilised as a means to improving safety behaviours.

7.4 Limitations of the research

The research was limited to a single organisation within the platinum mining industry and thus, the findings may not be applicable to other organisations or indeed the rest of the industry. Further, as previously discussed, a second limitation of the research methodology was the sample size. Despite the total population being small, a sample size of just more than 100 is lower than ideal for completing confirmatory analysis and drawing statistical conclusions. Furthermore, the population consisted of individuals whose home language may not be English, and whose level of education might be limited. These factors might limit the findings of the research due to interpretation of certain constructs.

The study was conducted as a static, cross-sectional survey, and as such, the results are limited to a static, one point in time view. This implies that responses to the constructs may be dependent on the mood of the participant. A supervisor who had just be held accountable by her manager may see the organisational culture more negatively than if she had experienced a more positive interaction.

The research methodology employed was quantitative in nature and this in itself is limited. The use of Likert scale responses limits the amount of detail included, and as a result, it is improbable that sufficient data will be collected to offer explanatory answers to the associations identified. Furthermore, the survey was long and it was noted that respondents were fatigued by the end of it, possible resulting in a rush to finish.

7.5 Suggestions for future research

There is little to no empirical evidence on the influence of supervisory accountability and engagement on safety behaviour in the mining industry and the following recommendations would add significant value to the current body of knowledge:

- Research into what managers versus supervisors versus employees perceive to be drivers of safety behaviour would be useful and of importance;
- The impact of informal accountability practices versus formal accountability practices and how these different approaches impact safety behaviour. Furthermore, it will be useful and important to understand the impact of informal accountability practices on the legal accountability requirements of the Mine Health and Safety Act
- An understanding on the type of systems implemented in an organisation and how these impact safety climate and supervisory engagement and accountability;
- Understanding how cultural background affects ones tendency to be held and to hold accountable and how these various approaches impact safety behaviour;
- An evaluation into how different accountability frameworks, implemented across various organisations, impact safety behaviour and safety performance would provide value insights and could affirm the findings of this study.

7.6 Conclusion

Literature confirms that supervision in the mining industry is critical to managing safety behaviour and performance. Further, literature affirms the importance of supervisory behaviours such as accountability and engagement in organisational performance. Despite this, very little evidence on how these supervisory behaviours impact safety performance within the mining industry exists, and further, how organisational culture factors influence these supervisory tendencies. This research attempted to close this gap in literature and the framework which emerged provided a clear understanding on which aspects of supervisory behaviour had the biggest impact on safety behaviour, and further, which organisational factors could be used to most effectively modify supervisory behaviour in order to improve safety performance.

This research contributes to literature by providing empirical evidence and key insights into the complexity of safety behaviour in the mining industry. Furthermore, it is suggested the research contributes to the practice of business leadership and management in providing a framework which can be utilised by consultants, managers and supervisors looking to prioritise factors by level of impact in an effort to drive improved safety behaviours and organisational performance.

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APPENDIX A

Table A1: Questionnaire employed to measure safety behaviour

Safety Behaviour	
	Safety climate
B1	Management places a strong emphasis on workplace health and safety
B2	Safety is given a high priority by management
B3	Management considers safety to be important
B4	I feel comfortable stopping production to ensure compliance to safety standards
B5	I report incidents and near misses so that they can be investigated
B6	I am satisfied that the systems in place at my company are good enough to eliminate all injuries
	Safety motivation
B7	I feel that it is worthwhile to put in effort to maintain or improve my personal safety
B8	I feel that it is important to maintain safety at all times
B9	I believe that it is important to reduce the risk of accidents and incidents in the workplace
B10	I feel comfortable putting safety ahead of production
	Safety compliance
B11	I use all the necessary safety equipment to do my job
B12	I use the correct safety procedures for carrying out my job
B13	I ensure the highest levels of safety when I carry out my job
B14	I stop production areas to correct sub-standard safety measures
B15	I spend most of my time supervising work to ensure safety compliance
B16	I ensure my team adhere to safety procedures by doing regular over inspections and PTO's
	Safety participation
B17	I promote the safety program within the organization
B18	I put in extra effort to improve the safety of the workplace
B19	I voluntarily carry out tasks or activities that help to improve workplace safety
B20	I confront and take corrective actions for unsafe behaviours when I see them
B21	I always take time to look for identify risks in a work area before starting any job

Table A2: Questionnaire used to measure levels of supervisory engagement

Supervisory Engagement	
	Vigour
D1	At my work, I feel bursting with energy
D2	At my job, I feel strong and vigorous
D3	When I get up in the morning, I feel like going to work
D4	I can continue working for very long periods at a time
D5	At my job, I am very resilient, mentally
D6	At my work I always persevere, even when things do not go well
	Dedication
D7	I find the work that I do full of meaning and purpose
D8	I am enthusiastic about my job
D9	My job inspires me
D10	I am proud on the work that I do
D11	To me, my job is challenging

	Absorption
D12	Time flies when I'm working
D13	When I am working, I forget everything else around me
D14	I feel happy when I am working intensely
D15	I am immersed in my work
D16	I get carried away when I'm working
D17	It is difficult to detach myself from my job

Table A3: Questionnaire use to measure organisational culture

Organisational Culture	
	Organizational Practices
C1	Senior leadership provides a clear direction for my company
C2	Senior leadership effectively communicates what the company is trying to accomplish
C3	I understand my company's goals and objectives
C4	My company is making the changes necessary to compete effectively
C5	Being supportive (ie: An attitude of service is common throughout my company)
C6	My company is always moving toward improved ways of doing things
C7	Sufficient effort is made to get the opinions and thinking of people who work here
C8	There is a clear link between performance and compensation at my company
C9	The procedures for considering employees for job openings are fair
C10	If I sustain a high level of performance, I will get ahead in my company
C11	When I do an excellent job, my accomplishments are recognized
C12	I receive ongoing feedback that helps me improve my performance
C13	My company provides flexible solutions for managing work and personal life
	Supervisory Support
C14	My immediate supervisor treats me with respect
C15	My immediate supervisor treats everyone in my work group fairly
C16	My immediate supervisor shows that he/she truly cares about the people in my work group
C17	I feel free to go to my immediate supervisor when I have a question or problem
C18	My immediate supervisor encourages an environment where individual differences are valued
C19	My immediate supervisor communicates useful information to employees
C20	My immediate supervisor takes an active interest in my growth and development
	Work Attributes
C21	My job makes good use of my skills and abilities
C22	My work gives me a feeling of personal accomplishment
C23	I have the authority to make decisions that improve the quality of my work
C24	I am empowered to make decisions that enable me to do my job effectively
C25	I have the flexibility to decide the best way to accomplish my goals
C26	The amount of stress I experience on my job is acceptable
C27	There is clear and transparent communication across all levels in my organisation
C28	I am satisfied with the feedback I receive when I raise concerns to my organisations leadership

Table A433: Questionnaire used to measure supervisory accountability

Accountability	
	Work Accountability

E1	Asked subordinates to explain their task activities
E2	Questioned subordinates about their performance on work tasks
E3	Discussed with subordinates the processes used to complete tasks
E4	Reviewed subordinates performance on specific tasks with them
E5	Asked subordinates to explain their approach to work tasks
E6	Questioned subordinates about their progress on a task activity
E7	Others in my organization can observe the outcome of my work performance in terms of achieving section goals
E8	In my organization achieving unit goals is directly attributed to an individual's personal actions
	Perceived Accountability
E9	I am required to justify or explain my performance in terms of achieving unit goals
E10	I am required to justify or explain my performance in terms of helping and cooperating with colleagues
E11	I am held accountable for the work that I am assigned
E12	I take full responsibility for the completion and success of tasks that I am involved at work

Table A5: Summary of descriptives for each measurement scale (factors described as per tables A1 - A4)

	Valid	**Missing**	**Mean**	**Median**	**Mode**	**Std. Deviation**	**Minimum**	**Maximum**
B1	104	0	4,52	5,00	5	0,668	3	5
B2	104	0	4,51	5,00	5	0,710	3	5
B3	103	1	4,56	5,00	5	0,737	2	5
B4	103	1	4,26	5,00	5	0,960	1	5
B5	104	0	4,52	5,00	5	0,737	2	5
B6	104	0	4,20	4,00	4	0,755	1	5
B7	103	1	4,76	5,00	5	0,533	3	5
B8	104	0	4,86	5,00	5	0,404	3	5
B9	104	0	4,88	5,00	5	0,402	2	5
B10	104	0	4,49	5,00	5	0,724	1	5
B11	103	1	4,70	5,00	5	0,591	3	5
B12	104	0	4,63	5,00	5	0,592	3	5
B13	104	0	4,71	5,00	5	0,515	3	5
B14	104	0	4,36	5,00	5	0,891	1	5
B15	102	2	4,14	4,00	5	0,965	1	5
B16	99	5	4,33	5,00	5	0,795	2	5
B17	104	0	4,44	5,00	5	0,822	1	5
B18	103	1	4,49	5,00	5	0,739	2	5
B19	101	3	4,18	4,00	5	0,984	1	5
B20	104	0	4,52	5,00	5	0,668	3	5
B21	104	0	4,62	5,00	5	0,687	2	5
C1	103	1	4,20	4,00	4[a]	0,784	2	5
C2	103	1	4,17	4,00	4	0,793	2	5
C3	100	4	4,52	5,00	5	0,731	2	5

C4	100	4	4,29	4,00	5	0,756	2	5
C5	99	5	3,88	4,00	4	0,799	2	5
C6	103	1	4,25	4,00	5	0,825	2	5
C7	102	2	3,50	4,00	4	1,141	1	5
C8	103	1	3,56	4,00	4	1,143	1	5
C9	102	2	3,37	3,00	3	1,258	1	5
C10	103	1	3,67	4,00	3	1,097	1	5
C11	101	3	3,15	3,00	3	1,090	1	5
C12	100	4	3,32	3,00	3	1,014	1	5
C13	101	3	3,36	3,00	3	1,035	1	5
C14	103	1	3,86	4,00	5	1,058	1	5
C15	102	2	3,70	4,00	5	1,225	1	5
C16	102	2	3,72	4,00	4	1,164	1	5
C17	102	2	3,78	4,00	5	1,131	1	5
C18	102	2	3,71	4,00	4	1,157	1	5
C19	103	1	3,83	4,00	4	1,014	2	5
C20	102	2	3,23	3,00	3	1,289	1	5
C21	103	1	3,86	4,00	4	0,991	1	5
C22	102	2	3,67	4,00	3	1,084	1	5
C23	102	2	4,00	4,00	4	0,901	1	5
C24	103	1	3,85	4,00	4	0,944	1	5
C25	103	1	3,88	4,00	4	0,963	1	5
C26	103	1	3,28	3,00	4	1,133	1	5
C27	103	1	3,41	4,00	4	1,052	1	5
C28	103	1	3,27	3,00	3	1,031	1	5
D1	102	2	3,52	3,00	3	0,853	2	5
D2	101	3	3,72	4,00	3	0,896	1	5
D3	102	2	3,56	3,00	3	1,001	1	5
D4	102	2	3,65	4,00	4	1,050	1	5
D5	101	3	3,94	4,00	4	0,785	2	5
D6	102	2	4,08	4,00	4	0,817	1	5
D7	102	2	3,92	4,00	4	0,951	1	5
D8	102	2	3,99	4,00	5	0,884	2	5
D9	102	2	3,80	4,00	5	1,025	1	5
D10	101	3	4,28	5,00	5	0,918	1	5
D11	102	2	3,77	4,00	3ª	1,062	1	5
D12	101	3	4,02	4,00	5	0,990	1	5
D13	102	2	3,44	4,00	4	1,157	1	5
D14	102	2	3,64	4,00	4	1,088	1	5

D15	99	5	3,63	4,00	3	0,876	1	5
D16	102	2	3,28	3,00	3	0,979	1	5
D17	103	1	3,38	3,00	3	1,086	1	5
E1	103	1	3,77	4,00	4	0,843	1	5
E2	102	2	3,84	4,00	4	0,952	1	5
E3	103	1	4,03	4,00	4	0,845	1	5
E4	103	1	3,98	4,00	4	0,907	1	5
E5	103	1	3,74	4,00	4	0,939	1	5
E6	103	1	4,01	4,00	4	0,913	1	5
E7	103	1	4,01	4,00	4	0,880	1	5
E8	102	2	3,68	4,00	4	0,997	1	5
E9	103	1	3,86	4,00	4	0,940	1	5
E10	103	1	3,66	4,00	4	1,116	1	5
E11	103	1	4,29	5,00	5	0,925	1	5
E12	102	2	4,38	5,00	5	0,923	1	5