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The impact of organisational culture on safety management in a South African thermal coal mining operation

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ABSTRACT

Organisational culture has increasingly come to the fore as an important aspect of safety management. Very little literature, if any, could be found on the application of the concept within the mining industry. The state of safety in South Africa's mining industry has been placed under the spotlight after a number of fatalities caused an outcry amongst mineworkers. The research was initiated to gain a better understanding of the impact of organisational culture factors on safety management in a South African thermal coal mining operation, with the view of finding ways to improve mining safety.

The research sought to develop a model from the literature to evaluate the safety culture of a coal mining operation. Further analysis compared the perceptions of various groups within the sample, which included contractors, managers and workers. The relationship between some of the factors were also explored to gain a better understanding of the dynamics of organisational factors that influence safety management.

The research yielded a useful model for evaluating the safety culture of a coal mining operation, and highlighted strong relationships between shared safety values, management involvement and the safety culture of the organisation. The research also showed that there was no significant difference in the culture perceptions of contractors and mine employees. Significant differences were however found between managers' perceptions of the safety culture and the perceptions of workers.

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DECLARATION

I declare that this research project is my own work. It is submitted in partial fullfillment 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.

_____ _____

Howard Pyoos **Date**

ACKNOWLEDGEMENTS

The research experience has been extremely insightful and enriching and has allowed me to journey a path of self discovery. I would however not have been able to achieve this if it had not been for the sacrifices that my family had to make while I pursued this dream. To my best friend and the love of my life, Jackie, thank you for being my pillar and source of encouragement when giving up seemed like the easiest thing to do. Thank you for allowing me to pursue this for the last two years instead of you. I love and appreciate you. To my boys, Quade and Trenton, thank you for being my best achievement and making me a proud dad.

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Finally, to my Lord and Saviour Jesus Christ, for reassuring me that I can do all things through Him who strengthens me, and that He knows the plans and purposes for my life. Thank You.

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CHAPTER 1: INTRODUCTION TO THE RESEARCH PROBLEM

1.1 Introduction

Safety management has historically been very reactive in the South African mining industry, with measures of improvement only happening after root causes of major incidents have been established. The trend in the last six years has been towards a more preventative approach, with the introduction of baseline risk assessments, formalised task observations, on job training, and behavioural based safety programmes. In order to become more competitive, companies have undergone major changes in organisational structure, with smaller numbers of permanent workers and larger numbers of contractor workers (Clarke, 2003). This brings with it challenges of diverse organisational cultures and managing them under one safety system.

While much work has been done in industries such as nuclear (Harvey, Bolam, Gregory & Erdos, 2001), air transport (Gibbons, von Thaden & Wiegmann, 2006), marine (Mitroussi, 2003), construction (Tam & Fung, 1998), and automobile (Clarke, 2006), very little research, if any, can be found on the role of organisational culture in managing safety within the mining industry. It is the researcher's experience that in the mining industry there is sense that culture plays a role in the management of safety. The aspects or impact of cultural influences are however not fully understood or quantified. This is evidenced by comments from colleagues when trying to explain the causes of accidents. Statements such as, "It's in the people's culture to take shortcuts", or "That team has always had a culture of working safely", are fairly common.

Schein (2004, p. 223) states that one of the unique functions of leadership is its concern for culture. Leaders play a significant role in culture building, embedding and evolving. Mining Resources Consulting (2008) report that the mining industry is facing a shortage of qualified talent, with forecasts of a 13% decrease in the number of persons employed within the industry between 2004 and 2014. The recent boom in commodity prices has made many large-scale expansion projects viable, and this has resulted in a high turnover rate across different levels in the industry. In the context of organisational culture, the recent transitory nature of management and leadership has the likelihood of posing a unique challenge to safety management.

There is substantive evidence to suggest that safe work behaviour is supported by a positive safety culture (Clarke, 2000 in Clarke, 2003). Part of organisational culture in industries with hazardous installations relates to safety (Parker, Lawrie & Hudson, 2006). Clarke (1999) in Parker *et al.* (2006) states that the beliefs and values related to health and safety form the subset of organisational culture referred to as safety culture.

Parker *et al.* (2006) state that it has been suggested that culture reaches equally into all parts of the organisational system and exerts a consistent effect (for good or ill) on the organisation. For this reason the improvement of the culture is more effective than increased supervision or more rigorous procedures in enhancing safety performance (Reason, 1998 in Parker *et al.*, 2006).

1.2 Relevance to South African Business

The South African mining industry boasts an abundance of mineral resources, and owns and produces a significant portion of the world's minerals (SAinfo, 2008). South Africa's wealth has been built on its vast mineral resources. The country holds leading positions in the production of numerous mineral resources, including gold, platinum, coal and chrome. Significant positions are also held in the mineral resource fields of diamonds and other base metals. Figure 1 indicates the mineral sectors in which South Africa has leading production positions. A comparison is shown of the percentage of the world's production mined in South Africa, versus the percentage of the estimated world reserves found in South Africa.

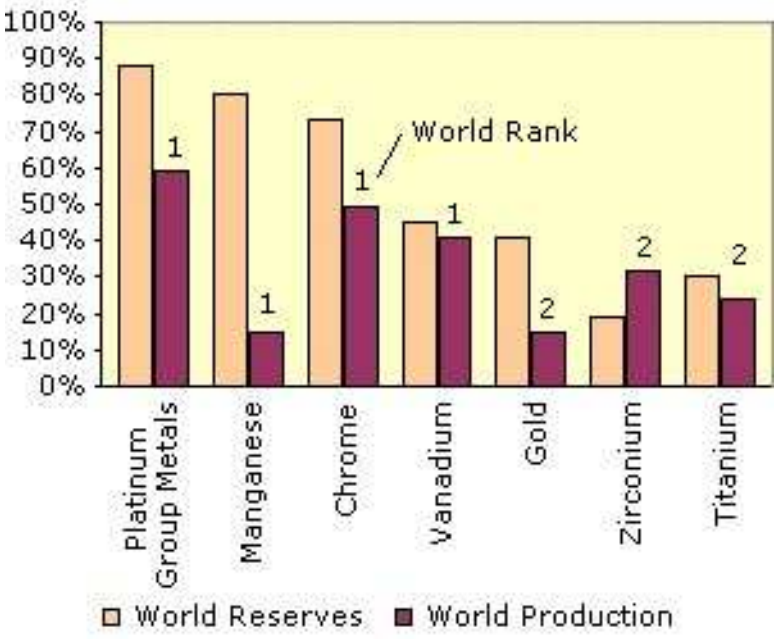

Fig 1: SA production and reserves in global context (SAinfo, 2008)

The South African mining industry has dealt with a record number of deaths that reached 199 in 2006, and 202 in 2005 (Bonelli, 2007). By early December in 2007, this number had already exceeded 200 (Bonelli, 2007). The final number of fatalities reported for 2007 by the South African Department of Minerals and Energy (DME) was 220 (Mine Health & Safety Inspectorate, 2008). These fatalities have prompted miners to down tools on 04 December 2007 and demand that more measures are taken to ensure better mine safety (Bonelli, 2007). The concerns have led to the first ever presidential request for an audit of the safety of South African mining operations. Figure 2 shows the fatalities per million hours worked in all mines in South Africa since 1999 to 2005. The graph shows how the safety performance has improved with time.

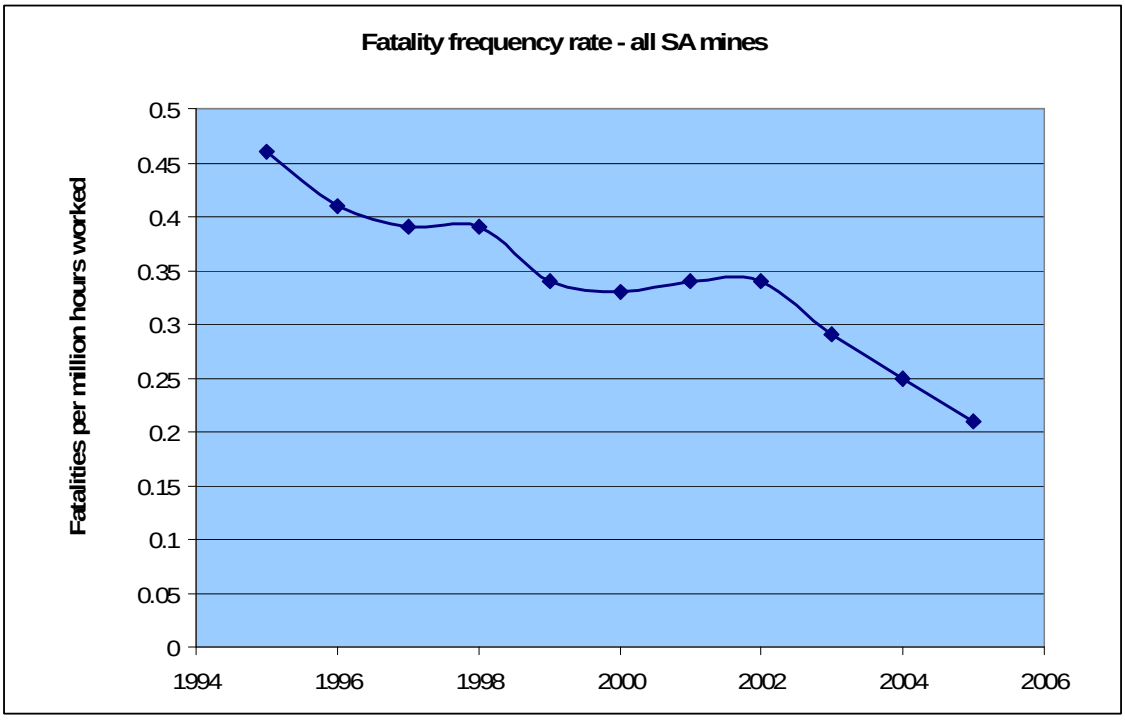

Fig 2: Fatality frequency rate (Randera, 2007)

While these numbers are a drastic improvement from the figures of 309

fatalities in 1999, and 285 in 2000 (Hall, Sage & Dodd, 2005), they are still unacceptably high. This is more so when the industry is benchmarked against mining operations in Canada, USA and Australia. Sietse van der Woude, an expert on mining safety at the South African Chamber of Mines, is quoted by Macharia (2008) as saying that South Africa is at least 50% worse than countries such as Australia and Canada when it comes to mine safety.

Extended shutdowns of mines due to safety issues, as has been witnessed in the media in the earlier half of 2008, has the potential to pose a huge threat to the South African economy (Ryan, 2008). The South African mining industry is responsible for approximately 7% of GDP, and approximately R215 billion in foreign earnings per year (Ryan, 2008). The industry also creates about 1 million jobs, of which about 450 000 are directly involved in mining, and the balance in related services.

The majority of listed mining resource companies report on safety as part of their sustainable development measures on the triple bottom line. Good safety performance is therefore critical for these companies in terms of sustainability and attraction of future investment. Many of the companies also portray a zero harm approach as one of their espoused values.

The traditional approach to managing hazardous environments relies on a hierarchy of controls. This hierarchy consists of two levels, both of which consider only hard issues such elimination of the hazard on the first level, and engineering controls, substitution, administration and protective equipment on

the second level. Given the amount of work that has been done in other highly regulated and hazardous industries on understanding the impact of the organisational culture on safety management, it would be appropriate to explore and understand how culture impacts on safety in a coal mining operation. The insights gained from such a study could prove valuable in improving the safety performance of South African mining operations.

1.3 Research Aim

The purpose of the research is to come to a better understanding of the impact that organisational culture has on the management of safety within the context of a South African thermal coal mining operation. The study aims to develop a suitable model to measure the safety culture of a coal mining operation, and use this model to analyse the organisational factors that influence safety.

The study also explores how the safety values of the organisation in terms of non-compromise on safety manifest itself within the organisation culture. Each mining company has certain safety targets that need to be reached, and these are often captured in an espoused value set e.g. “We will be a zero fatality business”. The actual value set is captured in the underlying beliefs that members of the organisation have about safety. This part of the study explores whether the shared safety values are reflected in the organisational culture, and whether such a set of values has the potential to positively influence the establishment of a safer workplace.

The next area to be explored ties in with first by exploring whether the factors that influence the organisational safety culture are consistent across all hierarchical levels within the organisation. There is evidence to suggest that shop floor workers generally have a less positive perception of the safety culture than what managers and supervisors have within an automobile manufacturing environment (Clarke, 2006). This can hold negative implications for the safety performance of an organisation. The assertion of unequal perceptions of the safety culture will be tested for a coal mining environment.

The research will also explore the impact of the inclusion of a diverse workforce in the form of short, medium and long term contractors on the organisational safety culture. Finally, the research will look at the role of management and leadership in the organisational culture, and how this influences the management of safety.

CHAPTER 2: THEORY AND LITERATURE REVIEW

2.1 Introduction

This section will deal with the theory and literature relevant to organisational culture and how it influences safety management. The origins of safety culture as a subset of organisational culture will be explored, together with the role of competitiveness in safety, factors that influence the safety culture and finally, the role of management and leadership in safety management.

2.2 Organisational Culture

Schein (1984) defines organisational culture as the pattern of basic assumptions that a given group has invented, discovered, or developed in learning to cope with its problems of external adaptation and internal integration, and that have worked well enough to be considered valid, and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems.

Schein (2004, p. 3) states that even though culture is an abstraction, the forces that are created in social and organisational situations as a result of culture can be very powerful. He further argues that failure to understand culture will result in one falling victim to it. This view is of particular relevance to this study, since a failure to understand the impact that culture may have on safety management could result in a missed opportunity for improving safety performance of mines.

Martin (2004) in Cummings & Worley (2005, p. 483) argues that culture can be viewed from an integrated, a differentiated or a fragmented view. The integrated view focuses on culture as a stable and an organisationally shared phenomenon. The differentiated view argues that the culture consists of subcultures that exist throughout the organisation. The fragmented view holds that culture is always changing and is dominated by ambiguity and paradox. For the purpose of summarising an organisation's culture, the fragmented view is somewhat meaningless.

Cummings & Worley (2005, p. 483) state that organisational culture includes four major elements existing at different levels of awareness. Figure 3 illustrates these elements and how they are observed from the outside. The highest level of cultural manifestation lies within the artefacts. These are visible symbols of the deeper levels of culture, and include observable behaviours of members such as dress codes, language, structures, systems etc.

The deeper elements include the norms which are the unwritten rules that guide the behaviour of members, the values that tell members what is important to the organisation and should deserve their attention and, finally, at the deepest level, the basic assumptions about how organisational problems are solved (Cummings & Worley, 2005, p. 484). The latter elements are not as obviously noticeable as the artefacts, and require some analysis and exploration to uncover.

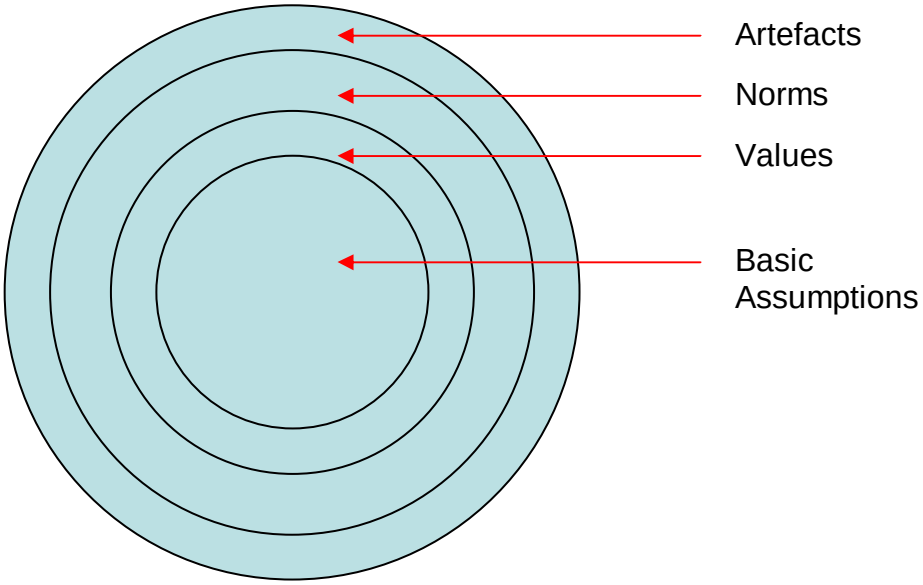

Fig 3: Levels of corporate culture (Cummings & Worley, 2005, p. 483)

Robbins and Judge (2007, p. 573) state that organisational culture refers to a system of shared meaning held by members that distinguishes the organisation from other organisations. They further posit that there are seven primary characteristics that capture the essence of an organisation's culture. These can be summarised as the level of risk taking and innovation, attention to detail, outcome orientation, people orientation, team orientation, aggressiveness and stability.

2.3 Organisational Culture and Safety

Of particular interest to the topic of safety from Robbins' and Judge's (2007, p. 573) work, are the issues of risk taking, outcome orientation and stability. Within the domain of safety management, the level of risk taking is generally a good indicator of the safety culture. Outcome orientation is largely focused on production, although a message of "safety first" is always advocated. The issue

of stability within the context of skills shortage, a larger component of contractor workers, and the transitory nature of skilled talent, would also play a key role in influencing organisational safety culture.

Within a highly regulated environment such as the mining industry in South Africa, certain norms that are convenient but not necessarily the safest or in compliance with legislation or procedures, may be taught and accepted. This develops into the accepted culture within the organisation. An example of this is when electricians bridge out safety devices to keep production going. The behaviour is rewarded since the machine is made operational much faster, ensuring continued production. High levels of production are rewarded through various production target incentives. The action however leaves the machine with a dangerous electrical fault that could have fatal consequences, but because of the perceived reward, the action becomes part of the culture. This relates to Robbins' and Judge's (2007) view of outcome orientation.

Dilley and Kleiner (1996) posit that employee accidents are largely related to behaviour issues. These issues arise from the culture and environment and can be prevented. If the cultural and environmental issues can be quantified and understood, the expectation is then that the necessary adjustments can be made to reduce employee accidents.

Over the last 30 years, the safety paradigm has progressed from purely technical aspects to human error, safety management and safety culture issues (Mengoli & Debarberis, 2008). Figure 4 shows how this development has

occurred over the last four decades.

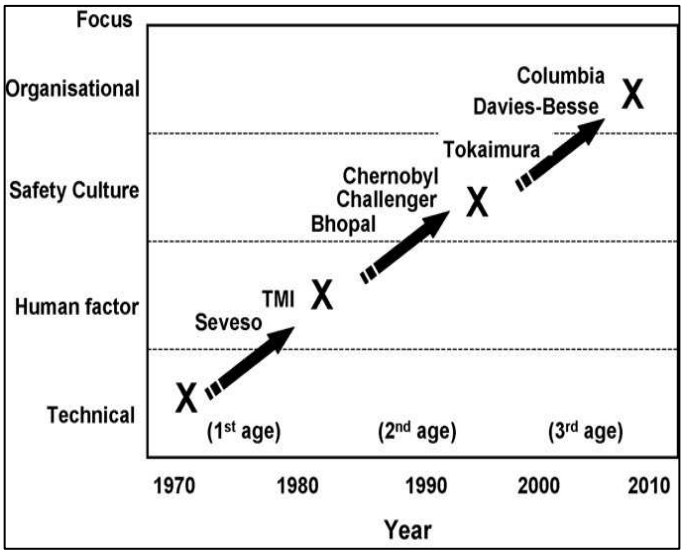

Fig 4: Chronological development of safety concepts (Mengoli & Debarberis, 2008)

The increasing role of organisational factors as indicators of safety has increasingly been acknowledged as a third age of safety (Mengoli & Debarberis, 2008). Figure 5 demonstrates how the focus has shifted from only considering structural components and installations to the consideration of the organisation as a whole.

In practice, the first age or technical focus age can be equated to the concept of trying to engineer out all possible hazards in the design and construction of the hazardous operation. The second age, which focuses on human factors, has to do with the development of procedures and regulations to ensure safety governance. Deviations from these rules are then ascribed to human error (Mengoli & Debarberis, 2008).

It is the researcher's experience that many investigations into safety incidents still have a strong focus on human factors. While the elimination of human error remains important in ensuring safe operations, organisational aspects can provide significant indications of the safety awareness of the organisation Mengoli & Debarberis (2008).

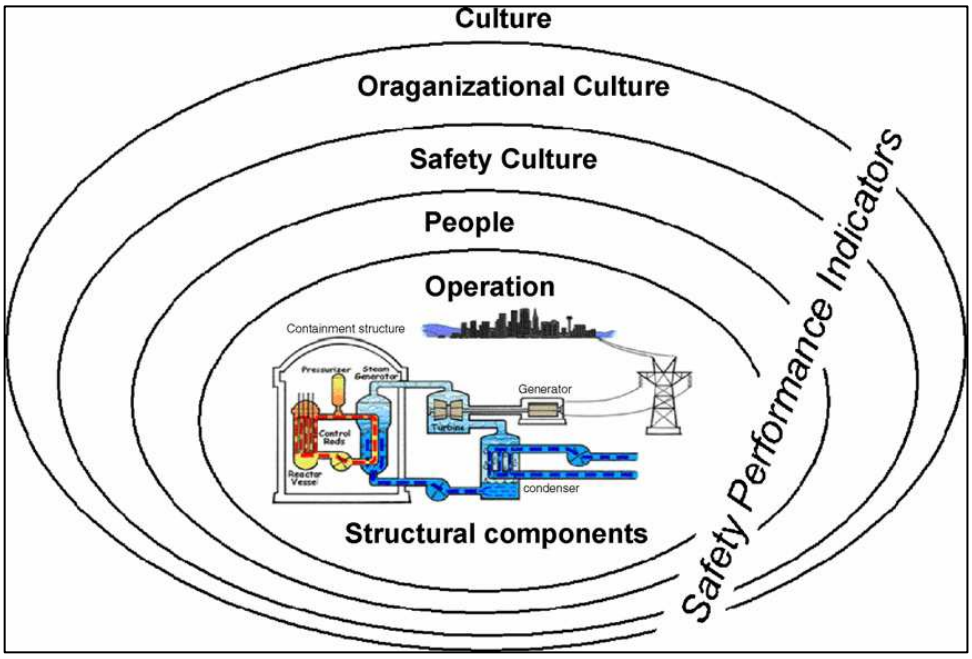

Fig 5: Contributors to the safety of hazardous installations (Mengoli & Debarberis, 2008)

2.4 What is Safety Culture?

Hopkins (2006) states that in trying to avoid some of the confusion that exists in understanding safety culture, the concept of organisational culture is in many respects a clearer concept. Hopkins (2006) states that every organisation has a culture and that culture can be expected to impact on safety.

Wiegmann, Zhang, von Thaden, Sharma & Gibbons (2004) provide a summary of the various definitions of safety culture that can be found in literature. Wiegmann *et al.* (2004) conclude that all the definitions have a number of common features, regardless of the industry being considered. These commonalities are:

- Safety culture is a concept defined at the group level or higher that refers to the shared values among all the group or organisation members.
- Safety culture is concerned with formal safety issues in an organisation and closely related to, but not restricted to, the management and supervisory systems.
- Safety culture emphasizes the contribution from everyone at every level of an organisation.
- The safety culture of an organisation has an impact on its members' behaviour at work.
- Safety culture is usually reflected in the contingency between reward systems and safety performance.
- Safety culture is reflected in an organisation's willingness to develop and learn from errors, incidents, and accidents.
- Safety culture is relatively enduring, stable, and resistant to change.

Wiegmann *et al.* (2004) state that there are at least five organisational indicators of a safety culture. These include organisational commitment, management involvement, employee empowerment, reward or accountability systems, and reporting systems. These indicators are crucial to this study, as they form the basis of the research methodology, as discussed in Chapter 4.

2.4.1 Organisational Commitment

Organisational commitment in the context of safety refers to the extent to which upper level management identifies safety as a core value of the organisation. An organisation's commitment to safety is therefore reflected in the ability of its upper level management to demonstrate a lasting, positive attitude toward safety, even in financially challenging times, and to actively promote safety in a consistent manner across all levels within the organisation. An organisation's commitment to safety is reflected by the efforts made to ensure that every aspect of its operations is routinely reviewed (Wiegmann *et al.*, 2004). In the context of a coal mining operation, an example of this commitment could be the willingness of management to stop mining in a certain area, as a result of an unacceptable level of risk to employees' safety.

2.4.2. Management involvement

Management involvement, in the context of safety, refers to the extent to which upper and middle level management get personally involved with critical safety activities. These include the presence and interaction of managers at safety seminars, their oversight of critical operations, and their ability to stay in touch with risks relevant to the day to day operations ((Wiegmann *et al.*, 2004).

2.4.3 Employee Empowerment

Janssen (2004) defines empowerment as a motivational process that fosters a feeling of enablement. Within the context of safety culture, employee empowerment means that employees have a substantial voice in safety decisions, have the leverage to initiate and achieve safety improvements, hold themselves and others accountable for their actions, and take pride in the safety record of their organisation (Wiegmann *et al.*, 2004).

2.4.4 Accountability

The rewards and penalties that an organisation use to hold employees accountable for either good or poor safety behaviour is a key component of the safety culture. An organisation's safety culture, therefore, is reflected by the extent to which it possesses an established system for reinforcing safe behaviours (e.g., through monetary incentives or public praise and recognition by management and peers) as well as systems that discourage or punish unnecessary risk taking and unsafe behaviours. However, an organisation's safety culture is signified not only by the existence of such reward systems but also by the extent to which the reward systems are formally documented, consistently applied, and thoroughly explained and understood by all of its employees (Wiegmann *et al.*, 2004).

2.4.5 Reporting Systems

An effective and systematic reporting system is the keystone to identifying the weakness and vulnerability of safety management before an accident occurs. It is important to ensure that employees will not experience reprisals or negative outcomes as a result of using the reporting system as well as to have a structured feedback system to inform the employees that their suggestions or concerns have been reviewed and what kind of action will be taken to solve the problems. An organisation with a good safety culture should have a formal reporting system in place and one that is actually used comfortably by employees. A good reporting system allows and encourages employees to report safety problems, and it also provides timely and valuable feedback to all employees (Wiegmann *et al.*, 2004).

2.5 Competitiveness, Contractors and Safety Culture

In order to become more competitive, companies have undergone major changes in organisational structure, with smaller numbers of permanent workers and larger numbers of contractor workers (Clarke, 2003). Clarke (2003) states that there are implications for the safety culture of organisations employing increasing numbers of contractor workers. The short time that contingent workers spend immersed in the organisation, allows for little time to build relationships and establish stability within the workforce.

Clarke (2003) states that empirical studies give mixed support for evidence that

contract workers have weak or transactional psychological contracts. McLean Parks and Kidder (1994) in Clarke (2003) state that transactional psychological contracts are associated with low organisational commitment. There has however not been any clear empirical evidence to suggest that there is a marked difference between the relational contracts of permanent employees compared to contractor workers within the air transport industry (Clarke, 2003).

This is largely due to the view of the contractors that they were obligated to render a professional service, and were there to earn an honest day's wages (Clarke, 2003). This study will test this assertion within the context of a mining operation, where there may not necessarily be a feeling of obligation to delivering professional service amongst contractors rendering non-critical services.

There is substantive evidence to suggest that safe work behaviour is supported by a positive safety culture (Clarke, 2000 in Clarke, 2003). Within the context of skills shortage and a larger contractor workforce that is of a transient nature, the exertion of cultural control becomes very difficult, if not impossible. Understanding the factors that drive the safety culture of an organisation can assist companies in ensuring that they exert the correct influence in terms of the organisational culture to promote safe work behaviour.

Clarke's (2003) conclusion is that organisational restructuring may damage the mutual trust between permanent employees and management. Furthermore, the addition of contractor workers could threaten the integrity of the safety

culture. Contractor workers are faced with dual loyalties to the host organisation on one hand, and their direct employer on the other hand. Demands from both the organisations may not always be compatible.

In a case study on the effect of safety culture in the marine environment, Mitroussi (2003) concludes that the organisational culture responsible for improvements in safety performance is subject to the same factors that contribute to change within other businesses, political or intergovernmental organisations and needs to evolve to meet the changing needs and challenges of the environment.

Fuller and Vassie (2001) state the importance of measuring and comparing cultures in partnering organisations, i.e. organisations where a large component of the workforce is comprised of contractors. The alignment of the cultures plays an important role in safety, since a sound culture brings about harmony where all employees feel respected, are optimistic and give of their best. In an environment where contractors are not treated as part of the team, the alignment may present a problem as there are no incentives provided for contractors to give of their best.

An earlier study by Smallwood (1998) in the construction industry indicates that clients have a pronounced effect on the health and safety of contractors. Clients have a legal obligation in South Africa to notify contractors of any possible hazards the contractor may be exposed to while on the client's site. The good work that is done in orientating the contractor to safety is however easily

compromised by undue pressure from the client for shorter delivery periods, changes of scope midway through the work etc.

2.6 Factors that influence organisational safety culture

Gibbons, von Thaden & Wiegman (2006) find that safety culture is consistently defined as a group or organisational level construct within five properties which are:

- Shared values about safety
- Concern with the formal safety related processes and procedures of the organisation
- Contributions of members at all levels of the organisation
- Evidence of the organisation's desire to improve and learn with regard to safety
- The safety culture is a reasonably stable feature of the organisation

Gibbons *et al.* (2006) posit that as a result of this definition, the safety culture of an organisation is situated on a continuum, and can therefore be improved. The counter to this is obviously that there are factors that could cause the safety culture to regress on the same continuum.

Harvey, Erdos, Bolam, Cox, Kennedy & Gregory (2002) state that the attempts to define the factors that constitute a good safety culture imply that effective provision for health and safety depends as much upon organisational culture generally, as it does upon specific health and safety matters. The number of groups of factors varies from between 2 to 9, but most include job satisfaction,

individual responsibility, management responsibility, leadership style and communication, commitment, risk awareness and risk taking.

Weyman, Clarke and Cox (2003) use a 3 factor model in their study of underground coal miners' attributions on risk taking at work. The model specifically groups time pressure, management commitment and the confidence in employees' ability to deal with risk. This model was specifically designed to survey attitudes towards risk taking, and measures only a portion of the safety culture. To get a more rounded view of the safety culture requires a wider spectrum of factors to be considered. Examples of these include the study done by Harvey *et al.* (2002) which uses a seven factor model, and the work done by Gibbons *et al.* (2006), which uses a five factor model.

2.6.1 Shared Values

Most definitions of organisational culture include some reference to the values or beliefs that are shared within an organisation. From the summarised communalities that Wiegmann *et al.* (2004) have identified from various definitions of safety culture, it is evident that shared values form an essential component of the safety culture of an organisation.

2.6.2 Hierarchical Perceptions of Culture

Clarke (2006) posits that there are significant differences in the perceptions of management and supervisors of the safety culture, versus that of the shop floor

workers. This has long been a perception of the mining industry in South Africa, where there is strong unionised activity surrounding demands for safer working environments from management. Conversations with DME inspectors have indicated a perception that the safety systems that management perceive to be in operation on their mines, are often not fully understood or implemented by shop floor workers.

In a study done in the financial sector, Winter and Jackson (2006) found managers and employees shared similar responses as to the state of the psychological contract. The psychological contract is often associated with organisational commitment, one of the factors of organisational safety culture. In Winter and Jackson's (2006) work, they found that managers tended to construct rational explanations and emphasise resource constraints and financial considerations, whilst employees constructed emotional explanations and attributed this situation to an unfair, uncaring or distant management. Employees regarded structures put in place by management as "symbolic acts" rather than genuine attempts to give employees a voice in the company.

The practical implications for this lies in the alignment of the psychological contract espoused by management more closely with that upheld by employees. This requires managers to adopt more personal, face-to-face communication strategies. The removal of status-related barriers to communication places managers in a better position to explain to employees how the organisation can meet (or not) specific contract expectations and obligations (Winter & Jackson, 2006).

2.7 The role of management and leadership in organisational safety culture

Most literature makes a clear distinction between management and leadership as two entirely different, yet connected constructs. Nienaber and Roodt (2008) have found that there are still a significant number of views held today regarding general management and leadership that align with classical management. Classical management views consider management and leadership to be the same thing. In the context of a mining operation, there is a clearly defined expectation for management to provide leadership in the area of safety. While it is therefore not generally accepted in mainstream literature to assume that management is the same as leadership, for the purpose of this study, issues of leadership will be associated with the role that managers play in managing safety.

Schein (2004, p. 10) posits that leadership and culture are two concepts that cannot be understood in isolation – they are two sides of the same coin. Cultural norms in organisations define the leadership of the organisation, e.g. who gets promoted, who gets the attention of the followers etc. On the other hand, it can be argued that leaders manage and create the organisational culture. Leadership and culture are therefore conceptually intertwined (Schein, 2004, p. 11).

Schein (2004, p. 225) further posits that culture has three sources: (1) the beliefs, values and assumptions of organisational founders, (2) the learning

experiences of group members as the organisation evolves, and (3) new beliefs, values and assumptions brought in by new members and leaders. The impact of the founders by far has the greatest impact on the formation of the organisational culture, as they choose the basic mission and environmental context in which the group will operate.

Schein (2004, p. 246) further explores the mechanisms leadership use to embed and transmit culture. These include primary mechanisms such as what the leaders pay attention to, how they react to critical incidents, how they allocate resources and how they allocate rewards and status. Secondary mechanisms include the organisational design and structure, systems and procedures, the rites and rituals of the organisation, and stories about events and important people.

Höpfl (1994) explores the sometimes cosmetic relationship between an organisation's corporate culture and the safety culture. Hopfl (1994) suggests that the manipulation of corporate culture reduces safety issues to a declared rhetoric supported by artefacts of a "safety culture", which has the danger of reducing the concern for safety to a superficial level. The researcher has in conversations with officials from the DME encountered concerns that echo Höpfl's (1994) findings. DME Inspectors find that during their visits to mines there is a disconnect between what mine management portrays as their espoused safety values, and what happens in practice. An example of this is where management do not follow the rules that they expect the rest of the employees to follow.

Gillen, Kools, Sum, McCall and Moulden (2004) have done a qualitative investigation in the construction industry of what workers perceive their managers' input is into facilitating or encouraging safe working practices. Some light is shed on issues such as management's commitment to safety, pressures of production versus safety, disregard and concerns for safety and communication in safety.

The understanding of the impact organisational culture has on safety management in the South African mining industry could provide some insights that will assist mining companies in reducing fatalities and poor safety records, thereby increasing investor confidence and sustainability in the industry.

CHAPTER 3: RESEARCH HYPOTHESES

The research hypotheses are aimed at gaining a better understanding of the role of organisational culture in the management of safety in one of the operations of a thermal coal mining company. This will be accomplished through empirical testing of survey data using statistical analysis. The hypotheses are as follows:

H1: There is a significantly positive linear relationship between a strong shared safety value set and the safety culture of a coal mining operation.

H2: There is a significant difference in the safety culture perception of contractors compared to that of permanent mine employees, such that contractors will perceive a weaker safety culture.

H3: There are significant hierarchical differences in the perception of the safety culture as measured in the factors, such that management and supervisors have a significantly stronger perception of the safety culture than that of shop floor workers.

H4: There is a significantly positive linear relationship between strong management involvement and the safety culture of a coal mining operation.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Introduction

This section will deal with the rationale for the proposed research method. The research design, population, sample and data collection tools will be discussed, together with some of the possible limitations of the research.

4.2 Rationale for methodology

Tools for assessing safety culture can be classified as either qualitative or quantitative methods (Wiegmann *et al.,* 2004). Qualitative measures include employee observations, focus groups, historical information reviews and case studies. Quantitative measures attempt to use numerical measures to score safety culture, by using standardised procedures such as highly structured interviews, surveys and questionnaires, and Q – sorts (Wreathall, 1995 in Wiegmann *et al,* 2004).

Hopkins (2006) explores two additional approaches aside from the survey method to establish an organisations safety culture. The first is an ethnographic approach, which requires the researcher to immerse him/herself in the culture for a long period of time. This type of methodology provides a richer account of the culture, but the description of culture is normally biased towards the researcher's own interpretation of the culture (Hopkins, 2006). These descriptions have to be validated with members of the organisation to ensure

that they truly reflect the organisational safety culture. This methodology is time intensive, and will require the researcher to have as little impact as possible on the culture while immersed in the organisation. For the purpose of this study, the approach was found to be unsuitable.

Another approach suggested by Hopkins (2006) is the use of data gathered from major accident inquiries. The transcripts of interviews of persons who were either directly involved or witness to accidents provide a wealth of information for the researcher to analyse and gain insights into the organisational culture. The downfall of this method is that it does not provide a complete picture of the culture of the organisation. While such data is available, this method was not adopted due to the relative age of the data and the dynamic nature of organisational cultures over time (van den Berg & Wilderom, 2004).

Researchers agree that both qualitative and quantitative methods have unique potential for assessment and theory testing, and that there is a benefit in combining methods to gain a comprehensive understanding of safety culture (Wiegmann *et al.*, 2004). Wreathall (1995) in Wiegmann *et al.*, (2004) states that quantitative approaches, especially surveys of individuals responses, are often more practical in terms of time and cost effectiveness.

Given the considerations of time and practicality, this research used a questionnaire survey. The approach for the research was quantitative and descriptive.

4.3 Population, Sample, and Data collection tool

4.3.1 Population

The target population consisted of the operational staff, which included managers and employees, of a single thermal coal mining operation of a large multinational mining resources company, and the contractors that render services to the mine. The mining operation consists of both a coal extraction and a coal beneficiation section, each with its own management structures, employees and contractors. Some contractors render services that are specific to only one structure, while others service both structures. Figure 6 gives a graphic representation of the population structure. The total population size (N) consisted of 794 workers, of which 492 were permanent mine employees, and 302 were contractors.

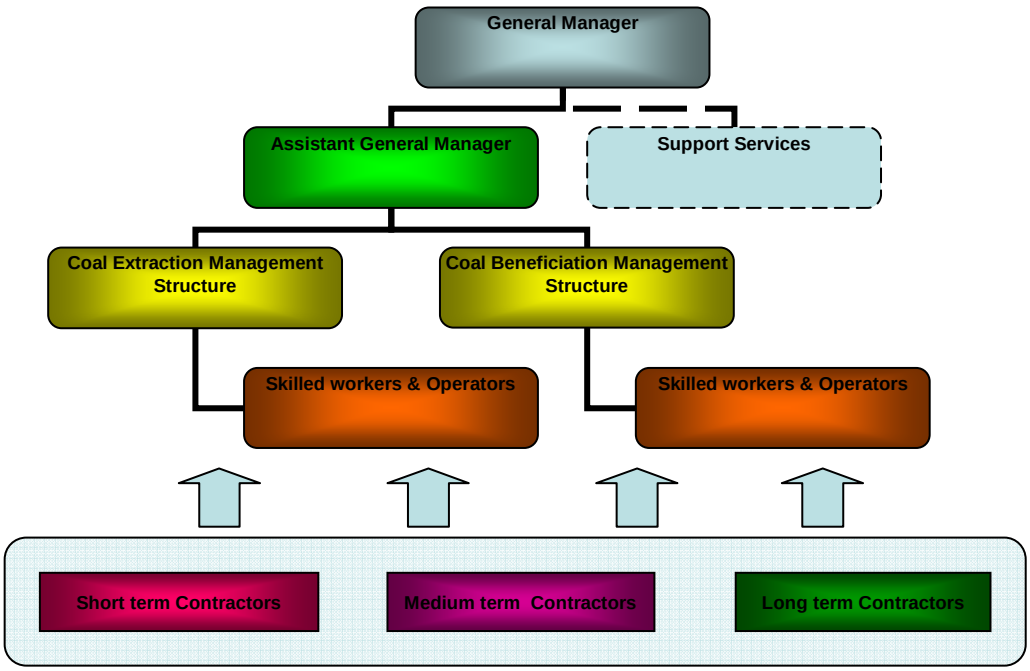

Fig 6. Population structure

4.3.2 Sample

The sample came from the following segments of the population:

- A non-random cross section of employees of one of the operations of an energy coal mining company, ranging from operators through to middle management and senior management
- Long term contractors that are based at the operation site and render a service essential for production.
- Medium term contractors that are not based on site, but visits the site at least once or twice a week for the rendering of a service.
- Short term contractors whose services are required on an ad hoc basis.

Support services were excluded from the population, as only operational staff was considered. The sample was convenient, since the researcher had access to the management and supervisory staff of both the mine employees and the contractors.

4.3.3 Data Collection Tool

Wiegmann, von Thaden, Mitchell, Sharma, & Zhang (2003) have created a database of more than 1000 items from previous surveys developed across a variety of industries, including transportation, oil, gas, mineral, nuclear, aviation, utilities, and manufacturing. Gibbons *et al.* (2006) used this database to create a questionnaire specific to the aviation industry. The survey measures five global indicators of safety culture. Gibbons *et al.* (2006) further developed the

survey to include subgroups of the five global indicators.

For the purpose of this study, the five global indicators were used. Although the original model did not fit the psychometric requirements well, the analysis was very useful into providing insight into the nature of the safety culture (Gibbons *et al.*, 2006). The poor fit was found to be as a result of duplication of certain items and some ambiguity and poorly worded statements that were open for misinterpretation. Gibbons *et al.* (2006) states that this is often a problem when assessment tools are synthesized from different industries. Safety culture is closely tied to the structure of the type of organisation and type of work performed by members of the organisation.

To measure the fit of the original model Gibbons *et al.* (2006) used a chi-square value of the model, the root mean square error of approximation (RMSEA), the normed fit index (NFI), Tucker Lewis Index (TLI), and a relativity noncentrality index (RNI). A good fit follows from a chi-square value that is insignificant compared to the degrees of freedom, the RMSEA is below 0.10, and the NFI, TLI and RNI are all above 0.90 (Gibbons *et al.,* 2006). Table 1 indicates the values for the measures of fit used for the original model versus that of a modified model.

	Initial model	**Modified model**
Chi-square	7879.94	3757
RMSEA	0.06	0.05
NFI	0.58	0.73
TLI	0.69	0.84
RNI	0.7	0.85

Table 1. Comparison of fit for initial model vs modified model.

While the modified model yielded a better fit, the factors that had been identified were largely specific to the air transport industry, and could not be reconciled to a mining operation. It was therefore decided to use the original model and from the subsequent analysis derive a model suitable for the mining operation. In order to derive this model, a principal component analysis was performed. Unfortunately the same parameters of fit could not be applied due to the limitations of the software package used.

The original questionnaire was modified to suit the mining operation surveyed. The original list of 84 items (Annexure A) was reduced to 82, and all references to the aviation industry were removed. The indicators include organisational commitment (n=29), management involvement (n=17), employee empowerment (n=14), reward or accountability systems (n=10), and reporting systems (n=12).

The questions in most cases were rephrased in a simpler way to accommodate ease of reading and understanding within the sample group. An example is where the original statement read “I am confident that maintenance on aircraft is adequately performed and that aircraft are safe to operate”, it was changed to “Our machines on this mine are kept in good condition and are safe to operate”.

The questionnaire items were put on a 5-point Likert scale ranging from 1 (strongly disagree), 3 (unsure), to 5 (strongly agree). Annexure B shows the modified questionnaire used in this study.

Items marked with an R on the questionnaire indicate items that were scored in

reverse, i.e. if the respondent chose “strongly disagree”, this item was marked as a 5, and “strongly agree” was marked as a 1. These items are negative indicators of the safety culture, and point to factors that could promote poor safety performance. The reverse marking indicator was removed from the final questionnaire distributed to respondents.

A pilot study was conducted to validate the questionnaire. The questionnaire was also distributed to subject matter experts who included the safety managers of various mining complexes, as well as the group safety manager of the company used for the research, to validate the content thereof. No changes were suggested to the format and content of the questionnaire.

A total of 200 questionnaires were distributed. The questionnaires were distributed to supervisors of both mine employees and contractors for completion by their crews during one of their safety sessions.

4.3.4. Data Analysis

The data was analysed using the NCSS 2007 statistical analysis software. Principal component analysis was performed on the raw data to confirm the validity and significance of the factors. Significance was assessed by evaluating the factor loadings of each item, as well as the communality of each item. A summated scale was then constructed to facilitate further statistical analysis. Correlations were performed on the reviewed factors to test the validity of the data and explore the relationships as postulated in hypotheses 1 and 4.

Descriptive statistics and two-tailed, two sample T-tests were then used to test research hypotheses 2 and 4. For the purpose of the testing, the following categorical coding was used:

- Contractor category: Mine employees = 0, Contractors = 1
- Level category: Management and supervisors =1, Artisans and Operators = 2

4.4 Research Limitations

Since organisational culture is specific to an organisation, no inferences can be made of cultures in other mining groups outside of the population sampled. The results can however shed some light on some of the relationships that drive the organisational culture, and this can be used as a base for culture driven safety programmes.

The research made use of a survey, and was open to response bias, with respondents giving perceptions they feel the researcher may have wanted to see reflected. To minimise the effect of this, supervisors were asked to tell respondents to fill in the questionnaire based on what their first natural response to the statement would be.

The study had the potential to be subject to researcher bias, since the researcher forms part of the management team of the population evaluated. The statistical nature of the evaluation ensured that biased interpretations of responses were avoided as far as possible.

CHAPTER 5: RESULTS

5.1 Introduction

This section deals with the results of the culture survey. The general demographics of the respondents are described, and the detail of how the data was manipulated to obtain meaningful results is explained. Commentary is given regarding the overall fit of the factor model, and the statistical results to test each of the research hypotheses are tabled.

5.2 General demographics

From the 200 questionnaires distributed, a total of 91 responses were received. Of the 91 returned, 12 were spoiled. The remaining 78 complete responses account for a 39% response rate. The sample consisted of 51 permanent mine employees, and 27 contractors. The results of the survey can be found in Annexure C.

	Mine Employees	Contractors	Contractors distribution		
			Short term	Medium term	Long term
Management	7	6			
Supervisors	5	4	4	9	14
Artisans/Miners/Process Controllers	17	4			
Operators/General workers	22	13			

Table 2: Demographic distribution of respondents

5.3 Principal Component Analysis

In order to verify the significance of the components of the factors, each of the five initial factors was subjected to principal component analysis (PCA). The process allowed for verification of whether an item present in the factor had significance in relation to the other items. For sample sizes less than 100, a factor loading of more than 0.30 was considered significant, and justified retention of the item (Hair, Anderson, Tatham & Black, 1998, p. 113). Coupled with this, the communality of the variables with insignificant factor loadings were considered prior to deleting the variable. If the communality was less than 0.3, i.e. the variable explained less than 30% of the variance, the variable was deleted. Varimax rotations were applied to all the factors to enhance the identification of significant positive or negative relationships between factors and the items they contain. Since the sample was less than 100, the Barlett test of sphericity was not applicable.

5.3.1 Analysis of Accountability factor

A single factor PCA was conducted on the data collected under the factor for Accountability. The result yielded a poor fit with 3 of the 10 items requiring deletion after the first round, and two more after the second round. A two factor PCA was then performed on the original 10 items, yielding two distinct sub factors with factor loading values all above 0.4. Item nr. 23 showed no significant loading (loading was <0.30) on either of the two factors, and the communality was less than 0.3. The item was then discarded. Two new sub

factors relating to accountability was identified, namely Effects of Accountability (n=5), and Consistency of Accountability (n=4).

Variables	Factor1	Factor2
Q7	-0.705075	-0.212063
Q15	-0.086794	0.543336
Q23	0.02222	-0.193023
Q29	0.409902	-0.288203
Q31	-0.184608	-0.636032
Q37	0.72719	-0.182888
Q40	0.028824	-0.550473
Q49	-0.104955	0.671599
Q61	-0.62715	-0.204713
Q80	-0.481114	0.200918

Table 3: Factor loading for Accountability

5.3.2. Analysis of Management Involvement

A single factor PCA was performed on the data collected under the factor for Management Involvement. The data had a reasonably good fit, with only 2 items out of 17 having non significant factor loadings (< 0.30). These items (nr 46 & 54) were deleted from the list after analysing the statements of the two items. Both were found to probably not directly relate to management involvement. The original factor was retained, with the exclusion of the two non-significant items.

Variables	Factor 1
Q1	-0.527
Q6	-0.390
Q13	-0.346
Q14	-0.525
Q21	-0.427
Q22	-0.301
Q30	-0.684
Q39	-0.707
Q42	-0.478
Q46	-0.231
Q51	-0.551
Q54	-0.234
Q59	-0.679
Q60	-0.633
Q68	-0.487
Q75	-0.651
Q80	-0.537

Table 4: Factor loading for Management Involvement

5.3.3. Analysis of Organisational Commitment.

After conducting single and double factor PCA on this factor, a three factor PCA was found to yield a better fit. Two items were found to have non-significant factor loadings across all three new factors, while one was found to have significant factor loadings across all three new factors. According to Hair *et al.* (1998, p. 113), items that have significant loadings across all factors are normally candidates for deletion. All three items (items 27, 69 and 77) were removed from the data set. Three new sub factors were identified, namely Safety Commitment (n=6), Safety System (n=11), and Safety Values (n=9).

Variables	Factor1	Factor2	Factor3
Q3	-0.251	-0.338	0.016
Q5	0.039	-0.611	-0.087
Q10	-0.317	-0.466	0.248
Q11	-0.330	0.012	-0.044
Q12	-0.600	-0.066	-0.103
Q18	-0.618	-0.237	0.094
Q19	-0.305	-0.505	-0.036
Q20	-0.406	-0.267	-0.393
Q26	-0.142	-0.580	-0.275
Q27	-0.199	-0.139	-0.210
Q28	-0.119	-0.258	0.657
Q33	-0.337	-0.268	0.489
Q35	-0.512	-0.027	0.254
Q38	-0.111	-0.106	0.710
Q45	-0.191	0.400	0.310
Q50	-0.145	-0.424	0.202
Q56	-0.495	-0.097	0.367
Q57	-0.314	-0.134	0.066
Q58	0.046	-0.428	0.348
Q65	-0.392	0.100	0.307
Q66	0.068	-0.583	0.166
Q69	-0.477	-0.348	0.323
Q72	-0.074	0.042	0.658
Q73	-0.650	0.046	0.394
Q75	-0.050	-0.614	0.317
Q78	-0.222	-0.155	0.119
Q79	0.458	-0.421	0.183
Q82	-0.575	0.090	0.219
Q83	-0.265	-0.196	0.727

Table 5: Factor loading for Organisational Commitment

5.3.4. Analysis of Employee Empowerment

This factor yielded a relatively good fit when subjected to a single factor PCA, with only 2 out of 14 items (items 43 and 63) yielding non-significant factor loading. These items were possibly interpreted by some as being positive statements, while others may have seen it negatively. These items were removed from the data list.

Variables	Factor1
Q4	-0.356
Q8	-0.639
Q16	-0.405
Q24	-0.388
Q32	-0.524
Q36	-0.417
Q41	-0.444
Q43	-0.149
Q47	-0.486
Q53	-0.444
Q62	-0.445
Q63	0.301
Q70	-0.536
Q76	-0.520

Table 6: Factor loading for Employee Empowerment

5.3.5 Analysis of Reporting System

The factor yielded a poor fit to a single factor PCA, but yielded better results with a two factor analysis. One of the items (nr 9) yielded non-significant factor loading figures, but however yielded a high communality result of close to 0.5. This item was retained in the data set and included in the factor with the highest factor loading. One of the items (nr 17) yielded high factor loadings on both factors and was deleted from the data set. Two distinct sub factors were identified namely Reporting Structure (n=5) and Reporting Practices (n=7).

Variables	Factor1	Factor2
Q2	-0.189	0.459
Q9	0.050	0.343
Q17	-0.481	0.512
Q25	-0.612	-0.326
Q34	0.175	0.704
Q44	0.144	0.387
Q48	0.054	0.580
Q52	-0.752	0.080
Q55	-0.740	0.107
Q64	-0.699	-0.279
Q67	-0.622	0.044
Q71	-0.178	0.676

Table 7: Factor loading for Reporting System

5.3.6 Construction of a Summated Scale

The PCA yielded a new factor model with 9 factors as opposed to the original 5 factor model. This is similar to the findings of Gibbons *et al.* (2006), with the difference being that different items were identified as being redundant, and the sub factors identified were significantly different owing to the environment and design of the questions. Annexure D shows the summated scale data derived from the averages of the variables within each factor. As indicated in Chapter 4, the content of the original factors were subjected to a face validity test with subject matter experts, in this case, the safety managers of various mining complexes.

The process of analysing each factor using a PCA, resulted in each of the factors, including newly created factors, being constructed of variables that had significant loading on the factors. This was necessary to ensure that the data used in the summated scale has unidimensionality.

The final requirement for ensuring a useful dataset is the issue of reliability. The most commonly used measure of data reliability for the entire scale, is Cronbach's alpha (Hair *et al.*, 1998, p. 118). The generally agreed lower limit for this measure is 0.7. Table 2 indicates the correlation matrix for the summated scale, as well as the Cronbach alpha value. The Cronbach alpha for the summated scale is 0.853, indicating that the summated scale is very reliable.

A total of 9 items were removed from the original list of variables, reducing the

total number of variables to 73 items. The summated scale made it easier to draw statistical comparisons between the different groups within the sample by providing a reduced and meaningful data set of 9 variables as opposed to 73. Each of the research hypotheses could now be explored using the appropriate statistical analysis. Figure 5 shows the aggregated values for each of the factors against the measurement scale.

	Effect of accountability	Consistency of accountability	Management involvement	Safety commitment	Safety system	Safety values	Employee empowerment	Reporting structure	Reporting practices
Effect of accountability	1.00								
Consistency of accountability	0.21	1.00							
Management involvement	0.35	0.38	1.00						
Safety commitment	0.10	0.32	0.68	1.00					
Safety system	0.42	0.51	0.65	0.45	1.00				
Safety values	0.12	0.20	0.57	0.46	0.31	1.00			
Employee empowerment	0.26	0.40	0.57	0.45	0.45	0.44	1.00		
Reporting structure	0.09	0.20	0.73	0.75	0.41	0.70	0.48	1.00	
Reporting practices	0.24	0.31	0.44	0.05	0.39	0.47	0.31	0.30	1.00
Cronbachs Alpha = 0.853547									

Table 8: Correlation matrix of summated data

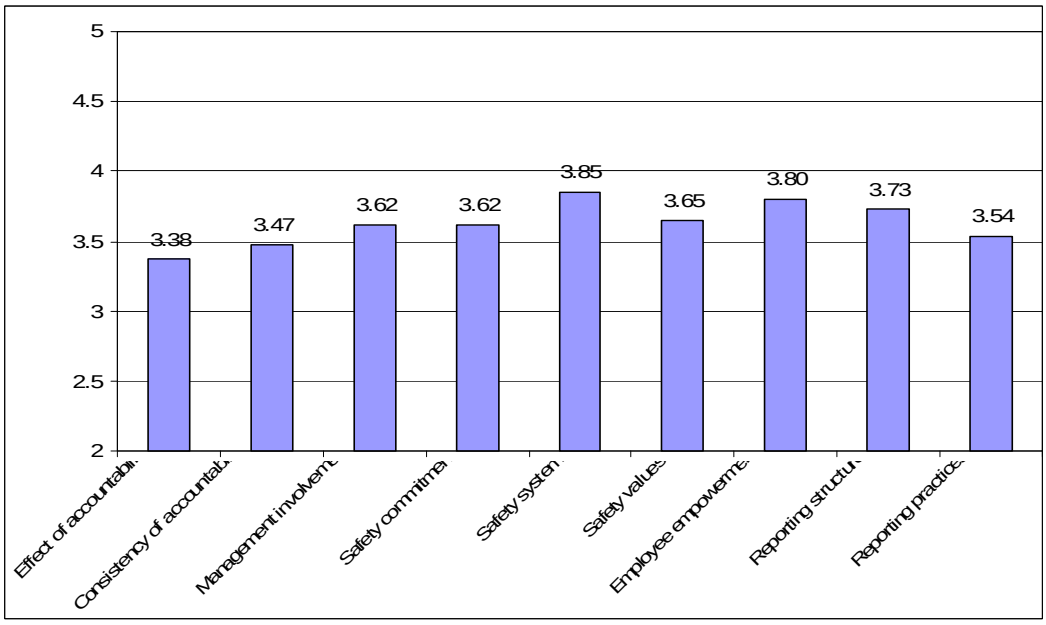

Fig 7: Aggregated overall scores for each factor.

5.4 Results for Research Hypothesis H1

In order to evaluate research hypothesis H1, a statistical relationship had to be explored between the Safety Value factors, and the other eight factors identified in chapter 5.3. The easiest way to do this is to construct a Pearson's Correlation between the different factors. Table 8 gives this correlation. Figure 8 indicates a scatter plot of Safety Culture versus the average of all other factors, excluding Safety Culture. While there is a clear linear relationship evident, there is also some random distribution of data points further away from the regression line.

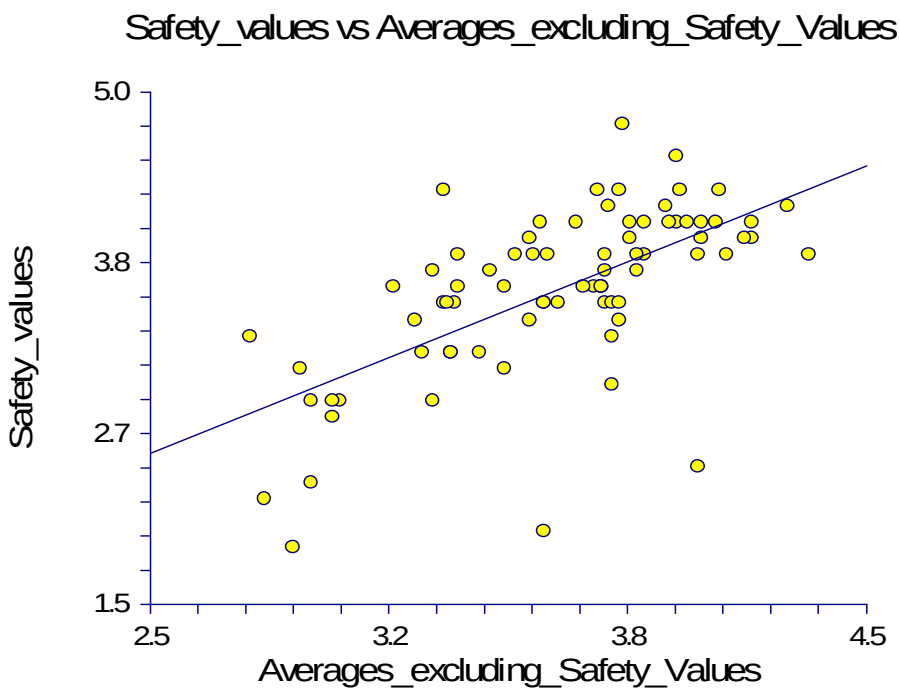

Fig 8: Scatter plot of Safety Values vs Average of all other Factors

When comparing the relationship between the Safety Values and other factors, there is a poor correlation between both the factor for the Effect of Accountability (0.12) and Consistency of Accountability (0.20). Practically significant relationships (correlation >0.3) are found between Safety Systems and Safety Values (correlation = 0.31). More significant correlations (>0.40) are found between the following factors: Safety Commitment (0.46), Employee Empowerment (0.44), and Reporting Practices (0.47). The strongest correlations can be found for the Management Involvement (0.57), and Reporting Structure factors (0.70). It is important to note that even for very weak correlations, all the correlation figures are positive.

	Effect of accountability	Consistency of accountability	Management involvement	Safety commitment	Safety system	Safety values	Employee empowerment	Reporting structure	Reporting practices
Safety values	0.12	0.2	0.57	0.46	0.31	1	0.44	0.7	0.47

Table 9: Correlation data for the Safety Values factor

5.4 Results for Research Hypothesis H2

In order to test whether there was a significantly lower perception of the safety culture amongst contractors, as opposed to permanent mine employees, a T-test for two samples was done firstly for the overall aggregated result, and then for each of the factors. The aim was to determine whether the difference in means was statistically significant to support the hypothesis. An alpha value of 0.05 was used for all T – tests.

5.4.1 T – test for overall average

The overall average result for the culture survey revealed a mean of 3.627 for permanent employees with standard deviation (SD) of 0.352, and a standard error (SE) of 0.0493. The comparative values for contractors revealed a mean of 3.648, with a SD of 0.408 and a SE of 0.0786. The mean difference on an unequal basis was -0.0206, with the probability for a difference < 0 at 0.41. This indicated that the difference in means was not found to be statistically

significant. It is however interesting that the mean score for the contractors is slightly, but not significantly higher than that of the mine employees. Box plots for all factors were constructed to investigate the possibility of outliers within the factor data set. Outliers affect the normal distribution required for doing the T-test. The box plots for the different factors in figure 6 indicate the outliers. These were removed from the data set to ensure normality within the data distribution.

5.4.2 T – test for Effects of Accountability

The result for the Effect of Accountability factor revealed a mean of 3.41 for mine employees with a SD of 0.395 and a SE of 0.0554. Values for contractors revealed a mean of 3.35, a SD of 0.390 and a SE of 0.0765. The mean difference based on unequal sample sizes was 0.0695. The null hypotheses for a difference > 0 could not be rejected, i.e. the means are not significantly different, with the absolute difference being very small.

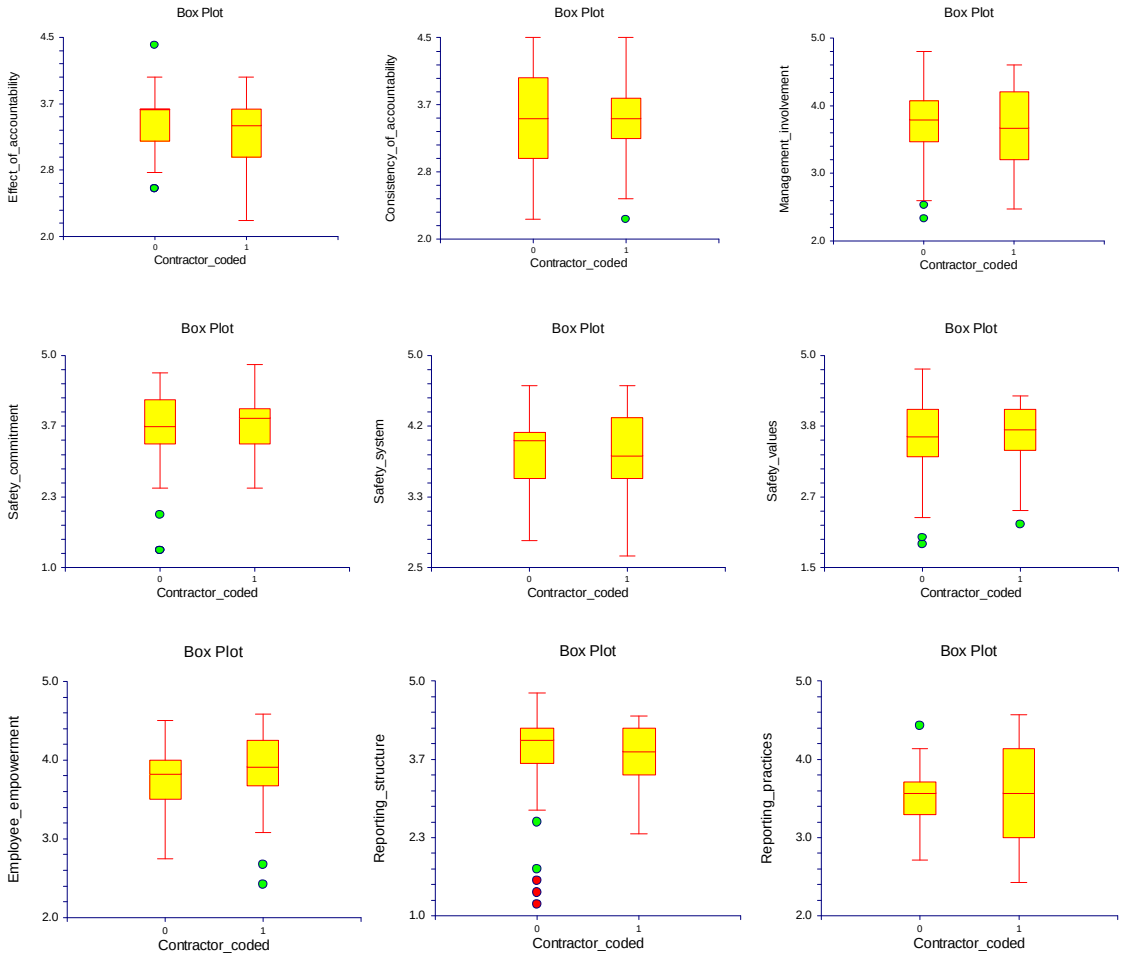

Fig 9: Box plots for all factors for mine employees and contractors.

5.4.3 T – test for Consistency of Accountability

The results for the T-test for the Consistency of Accountability factor revealed a mean of 3.48 for mine employees, with a SD of 0.510 and a SE of 0.0715. Results for contractors revealed a mean of 3.50, with a SD of 0.441 and a SE of 0.00866. The mean difference was - 0.0147. The null hypothesis for differences < 0 could not be rejected, with a probability of 0.45. The mean difference was therefore insignificant.

5.4.4 T – test for Management Involvement

The result for the T – test revealed a mean for mine employees of 3.734, versus a mean of 3.679 for contractors. For mine employees, the test yielded a SD of 0.449 and a SE of 0.0641. Contractors had a SD of 0.575 and a SE of 0.1108. The mean difference of – 0.05526 is insignificant, since the null hypothesis was not rejected for a difference < 0, with a probability of 0.46.

5.4.5 T – test for Safety Commitment

The T-test revealed almost identical means, with mine employees scoring 3.730, and contractors scoring 3.734. The SD for mine employees was 0.519 with a SE of 0.0757. Contractor values were 0.545 and 0.104 for the SD and SE respectively. The difference in means was - 0.00322, which was found to be insignificant since the null hypothesis could not be rejected for a difference < 0, with a probability of 0.48.

5.4.6 T – test for Safety System

Results for the T-test revealed a mean of 3.862 for mine employees, with a SD of 0.419 and a SE of 0.0587. Contractors yielded a mean of 3.815, with a SD of 0.513 and a SE of 0.0989. The mean difference was 0.0468, with the null hypothesis being rejected for a difference > 0, at a probability level of 0.33. The difference in means is therefore insignificant.

5.4.7 T – test for Safety Values

The T – test for Safety Values yielded a mean of 3.687 for mine employees, with a SD of 0.493 and a SE of 0.0705. Results for contractors yielded a mean of 3.765, with a SD of 0.454 and a SE of 0.0890. The difference in means was – 0.0776. The null hypothesis could not be rejected at a probability of 0.25. The difference in means is therefore insignificant.

5.4.8 T – test for Employee Empowerment

The T – test results indicated a mean of 3.776 for mine employees, with a SD of 0.396 and a SE of 0.0555. Results for contractors yielded a mean of 3.950, with a SD of 0.357 and a SE of 0.0714. The difference in means is -0.174. The null hypothesis could not be rejected for a difference < 0, and a probability of 0.029. There is therefore a significant difference in the mean score between mine employees and contractors.

5.4.9 T- test for Reporting Structure

The results for the Reporting Structure factors yielded a mean of 3.956 for mine employees, with a SD of 0.476 and a SE of 0.0703. The results for contractors yielded a mean of 3.725, with a SD of 0.568 and a SE of 0.109. The difference in means was 0.230. The null hypothesis was rejected for a difference > 0, with a probability of 0.041. The difference in means is therefore significant.

5.4.10 T – test for Reporting Practice

Results for the T-test yielded a mean of 3.502 for mine employees, with a SD of 0.315 and a SE of 0.0445. Contractors scored a mean of 3.571, with a SD of 0.621 and a SE of 0.119. The difference in means was - 0.0689, which was found to be insignificant since the null hypothesis could not be rejected for a difference < 0, at a probability of 0.29.

5.4.11 Summary

The T – tests revealed insignificant differences in means between mine employees and contractors for all factors except two. The factors displaying significant differences in means were the Employee Empowerment factor, and the Reporting Structure. Employee Empowerment yielded a significantly higher mean for contractors, while Reporting Structure yielded a significantly higher mean for mine employees.

5.5 Results for Research Hypothesis H3

Similar to hypothesis H2, T-test for two samples was done firstly for the overall aggregated result, and then for each of the factors. The aim was to find statistically significant differences between the response of management and supervisors as opposed to that of shop floor employees. Shop floor employees include artisans, miners, process operators, machine operators, general workers and assistants. T – tests were conducted with an alpha value of 0.05.

5.5.1 T – test for Overall Average

The T – test for the overall average data revealed a mean of 3.818 for management, with a SD of 0.295 and a SE of 0.00629. The data for workers revealed a mean of 3.563, with a SD of 0.374 and a SE of 0.00500. Boxplots were constructed for each of the factors to indicate the presence of any outliers that would affect the normality of the data distribution. Figure 7 shows the box plots for the factors, clearly indicating the areas where outliers were present. The outliers were removed to ensure normality in the data distribution. The difference in means was found to be 0.255 for unequal sample sizes, with a probability of 0.0027. The null hypothesis was rejected for a difference> 0, indicating statistically significant differences between the mean scores of management and workers.

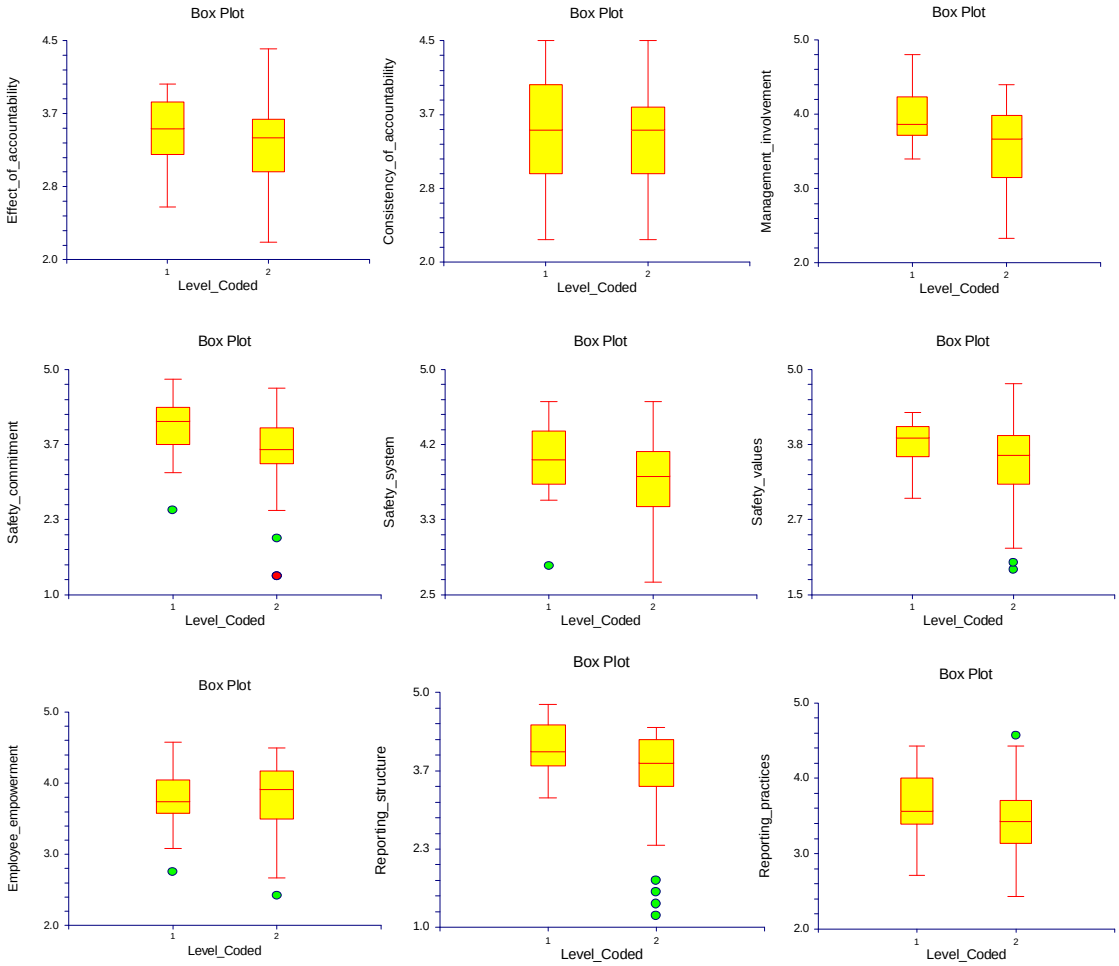

Fig 10: Box plots for all factors grouped according to level categories.

5.5.2 T – test for Effects of Accountability

Results for the factor revealed a mean of 3.418 for management, with a SD of 0.394 and a SE of 0.0841. Workers scored a mean of 3.360, with a SD of 0.421 and a SE of 0.0563. The difference in means was 0.0574. At a probability of 0.29, the null hypothesis could not be rejected, indicating that the difference in means is not statistically significant.

5.5.3 T – test for Consistency of Accountability

The T – test performed on this factor yielded a mean for management of 3.579, with a SD of 0.579 and a SE of 0.123. The results for workers yielded a mean of 3.433, with a SD of 0.468 and a SE of 0.0625. The mean difference was found to be 0.146. With a probability of 0.12, the null hypothesis could not be rejected. This indicated that there was no significant difference between the means of management and workers.

5.5.4 T – test for Management Involvement

The results of the test revealed a mean of 4.004 for management, with a SD of 0.359 and a SE of 0.0767. Workers scored a mean of 3.555, with a SD of 0.534 and a SE of 0.0714. The difference in means was 0.448. For a difference > 0, the null hypothesis was rejected with a probability of 0.000037. This indicated that there was a significant difference in the means.

5.5.5 T – test for Safety Commitment

Management scored a mean of 4.056 for Safety Commitment, with a SD of 0.453 and a SE of 0.0988. The mean score for workers was 3.624, with a SD of 0.479 and a SE of 0.0664. The difference in means was 0.431. The null hypothesis could not be rejected for a difference > 0, and a probability of 0.000362. There is therefore significant difference in the means of the two groups.

5.5.6 T – test for Safety System

Safety System data for management yielded a mean of 4.057, with a SD of 0.360 and a SE of 0.0786. Data for workers indicated a mean score of 3.785, with a SD of 0.445 and a SE of 0.0595. The difference in means was 0.271. The null hypothesis was rejected for a difference > 0 and a probability of 0.0042. There was therefore a significant difference between the means of the two groups.

5.5.7 T – test for Safety Values

The data set for Safety Values yielded a mean score of 3.886 for management, with a SD of 0.327 and a SE of 0.0697. The mean score for workers was 3.616, with a SD of 0.546 and a SE of 0.0743. The mean difference was 0.269. For a difference > 0, the null hypothesis was rejected, with a probability of 0.0051. This indicated that difference in means was statistically significant.

5.5.8 T – test for Employee Empowerment

The results for Employee Empowerment indicate a mean score of 3.820 for management, with a SD of 0.363 and a SE of 0.0793. Workers' data indicated a mean of 3.836, with a SD of 0.407 and a SE of 0.0549. The difference in means was -0.0159. The null hypothesis could not be rejected for a difference < 0, and a probability of 0.437. No significant difference in means could therefore be concluded.

5.5.9 T – test for Reporting Structure

Management scored a mean of 4.054 for this factor, with a SD of 0.423 and a SE of 0.0903. The mean score for workers was 3.769, with a SD of 0.562 and a SE of 0.0779. The difference in means was 0.285. The null hypothesis was rejected for a difference > 0, with a probability of 0.018. The difference in means was therefore statistically significant.

5.5.10 T – test for Reporting Practice

The mean score for management for this factor was 3.668, with a SD of 0.440 and a SE of 0.0938. Workers scored a mean of 3.486, with a SD of 0.451 and a SE of 0.0603. The difference in means was 0.181. The null hypothesis could not be rejected for a difference > 0 and a probability of 0.056. There was therefore no significant difference in the means of the two groups.

5.5.11 Summary

Of the nine factors subjected to T-tests, five indicated significant differences between the means of the two groups evaluated. Four indicated no significant differences. Of the five that had significant differences, all five had more positive means for management. The total aggregated data also indicated a significant difference in means, strengthening the assessment that a significant difference between means is prevalent in the data set.

5.6 Results for Research Hypothesis H4

Research hypothesis H4 explores the relationship between management involvement and an overall positive safety culture. In order to evaluate if such a relationship exists, a statistical correlation between the Management Involvement factors and the remaining eight factors needs to be explored. The correlation matrix in table 2 already contains this data. Table 4 shows the correlation between Management involvement and the other factors.

	Effect of accountability	Consistency of accountability	Management involvement	Safety commitment	Safety system	Safety values	Employee empowerment	Reporting structure	Reporting practices
Management Involvement	0.35	0.38	1	0.68	0.65	0.57	0.57	0.73	0.44

Table 10: Correlation figures for Management involvement.

From table 4, one can conclude that there are significant positive linear relationships between most of the factors and management involvement. Some relationships are less significant, such as the relationship for both factors of Accountability. These relationships can however not be discarded as being totally insignificant. Figure 8 indicates a clear relationship around a central line when a scatter plot is constructed of Management Involvement versus the average of all the factors, excluding Management Involvement.

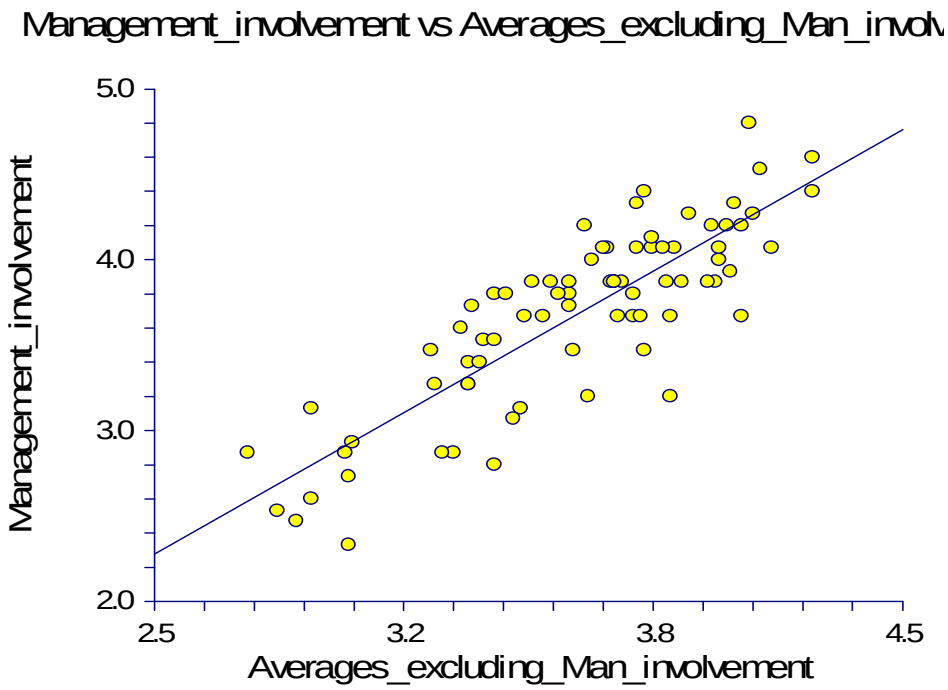

Fig 11: Scatter plot of Management Involvement vs all other factor averages

5.7 Conclusion

This concludes the section on statistical results. The initial data set was subjected to principal component analysis to verify the significance of each of the initial five factors. The data revealed the existence of 7 sub factors within the data set. Some of the data items were removed from the list in order to obtain a better fit of the model. While the fit was not the best possible, it was better than that of the original data. The aggregated data from the principal component analysis provided a point of departure for further analysis specific to the hypotheses made.

Hypothesis H1 and H4 required the verification of correlations between factors.

This was obtained through the construction of a Pearson's correlation matrix for the nine factors identified. Hypothesis H2 and H3 explored the significance of the differences between certain groups' perceptions of the safety culture. This was accomplished by performing two tailed T-tests for 2 samples. Statistical significance of difference in means was used to either support or discount the hypotheses.

CHAPTER 6: DISCUSSION OF RESULTS

6.1 Introduction

In this chapter, the results found by the researcher are explored in more detail. The results are reviewed against the overarching aim of understanding the role that organisational culture plays in the management of safety at a thermal coal mining operation. Each research hypothesis is explored within the context of the literature reviewed in chapter 2, and the results obtained for the sample in chapter 5. The results are critically reviewed, and possible deviations or correlations with the literature base are explored.

The data coding process, principal component analysis and data aggregation have provided a base from which statistically significant insights into the interplay between factors that influence organisational safety culture were gained. It has also provided insight into how different organisational groups respond to these factors.

6.2 Factor Modelling

The factor model derived by Gibbons *et al.* (2006) from the work of Wiegmann *et al.* (2003), delivered factors that were specific to the aviation industry. These factors would have been difficult to reconcile to a measurement of the safety culture of a coal mining operation. The researcher therefore chose to use the original five factor model as presented by Wiegmann *et al.* (2003), and derive a

suitable model for a coal mine.

The analysis of the Accountability factor produced two distinct factors. Given the content of the factors, these factors were named The Effect of Accountability and The Consistency of Accountability. According to Wiegmann *et al.* (2003), communication and understanding of the accountability systems in an organisation are significant indicators of the safety culture. The Effect of Accountability factor that was derived measured this specific aspect of Accountability in the safety culture. Wiegmann *et al.* (2003) also states that the safety culture of an organisation is in part signified by the extent to which accountability systems are consistently applied. The Consistency of Accountability factors measured this aspect of the Accountability construct. The sub factors were found to be consistent with the definitions postulated in the literature.

Three sub factors were derived from the Organisational Commitment factor. These were named the Safety Commitment, Safety Systems and Safety Values factors. Wiegmann *et al.* (2003) states that in the context of safety, the organisational commitment can be measured by evaluating the extent to which senior management identifies safety as a core value. The extent to which operational issues such as procedures and systems are reviewed also form a key component of the commitment measure. The sub factors identified are consistent with the construct definition, with the inclusion of an overall commitment measure.

The Reporting Systems factor provided for the derivation of two sub factors, namely Reporting Structure and Reporting Practices. According to Wiegmann *et al.* (2003), the organisation's reporting system should provide a means for management to take action on potentially dangerous situations before they happen and also provide feedback to employees of action taken to rectify potential safety hazards. The two sub factors derived allow for the measurement of both these requirements.

The Employee Empowerment and Management Involvement factors are similar to that described by Wiegmann *et al.* (2003), with the only difference being the specifics of the environment that were modified, and the questions that were removed for the final analysis. Figure 12 shows the original 5 factor model, and how it has developed into a 9 factor model.

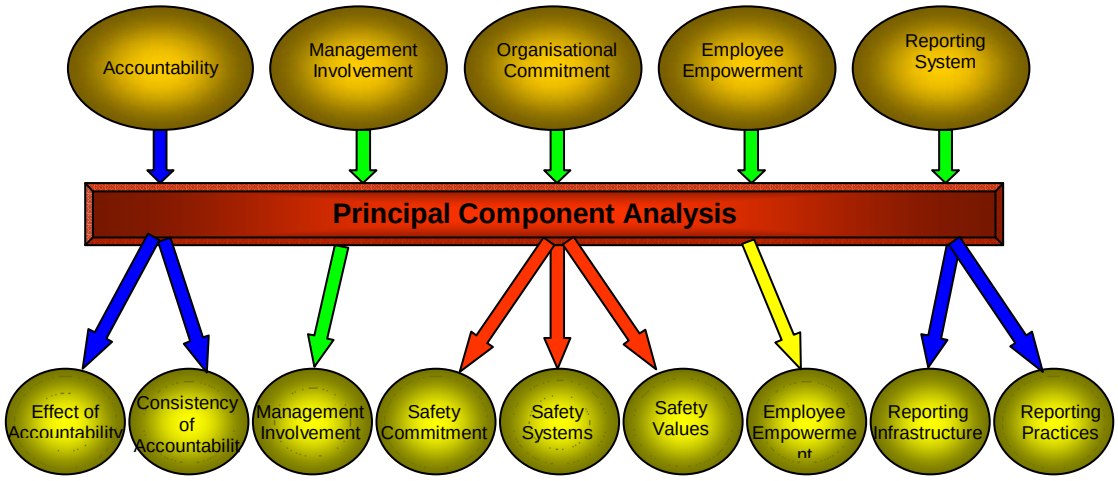

Fig 12. Development of a 9 Factor Model

The factors derived contained elements specific to a mining environment and delivered reliable data as evidenced in Chapter 5, resulting in a very useful

model for evaluating the safety culture of a coal mining operation.

6.3 Research Hypothesis H1

Research hypothesis H1 stated that there is a significantly positive relationship between a strong shared safety value set and the safety culture of a coal mining operation. Wiegmann *et al.* (2004) has identified that shared safety values is an essential component of the safety culture of an organisation. Cummings & Worley (2005, p. 484) have stated that values tell employees what is important to the organisation and should therefore deserve the employees' attention. The values underpin how things are done within the organisation.

In the light of this, the hypothesis sought to explore the deductive notion that can be derived from such definitions. If safety is a strong shared value within the organisation, then the safety culture, and therefore the associated factors of a safety culture model, should have a strong positive relationship with the values.

The result for the hypothesis indicates that there is clearly a positive relationship between the shared safety values and most of the other factors, with the exception of the sub factors identified for Accountability. While the relationship with Accountability is positive, it can at best be described as weak. This implies that within the safety culture, shared safety values will not have a significant impact in ensuring that the reward and penalty systems an organisation implements are documented, communicated and consistently applied. It could

be argued that values are a deeply entrenched characteristic of the organisation, while the reward systems deal with behavioural issues, and not the underlying beliefs and motives that foster a particular type of behaviour.

A moderately significant positive relationship was found for Safety Systems, while more significant positive relationships were found for Safety Commitment, Employee Empowerment and Reporting Practices. Significantly strong positive relationships were found for Management Involvement and Reporting Structure.

On the whole, the results have proved that there is a largely significant positive linear relationship between the shared safety values of the organisation, and the safety culture of the organisation. It has however also revealed that not all the factors that constitute the safety culture are informed by an underpinning shared safety value set. In light of this the research hypothesis H1 is accepted as being proved.

6.4 Research Hypothesis H2

Research hypothesis H2 explores the perceptions of the safety culture of contractors against that of permanent mine employees. The expectation is that contractors will have a weaker perception of the safety culture than what permanent employees do.

Clarke (2003) asserts that contractors face a conflict of demands, with requirements for loyalty from both the host organisation and the direct

employer. This is perceived as a threat to the integrity of the safety culture. Fuller and Vassie (2001) find that the alignment of cultures of partnering organisations bring about harmony where employees feel respected, are optimistic and give of their best. If contractors are not considered as part of the team, and no incentives are provided for contractors to give of their best, such cultural alignment may be difficult, if not impossible.

Two tailed T-test for two samples were carried out on the means of each of the factors. The results for the tests revealed insignificant differences in the means of contractors and mine employees for all factors except two. The Employee Empowerment factor revealed a significantly higher mean score than that of mine employees, while Reporting Structure yielded a significantly lower mean score for contractors.

The Employee Empowerment result presents a paradox, since the implication is that contractors, who are not permanent members of the host organisation, perceive a greater level of enablement than what the permanent members of the organisation do. Clarke (2003) states that the short time contract workers spend immersed in the organisational culture does no allow for them to build relationships and establish stability within the workforce.

The lower score on the Reporting Structure factor indicates that contractors find it more difficult to report incidents, or are more hesitant to report incidents. This could be as a result of fear that they are perceived as trouble makers, or that they are not fully aware of the existing structures to report incidents.

The same T-test was applied to the overall aggregate score of the safety culture survey. The result indicated no significant difference in the mean scores of contractors when compared to that of mine employees. The hypothesis is therefore disproved, implying that the perceptions of the safety culture from both contractors and mine employees can be considered to be almost the same.

A further implication is that the partnering organisations have reached a level of alignment within the organisational safety cultures that allows for contractors to feel part of the team and give of their best. Clarke (2003) stated that there was no clear empirical evidence to suggest that contractors have lower levels of organisational commitment, evidenced through the psychological contracts of the workers, within the aviation industry. This study has provided a basis for arguing that within the mining industry, both mine employees and contractors can have the same perceptions of the safety culture. Such alignment makes it easier to manage the safety aspect of the business, and provide effective leadership to ensure continued safety improvement.

6.5 Research Hypothesis H3

Research Hypothesis H3 sought to explore the perceptions that managers have of the safety culture compared to that of workers. Clarke (2006) posited that there are significant differences in the perceptions of the safety culture between managers and workers within an automobile manufacturing environment. The hypothesis would test whether the same result would be found for a coal mining

operation.

Two tailed T- tests for two samples were conducted on each of the factors of the safety culture model, as well as the overall average score, in order to compare the statistical significance of the difference in means between managers and workers. The result for the overall average score indicated that there was a statistically significant difference in the means of the scores for management and workers. The scores also indicated that the mean score for management was significantly higher than that of workers, implying that managers have a significantly stronger perception of the safety culture than what workers do.

The analysis for the individual factors revealed that five factors had significant mean differences, and the remaining four had no statistically significant differences. All five factors that yielded significant differences had a stronger management perception of the safety culture. The factors that had differences were: Management Involvement, Safety Commitment, Safety System, Safety Values and Reporting Structure.

Management involvement measures the extent to which middle and senior managers get personally involved with issues pertaining to safety. Managers may feel that they are consistently busy driving their involvement with safety through their involvement in safety forums, group risk assessments and safety meetings. Workers however measure the involvement of managers based on how often they see them on the shop floor, engaging workers' concerns

regarding safety and showing concern for the safety of the individual. These tangible engagements leave more of an impression on the average worker than a written instruction from the office of the manager.

The factors of Safety Commitment, Safety System and Safety Values all form part of the original Organisational Commitment factor introduced by Wiegmann *et al.*(2004). The finding of the research is consistent with that of Clarke (2006) and Winter and Jackson (2006), where the measure of the psychological contract (and therefore by implication the organisational commitment) of managers was found to be stronger than that of workers.

Reporting Structure, as a sub construct of the original Reporting System factor, seeks to measure the presence and effectiveness of systems that are available for employees to report unsafe conditions or practices without fear of reprisal. The reason for the significant difference can be ascribed to perceptions that employees reporting incidents are seen as troublemakers.

The factors that yielded no significant mean difference are the following: Effects of Accountability, Consistency of Accountability, Employee Empowerment and Reporting Practices. The two Accountability constructs were developed from the original construct of Wiegmann *et al.* (2004). The constructs measure the extent to which systems for the reward and penalty of safety related behaviour is consistently applied, communicated and understood by all members of the organisation. The fact that the results indicate no significant difference in means implies that the system is indeed effectively communicated and the

understanding of the system is the same across the organisation.

The construct for Employee Empowerment measures the level to which employees feel enabled to make a difference to the safety performance of the mine. The non-significant difference in means between management and workers implies that management and workers have the same views and understanding regarding the rights employees have with regard to representation and rights with regard to safety issues. Furthermore, forums are provided for the enabling of these representations and rights. In the South African mining industry, much of this empowerment is framed through legislation in the form of the Mine Health and Safety Act (MHSA) of 1996.

Reporting practices measures the extent to which employees report near misses or incidents in which they are involved. The lack of a significant difference in means either points to a strong culture of reporting or that management is aware that employees do not always report incidents, and therefore have a lower expectation of reporting practices. Given the finding for the Reporting Structure, the researcher is inclined to accept the second argument.

The overall result is that hypothesis H3 has been proved and accepted. The finding is consistent with results from previous research done in other industries to determine the perspective of management compared to workers within the context of the safety culture.

6.6 Research Hypothesis H4

Research hypothesis H4 sought to find a significantly positive linear relationship between the level of management involvement and the safety culture of a coal mining operation. As indicated in the literature review, this research considers issues of leadership as being associated with the role that management plays with regard to safety. Schein (2004, p. 11) stated that issues of leadership and culture are conceptually intertwined. The expectation would therefore be that if there is a strong level of management or leadership involvement in matters relating to safety, this should be reflected by an equally strong safety culture, i.e. there is a strong relationship between the two constructs.

In order to test the hypothesis, correlations were drawn between the results obtained for Management Involvement and all other factors. The results revealed a strong, positive linear relationship between the level of Management Involvement and other factors of the safety culture. The hypothesis was therefore proved.

The Accountability sub factors showed the lowest correlation indices, yet these were not insignificant. The reason for the low correlation can probably be ascribed to the fact that the Accountability construct does not contain many references to management or leadership involvement, except for one statement. It would therefore stand to reason that there would be low levels of correlation between Management Involvement and Accountability.

The sub factors of Organisational Commitment, namely Safety Commitment, Safety System and Safety Values all indicated fairly significant correlations with Management Involvement, ranging from 0.57 to 0.68. Organisational Commitment in the context of safety refers to the extent to which upper level management identifies safety as a core value of the organisation and demonstrate a lasting, positive attitude toward safety, and to actively promote safety in a consistent manner across all levels within the organisation (Wiegmann *et al.,* 2004). The strong correlation between Management Involvement and Organisational Commitment can therefore be argued to be inseparable, since the extent to which the organisation is committed to safety is directly linked to the extent to which management drive and promote safety.

Reporting Practices had a correlation index of 0.44. While the value is relatively low, it cannot be considered as indicating no significant positive relationship. The reason for the lower correlation is probably linked to the content of the construct. Very little reference is made to direct management involvement. The reporting culture is however reliant on the environment that management create for employees to report incidents and accidents without fear of reprisal.

The Reporting Structure has the highest correlation at an index of 0.73. The structure for reporting is directly linked to management involvement as managers are responsible for creating the systems and channels that employees use to report incidents. Managers also need to regularly communicate these systems and channels, and promote their continued use.

6.7 Summary

In this chapter, the results presented in Chapter 5 were discussed in more detail. The development of the 9 factor model to measure safety culture for a coal mining operation was discussed to provide additional context for the evaluation of the hypotheses. Hypotheses H1, H3 and H4 were proved and accepted, while hypothesis H2 could not be proved and was therefore rejected. The literature base established in Chapter 2 was used as a sounding board to assist with gaining a better understanding for reasons why the hypotheses were either proved or disproved.

CHAPTER 7: CONCLUSION

7.1 Introduction

This chapter briefly discusses the factor model derived as a measurement tool for safety culture within a coal mining operation. The implications of organisational culture based safety management are explored, with recommendations to those tasked with managing safety at coal mining operations. Some of the shortcomings of the research are discussed, together with suggestions for future research.

7.2 Implications of Culture Based Safety Management

The overarching aim of the research was to determine whether organisational culture has any influence on the management of safety in a thermal coal mine. A literature base was developed from work done in industries other than mining, and this was used to develop a measurement tool for the safety culture, a defined subset of organisational culture. The elements identified in the development of the model have clear linkages with the concept of safety management within the context of a thermal coal mining operation.

Organisational cultural factors have already been identified as indicators of safety (Mengoli & Debarberis, 2008). As has been evidenced from the research, organisational cultural factors are applicable within the context of safety management in a coal mining operation. While culture is a dynamic concept, is

different from organisation to organisation, and has the potential to change within an organisation with a change of leadership, one could assert that the concept of organisational safety culture is applicable to the wider mining community.

As a lead indicator, safety culture can give indications of potential threats to safety performance by highlighting changing trends. In the context of the research conducted, and example would be if a sudden significant difference in safety perceptions from contractors is identified. This could alert management to possible negative safety perceptions and attitudes that can be targeted for specific attention and corrective action.

Safety culture analysis has the potential to identify underlying perceptions and attitudes regarding safety that cannot be observed through traditional methods of task observations and the more recent behavioural based safety systems. The latter methods tend to address the symptoms of safety problems with the result that the problems keep recurring. A culture based approach would identify the underlying perceptions and attitudes, allowing management the opportunity to address the root of safety problems.

7.3 Recommendations To Managers

The research opens opportunities for mine managers and those responsible fro safety at mines to harness additional tools against the fight against accidents and fatalities at mines. Safety culture does not address the inherent hazards

associated with mining, but rather focuses on the human response and attitudes to the work environment, its systems and social structures.

While the research used a very complex model to describe the safety culture, the strong relationships identified between some of the factors of the safety culture present an opportunity to develop a simpler model that is easier to administer and analyse. This research specifically identified strong relationships between management involvement, the presence of a shared safety value set, and the safety culture. A survey of one of these factors can be used as a yardstick for the safety culture. Inferences can then be made based on the strength of the relationship between the factors. It is suggested that such survey interventions be done at intermittent periods so that the organisation can build a database with trends.

If a culture based approached is to be implemented, it would be advisable to automate the data gathering process to fast track the analysis. In this way, management can react faster to any changing trends. Such surveys should be anonymous to encourage their use by assuring respondents that their responses open no opportunities for reprisal. Feedback should also be given together with concrete actions to correct problems areas.

The consistency with which previous research as well as this research finds a significant difference in managers' and employees' perceptions of the safety culture creates an opportunity for alignment between managers and employees. Such alignment will require a concerted effort by management to ensure the

gaps in perception of management's involvement in issues of safety are redressed.

Shared safety values have indicated clearly strong relationships with other factors of safety culture. These values are not the espoused values that management develop for the organisation, but are the underlying beliefs that the organisation have regarding safety within the organisation. Over time, the espoused values can become reflected within this underlying set of beliefs if it is consistently lived, communicated and demonstrated. Managers need to understand the gap between what the actual shared values are and what the espoused values are. This will assist managers to steer the organisation towards an improved safety culture.

7.4 Recommendations For Future Research

While the concept of organisational culture in safety is not new, there are a number of areas that can be explored that can add to the body of knowledge already developed. This study has not been able to distinguish any difference in the perceptions of the safety culture between mine employees and contractors. This brings about more questions than answers, since the natural perception within the mining industry is that contractors are less concerned with safety than what mine employees are. Some of the issues pertaining to contractors that may be considered for future research are the following:

- In cases where there is no significant difference between the safety cultures of contractors and mine employees, evaluate whether the

perceived alignment between the contracting company and the host organisation is by design, or due to the natural dynamics of organisational culture.

- Evaluate whether there a significant difference in the safety culture perceptions of contractors that perform work on construction projects as opposed to those that render services under a fixed term, renewable contractual agreement.
- Contractors working on construction projects often make use of subcontractors. Evaluate whether there is a significant difference in the safety culture perceptions between the host contractor and the subcontractor.
- Evaluate whether the unequal distribution of safety incentives between mine employees and contractors has any influence on safety performance and safety culture perceptions.

In the overall evaluation of safety management, the following are areas that can be explored during further research:

- Evaluate whether there is any correlation between strong safety culture perceptions and actual safety performance.
- Reference is often made of the “silly season” in the period during October to December, when the frequency of accidents seems to increase. Evaluate whether these periods correspond with any negative shifts in safety perceptions.

7.5 Summary

The research has added to the body of knowledge in organisational safety culture by extending the understanding of the concept to the context of a South African thermal coal mine. A useful model was developed for the evaluation of the safety culture on a coal mining operation. The hypotheses that were tested have developed better insights into the factors that influence the safety culture of a coal mining operation. Based on the insights, recommendations were made to stakeholders responsible for safety on coal mining operations, and further research areas have been suggested.

Organisational culture based safety management provides an opportunity for mining professionals concerned with safety to develop new leading indicator tools to improve the safety in mines.

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APPENDIX I: Original list of questions

	Accountability system
7	Being involved in an accident or incident, even if it was not your fault, would have an adverse effect on your career with this airline (R).
15	Airline management shows favoritism to certain pilots (R).
23	Pilots who cause accidents or incidents are not consistently held accountable for their actions (R).
29	Standards of accountability are consistently applied to all pilots in this airline.
31	Pilots are consistently held accountable for acting unsafely, even if their actions saved time or money.
37	Being the cause of an accident or incident would have an adverse effect on your reputation with fellow pilots.
40	Action is consistently taken against pilots who violate safety procedures or rules.
49	Pilots get little recognition for new safety ideas (R).
61	Being involved in an accident or incident, even if it was not your fault, has an adverse effect on your reputation with fellow pilots (R).
80	When pilots make a mistake or do something wrong, they are dealt with fairly by the airline.

	Management involvement
1	Management involvement in safety issues has a high priority at my airline.
6	My airline only keeps track of major safety problems and overlooks routine ones (R).
13	Flight management closely monitors proficiency and currency standards to ensure pilots are qualified to fly their assigned flights.
14	My airline's safety department is doing a good job.
21	Upper level management gets personally involved in safety activities.
22	Safety standards are seldom discussed openly (R).
30	Management is receptive to learning about safety concerns.
39	Management has a clear understanding of risks associated with flight operations.
42	Management often fails to recognize when pilots are flying unsafely (R).
51	Results of FAA safety inspections are made available to pilots for review and information.
54	Safety issues are assigned high priority in meetings at this airline.
59	Management stops unsafe operations or activities.
60	Chief pilots do not hesitate to contact pilots to discuss safety issues.
68	Pilots are kept informed of any changes that affect safety.
76	Chief pilots are unavailable when pilots need help (R).
81	There are good communications here about safety.
84	As long as there is no accident, management doesn't care how the flight operations are performed (R).

	Organizational commitment
3	I am confident that maintenance on aircraft is adequately performed and that aircraft are safe to operate.
5	Training focuses more on minimum requirements for a check ride than on safety (R).
10	Management doesn't show much concern for safety until there is an accident or incident (R).
11	Safety is identified as a core value in my airline.
12	Checklists and procedures are easy to understand.
18	Management expects pilots to push the weather (R).

19	Following safety procedures is consistently expected.
20	My airline's manuals are up to date.
26	Safety works until we are busy (R).
27	Management tries to get around safety requirements whenever they get a chance (R).
28	Management is willing to invest money and effort to improve safety.
33	My airline is more concerned with making money than being safe (R).
35	Training practices at my airline are centered around safety.
38	Management views regulation violations very seriously, even when they don't result in any serious damage.
45	Personnel responsible for safety hold a high status in my airline.
46	My airline inappropriately uses the MEL (e.g. illegally, use when it would be better to fix aircraft) (R).
50	Safety is always discussed during training at my airline.
56	Management's view is that not all accidents are preventable (R).
57	Management views FARs as a hindrance (R).
58	Safety is emphasized by my airline during the interview and orientation process.
65	It is hard for pilots here to maintain a consistent sleep schedule (R).
66	My airline does all it can to prevent accidents or incidents.
69	When an accident occurs, management always blames the pilot (R).
72	Management is committed to equipping aircraft with up-to-date technology.
73	Pilots who are not feeling well or are tired are encouraged not to fly.
75	Management expects pilots to push for on time performance, even if it means compromising safety (R).
78	When it comes down to it, people in this airline would rather take a chance with safety than cancel a flight (R).
79	Personnel responsible for safety have authority to implement changes.
82	Some safety procedures/rules are not really practical (R).
83	My airline does not cut corners where safety is concerned.

	Pilot empowerment
4	Pilots are seldom asked for input when airline procedures are developed or changed (R).
8	Pilots are actively involved in identifying and resolving safety concerns.
16	The best pilots in the group expect other pilots to behave safely.
24	Management ensures that all pilots are responsible and accountable for safe flight operations.
32	Pilots are given sufficient opportunities to make suggestions regarding safety issues.
36	Pilots do all they can to prevent accidents.
41	Pilots look at the airline's safety record as their own and take pride in it.
43	My airline rarely questions a pilot's decision to turn around due to weather.
47	Pilots who violate safety regulations upset other pilots even when no harm has resulted.
53	I am encouraged to stop flight-related activities that are unsafe.
62	Peer influence is effective at discouraging violations of operating procedures and flying regulations.
63	Pilots try to get around safety requirements whenever they get a chance (R).
70	It is important to fly safely if I am to keep the respect of other pilots in my airline.
77	Pilots often encourage one another to work safely.

	Reporting system
2	I am familiar with the system for formally reporting safety issues with my airline.

9	Pilots are willing to report information regarding safety violations, marginal aviator performance, and other unsafe behavior.
17	Safety issues raised by pilots are communicated regularly to all pilots in the airline.
25	This airline's safety program includes mechanisms for me to report safety deficiencies.
34	Pilots do not report their own mistakes when they are not obvious (R).
44	Pilots often cover up a hard landing or a close call if they feel they can get away with it (R).
48	It is best to remain anonymous when reporting an unsafe condition or incident (R).
52	When a pilot reports a safety problem, management acts quickly to correct safety issues.
55	Pilots who raise safety concerns are seen as troublemakers (R).
64	Pilots can report safety discrepancies without the fear of negative repercussions.
67	Pilots who admit errors make a big mistake (R).
71	There is no point in reporting a near miss (R).

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

APPENDIX II: Modified Questionnaire

Universiteit van Pretoria
University of Pretoria

GORDON INSTITUTE OF BUSINESS SCIENCE

My name is Howard Pyoos, and I am a registered student at the Pretoria University's Gordon Institute of Business Science, for the Masters in Business Administration degree. I am conducting research on the impact of organisational culture on safety management in a South African thermal coal mining operation. Please assist me by filling in the questionnaire below. It should not take more than 20 minutes to complete. Your participation is completely voluntary and you can withdraw at any time without penalty. All data is completely confidential. By completing the survey, you indicate that you voluntarily participate in this research. If you have any concerns, please contact me or my supervisor.

Researcher: Howard Pyoos **Research Supervisor** Dr Mandla Adonisi
Phone 0837621154 **Phone** 0832940316

Position (Tick the correct box)	Management	Supervisor	Artisan/Miner/Process controller	Operator / Assistant / General worker
Tick the appropriate box	Contractor	Mine employee		

If you are a contractor, please choose one of the boxes below that is applicable to you

Long term contractor, on site almost every day	Medium term contractor , on site at least once or twice a week	Short term contractor, only on site when required by mine

How long have you been working at the mine?

years	months

Please mark only the box you feel best fits the statements below. There are no wrong answers.

		Strongly disagree	Disagree	Uncertain	Agree	Strongly agree	
1	Managers are very involved with safety issues at this mine						
2	I know how to report incidents and accidents at this mine						
3	Our machines on this mine are kept in good condition and are safe to operate						
4	Employees are not asked for input when procedures are developed or changed						R
5	Training focuses more on how to mine and operate machinery, than on safety						R
6	This mine only keeps track of major safety problems and overlooks day to day problems						R
7	Being involved in an accident or incident, even if it was not my fault, would be bad for my career at this mine						
8	Employees are actively involved in identifying and resolving safety concerns.						
9	Employees are willing to report information regarding safety rules that are broken, and other unsafe behavior.						
10	Management doesn't show much concern for safety until there is an accident or incident						R
11	Safety is identified as a core value at this mine						
12	Checklists and procedures are easy to understand.						
13	Mine management closely monitors training and competency tests to ensure employees are qualified to do their jobs.						
14	This mine's safety department is doing a good job.						
15	Mine management shows favouritism to certain employees.						R
16	The best employees in the group expect other employees to behave safely.						
17	Safety issues raised by employees are communicated regularly to all other employees at the mine.						
18	Management expects employees to work in poor conditions such as dust, mist or storms						R
19	Following safety procedures is always expected.						
20	The mine's procedures are up to date.						
21	Upper level management gets personally involved in safety activities.						
22	Safety standards are seldom discussed openly.						R
23	Mine workers who cause accidents or incidents are not always held responsible for their actions .						R
24	Management ensures that all employees are responsible and accountable for safe mining operations.						
25	This mine's safety program includes ways for me to report safety problems.						
26	Safety only works until we are busy with a breakdown .						R
27	Management tries to get around safety requirements whenever they get a chance.						R

28	Management is willing to invest money and effort to improve safety.						
29	Employees are always held accountable for safety at this mine						
30	Management always listens to safety concerns that are raised.						
31	Employees are always held accountable for acting unsafely, even if their actions saved time or money.						
32	Employees are given enough opportunities to make suggestions regarding safety issues.						
33	The mine is more concerned with making money than being safe						R
34	Employees do not report their own mistakes when no one else has seen them						R
35	Training practices at the mine are centered around safety.						
36	Employees do all they can to prevent accidents.						
37	Being the cause of an accident or incident would have an negative effect on my reputation with fellow employees						
38	Management views breaking of safety rules very seriously, even when they don't result in any serious incident or accident.						
39	Management has a clear understanding of risks associated with mining/process operations.						
40	Action is always taken against employees who break safety procedures or rules.						
41	Employees look at the mine's safety record as their own and take pride in it.						
42	Management often fails to recognize when employees are working unsafely						R
43	The mine rarely questions an employee's decision to stop working due to unsafe conditions						
44	Employees often cover up a near miss or a close call if they feel they can get away with it						R
45	Personnel responsible for safety hold a high status at the mine						
46	As long as there is no accident, management doesn't care how the mining/washing operations are performed						R
47	Employees who break safety regulations upset other employees even when no harm has resulted.						
48	It is best if you do not give your name when reporting an unsafe condition or incident .						R
49	Employees get little recognition for new safety ideas						R
50	Safety is always discussed during training at the mine.						
51	Results of DME safety inspections are made available to employees for review and information.						
52	When an employee reports a safety problem, management acts quickly to correct safety issues.						
53	I am encouraged to stop my work if conditions are unsafe.						
54	Safety issues are very important in meetings at this mine.						
55	Employees who raise safety concerns are seen as troublemakers						R
56	Management's view is that not all accidents are preventable						R
57	Management views risk assessments as a waste of time						R
58	Safety is emphasized by this mine during the interview and induction process.						
59	Management stops unsafe operations or activities.						
60	Supervisor and HOD's do not hesitate to contact employees to discuss safety issues.						
61	Being involved in an accident or incident, even if it was not my fault, has an negative effect on my reputation with fellow employees						R
62	My fellow employees encourage me not to break safety rules						
63	Employees try to get around safety requirements whenever they get a chance .						R
64	Employees can report safety incident without the fear of victimisation.						
65	It is hard for shift worker at this mine to maintain a consistent sleep schedule						R
66	This mine does all it can to prevent accidents or incidents.						
67	Employees who admit errors make a big mistake						R
68	Employees are kept informed of any changes that affect safety.						
69	When an accident occurs, management always blames the employee involved						R
70	It is important to work safely if I am to keep the respect of other employees at this mine.						
71	There is no point in reporting a near miss						R
72	Management is committed to equipping the mine with up-to-date technology.						

73	Employees who are not feeling well or are tired are encouraged not to work.						
74	Management expects employees to push production, even if it means compromising safety						R
75	Supervisors and managers are unavailable when employees need help						R
76	Employees often encourage one another to work safely.						
77	When it comes down to it, people in this mine would rather take a chance with safety than stop production						R
78	Personnel responsible for safety have authority to implement changes.						
79	When employees make a mistake or do something wrong, they are dealt with fairly by this mine.						
80	There are good communications here about safety.						
81	Some safety procedures/rules are not really practical						R
82	The mine does not cut corners where safety is concerned.						

Note: R denotes reverse scoring statements. This column was removed from the final questionnaire distributed to repondents

APPENDIX III: Results of Survey

Management	M	Supervisor	S	Long term contractor	Lo
				Medium term	Me
Artisan/Miner/Process operator	A	Operator / Assistant / General worker	O	Short term	Sh

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Position	M	A	A	M	S	A	A	O	O	A	A	A	O	M	M	O	O	M	O	A	O	O	O	O	A
Contractor (Yes/ No)	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	N	N	Y	N	N	N
If Contractor, term																		Sh	Sh			Me			
Years at mine	21	12	1	5	20	3	2	3	7	11	11	2	8	2	1	2	10			1	16		17		2
1	5	5	5	5	4	2	4	5	4	5	4	5	4	5	5	4	4	4	5	5	4	5	5	4	4
2	4	5	5	5	5	5	5	5	5	4	4	4	4	5	5	5	4	4	4	4	4	3	5	4	4
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68	4	4	3	5	4	4	4	4	3	4	4	4	4	4	4	5	4	5	4	4	4	5	4	4	4
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70	4	4	4	5	4	4	4	5	4	4	4	4	4	2	4	5	4	4	3	4	5	3	2	4	4
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72	4	4	3	4	3	5	1	1	1	4	4	4	4	4	1	5	2	5	4	4	5	3	4	3	3
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74	5	4	5	4	4	3	3	3	3	2	4	4	2	5	4	1	1	2	2	4	2	2	4	5	5
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82	5	4	4	5	3	1	1	1	1	2	4	4	4	4	5	5	4	4	5	4	3	4	4	4	4

Management	M	Supervisor	S	Long term contractor	Lo
				Medium term	Me
Artisan/Miner/Process operator	A	Operator / Assistant / General worker	O	Short term	Sh

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Position	S	O	O	M	O	O	M	S	O	O	A	S	O	O	A	O	M	A	O	O	O	O	O	O	O	A	S
Contractor (Yes/ No)	N	Y	Y	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N
If Contractor, term		Sh	Sh				Lo													Lo							
Years at mine	14			14	12	27	5	2	2	2	16	1	3	13	4	23	0.3	16	0.5	0.6	7	3	16	18	25	10	11
1	5	1	1	5	4	2	4	4	5	5	5	4	4	5	3	5	2	5	4	4	4	4	5	5	5	3	5
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69	4	2	2	4	1	2	4	4	2	5	4	4	4	1	1	1	4	4	4	4	2	4	4	4	4	2	4
70	4	5	5	4	5	4	3	4	5	5	4	2	5	5	4	5	3	4	4	4	5	4	5	4	4	4	4
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73	2	4	3	3	1	2	4	4	4	5	4	3	3	3	2	3	4	2	3	3	3	3	4	4	2	1	4
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81	2	4	2	3	1	2	3	4	5	1	4	3	2	3	2	3	2	2	4	5	2	4	2	2	4	2	1
82	4	2	4	4	5	2	4	4	4	2	5	4	5	4	3	4	5	5	4	4	2	5	4	4	2	2	5

Management	M	Supervisor	S											Long term contractor	Lo												
														Medium term	Me												
Artisan/Miner/Process operator	A	Operator / Assistant / General worker	O											Short term	Sh												

	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
Position	O	M	A	A	A	A	A	S	O	O	O	O	M	A	O	O	A	S	M	A	M	S	O	O	M	S
Contractor (Yes/ No)	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
If Contractor, term						Me	Me	Me	Me	Me	Me	Me	Me		Lo	Lo	Lo	Lo	Lo	Lo	Lo	Lo	Lo	Lo	Lo	Lo
Years at mine	1	21	12	1	12	0.6		2	4	4	2	4		2		2	1	1			1	6		0.2	1	
1	5	5	5	5	4	4	5	4	4	4	1	4	4	4	4	5	4	5	5	5	5	5	4	4	4	1
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36	4	3	4	5	3	4	4	4	4	2	4	4	4	5	4	5	4	5	4	4	4	4	4	5	5	3
37	5	3	1	4	4	4	3	4	4	4	2	2	2	5	2	5	3	5	3	3	4	2	5	5	2	3
38	5	5	4	5	5	4	4	4	4	5	2	2	3	5	4	5	4	5	4	4	5	5	3	4	4	1
39	4	4	4	4	5	4	4	4	4	4	2	4	4	5	4	5	4	4	4	4	4	5	3	4	2	5
40	4	4	4	5	5	4	4	4	4	4	2	5	4	5	4	4	4	3	4	4	4	5	5	5	4	1
41	4	4	5	4	4	4	4	4	4	4	4	4	3	5	5	5	4	5	5	4	4	4	3	5	5	2
42	4	4	3	4	3	2	4	3	2	4	2	2	4	1	4	5	4	5	4	4	4	4	5	4	5	5
43	2	3	4	2	2	4	4	4	4	2	3	4	3	5	2	2	4	2	2	2	2	2	3	1	4	3
44	2	2	2	2	2	4	2	3	4	2	2	2	3	1	4	5	4	5	5	4	4	4	3	4	4	5
45	4	4	4	3	2	4	4	3	4	2	4	2	2	5	2	1	2	1	4	4	4	2	3	3	5	2
46	4	5	4	4	4	4	4	4	4	2	4	4	3	1	4	5	4	5	4	4	5	4	2	4	4	2
47	4	2	4	4	4	4	4	4	4	5	2	4	2	5	5	4	4	4	4	4	4	4	3	4	2	1
48	4	4	4	2	4	2	4	5	2	3	2	4	2	2	4	2	4	2	3	4	4	4	5	3	5	5
49	4	4	2	3	1	2	4	4	2	2	4	2	2	1	4	5	4	5	2	2	4	4	3	3	4	5
50	4	4	5	4	5	4	4	4	4	5	4	5	4	1	5	5	4	5	5	4	2	4	4	5	5	5
51	4	3	4	3	2	4	4	4	4	3	2	3	3	3	5	4	4	4	4	4	4	4	3	4	4	5
52	4	4	4	4	4	3	4	4	3	4	2	4	4	3	5	5	4	5	4	4	4	4	2	4	5	4
53	4	5	4	5	5	5	4	5	5	5	4	5	5	5	4	5	4	5	4	4	4	4	3	4	4	5
54	4	5	4	5	4	4	4	4	4	5	4	5	4	5	4	5	4	5	4	4	4	4	3	5	5	5
55	4	5	4	5	5	2	4	2	2	5	4	5	4	1	4	4	4	4	5	4	4	4	2	4	4	4
56	4	4	4	4	4	3	2	2	3	5	2	4	4	5	4	5	4	3	4	4	4	4	3	3	4	5
57	5	5	4	4	5	5	4	4	5	4	4	5	4	5	4	1	4	5	5	4	5	4	3	5	5	5
58	4	4	4	5	4	4	4	2	4	5	2	5	4	5	4	5	4	5	4	4	2	4	4	5	2	4
59	4	4	4	5	4	4	4	4	4	1	2	1	4	5	4	5	4	5	4	4	4	4	2	4	2	5
60	4	4	4	4	4	4	4	4	4	2	2	2	4	4	4	5	3	5	4	4	4	4	4	5	2	5
61	2	4	2	2	3	2	3	3	2	2	4	2	2	1	4	2	2	2	4	4	2	4	4	4	2	1
62	4	3	4	5	5	2	4	4	2	5	2	5	4	5	5	4	4	1	4	4	1	4	3	4	4	5
63	4	4	4	3	4	2	4	2	2	4	4	4	3	3	3	1	4	2	4	4	3	4	3	2	2	2
64	3	5	4	4	5	4	4	4	4	4	2	4	4	2	4	5	4	5	4	4	3	5	3	4	2	2
65	3	4	2	4	1	4	3	2	4	4	2	4	3	2	4	4	4	4	3	3	4	4	3	3	2	3
66	5	4	4	4	4	4	4	4	4	4	2	4	4	4	4	5	4	5	4	4	4	5	3	5	5	4
67	4	5	5	5	3	4	4	2	4	2	2	2	3	3	4	2	4	2	4	4	4	4	3	5	4	3
68	4	4	4	3	4	2	4	4	2	5	2	5	4	5	4	5	4	5	4	4	4	5	3	4	4	2
69	3	4	4	3	1	2	4	3	2	4	4	4	2	2	4	5	4	5	4	4	4	4	3	3	2	5
70	4	4	4	4	4	4	4	4	4	5	2	5	4	5	4	5	4	5	4	4	4	4	3	4	4	1
71	4	5	5	5	4	3	4	4	3	4	4	4	4	5	4	1	4	1	5	4	5	4	2	5	4	5
72	4	4	4	3	4	4	4	4	4	4	2	4	4	3	4	5	4	5	4	4	4	5	3	4	4	2
73	4	4	2	4	4	1	4	3	1	4	4	4	3	3	3	2	3	2	4	4	4	5	4	3	4	2
74	4	5	4	5	5	3	4	4	3	4	3	4	4	4	4	5	4	5	4	4	4	4	2	5	2	1
75	4	3	4	4	4	2	4	4	2	1	2	1	4	4	4	5	4	5	4	4	5	4	2	4	4	1
76	4	4	4	4	4	3	4	4	3	4	4	4	5	5	4	5	2	5	5	4	5	4	5	5	5	5
77	4	4	4	4	2	2	2	3	2	5	2	5	4	3	4	1	4	1	4	4	4	4	4	2	2	2
78	4	4	2	3	3	4	2	4	4	4	3	4	4	5	4	5	4	5	4	4	4	4	3	3	4	3
79	4	4	4	4	2	3	4	3	3	3	2	3	3	3	4	1	4	1	4	4	4	5	3	4	2	2
80	4	4	4	4	4	4	4	4	4	5	4	5	4	5	5	5	3	5	5	4	4	4	3	5	4	2
81	4	4	2	3	1	2	4	3	2	4	4	4	3	1	4	1	4	1	4	4	4	4	3	3	4	3
82	4	4	4	4	4	2	4	4	2	4	2	4	4	5	4	5	4	5	5	4	4	4	3	4	4	3

APPENDIX IV: Summarised Scale

Level coded	Contractor coded	Effect of accountability	Consistency of accountability	Management involvement	Safety commitment
1	0	4.00	3.87	4.67	4.09
2	0	3.50	3.87	3.67	4.09
2	0	3.50	3.87	3.50	4.27
1	0	4.25	4.53	4.67	4.45
1	0	3.00	3.40	3.50	3.55
2	0	3.00	2.53	2.50	3.82
2	0	3.50	2.73	1.33	4.09
2	0	3.50	2.60	1.33	3.73
2	0	3.50	2.93	1.33	4.00
2	0	2.75	2.87	3.67	3.45
2	0	4.00	4.20	4.00	4.18
2	0	4.00	4.27	4.17	4.27
2	0	2.25	3.47	3.83	3.45
1	0	3.50	4.80	4.33	4.64
1	0	3.75	4.20	4.17	4.55
2	0	4.50	3.67	4.50	3.55
2	0	4.00	3.53	2.00	3.18
1	1	2.25	3.73	4.00	2.82
2	1	3.50	3.47	4.17	3.73
2	0	3.25	4.07	3.83	3.73
2	0	3.50	3.67	4.17	4.00
2	1	3.25	2.87	3.33	3.55
2	0	3.50	3.80	3.50	4.00
2	0	3.75	3.87	3.50	3.82
2	0	3.75	3.87	3.33	3.91
1	0	4.00	3.87	3.67	4.00
2	1	3.25	2.80	3.50	3.45
2	1	3.00	3.13	2.83	2.64
1	0	3.00	4.20	4.33	4.09
2	0	4.50	3.13	4.17	4.27
2	0	3.50	2.33	2.67	2.91
1	1	3.75	4.00	3.67	3.91
1	0	3.25	3.67	3.50	3.73
2	0	3.75	4.07	3.17	4.00
2	0	2.75	3.07	3.50	3.00
2	0	3.75	4.07	4.17	3.55
1	0	3.00	3.87	3.17	3.91
2	0	3.00	3.40	3.50	3.09
2	0	3.25	3.73	3.33	3.55
2	0	3.50	2.87	2.67	2.82
2	0	2.50	3.80	3.33	3.45
1	0	4.50	4.07	4.33	4.64
2	0	3.50	4.07	4.33	4.00
2	0	4.00	4.00	3.83	4.27
2	1	3.50	4.20	3.50	4.45
2	0	3.50	3.80	3.17	3.82
2	0	3.00	3.80	3.83	4.09
2	0	2.75	3.67	3.83	3.91
2	0	4.00	4.07	4.00	4.09
2	0	3.00	3.60	3.00	3.45
2	0	3.00	3.27	3.17	3.36
1	0	3.50	3.87	4.00	3.73
2	0	4.00	4.07	4.17	4.18
1	0	4.00	3.87	4.50	4.09
2	0	3.50	3.87	3.67	4.09
2	0	3.50	3.87	3.83	4.27
2	0	3.00	3.47	3.67	3.82
2	1	3.25	3.27	3.33	3.55
2	1	4.00	4.13	3.83	4.00
1	1	4.00	3.87	3.67	3.55
2	1	3.25	3.27	3.33	3.55
2	1	3.75	3.20	3.83	3.55
2	1	2.50	2.47	2.67	3.00
2	1	3.75	3.20	3.83	4.27
1	1	3.25	3.67	3.67	3.64
2	0	3.00	3.80	3.33	4.00
2	1	4.00	4.33	4.00	4.00
2	1	3.75	4.40	4.67	4.64
2	1	3.50	3.67	4.00	3.82
1	1	4.50	4.60	4.83	4.64
1	1	3.00	4.07	4.33	4.27
2	1	3.00	4.27	3.83	4.27
1	1	3.50	4.33	4.17	4.00
1	1	4.25	4.40	4.33	4.18
2	1	3.50	2.87	3.33	3.45
2	1	3.50	3.93	4.00	4.55
1	1	3.50	3.67	3.67	3.73
1	1	3.00	3.53	2.50	3.82

Level coded	Contractor coded	Safety values	Employee empowerment	Reporting structure	Reporting practices
1	0	3.58	4.60	3.14	2.47
2	0	3.83	4.20	3.71	2.75
2	0	4.17	4.40	3.57	2.83
1	0	4.00	4.20	3.57	2.55
1	0	3.58	3.80	3.14	2.31
2	0	3.33	1.80	2.71	1.97
2	0	3.33	1.60	3.71	2.13
2	0	3.42	1.40	3.86	2.13
2	0	3.17	1.20	3.71	2.02
2	0	3.00	3.80	3.14	2.39
2	0	4.00	4.20	4.00	2.84
2	0	4.00	4.40	4.00	2.88
2	0	3.17	3.80	3.14	2.42
1	0	3.92	4.80	3.86	2.71
1	0	4.17	4.60	4.00	2.75
2	0	4.42	4.40	3.86	2.93
2	0	4.00	3.00	3.86	2.57
1	1	3.75	4.00	2.71	2.49
2	1	4.25	4.00	3.57	2.96
2	0	4.00	3.80	3.71	2.70
2	0	4.17	3.60	3.43	2.64
2	1	2.42	2.60	2.43	2.09
2	0	3.50	4.20	3.71	2.68
2	0	3.75	4.20	3.57	2.70
2	0	3.92	4.00	3.57	2.70
1	0	3.83	4.00	3.57	2.48
2	1	3.50	3.80	3.00	2.66
2	1	3.83	2.60	2.71	2.43
1	0	3.75	3.80	3.43	2.40
2	0	4.00	2.60	3.29	2.38
2	0	3.17	2.80	3.43	2.28
1	1	3.58	3.80	3.57	2.59
1	0	3.50	3.60	3.29	2.28
2	0	4.33	4.20	3.71	2.85
2	0	3.08	3.60	4.43	2.62
2	0	3.83	3.60	3.43	2.57
1	0	3.25	4.20	3.86	2.46
2	0	3.83	3.80	3.14	2.56
2	0	3.92	4.00	3.71	2.73
2	0	3.42	2.80	3.43	2.33
2	0	4.00	4.00	3.29	2.66
1	0	3.83	4.60	3.71	2.63
2	0	4.00	3.60	2.86	2.49
2	0	4.17	4.20	4.14	2.90
2	1	4.08	4.40	4.57	3.21
2	0	4.42	4.40	3.57	2.88
2	0	3.75	3.80	3.29	2.57
2	0	4.25	4.00	3.43	2.74
2	0	3.83	4.00	3.14	2.60
2	0	3.42	3.60	3.71	2.55
2	0	3.67	3.60	3.29	2.51
1	0	2.75	3.60	3.43	2.16
2	0	4.00	3.80	3.43	2.65
1	0	3.58	4.60	3.14	2.47
2	0	3.83	4.20	3.71	2.75
2	0	4.17	4.40	3.57	2.83
2	0	4.08	4.40	3.00	2.70
2	1	3.67	3.40	3.29	2.67
2	1	3.92	4.00	3.43	2.87
1	1	3.75	3.20	3.57	2.50
2	1	3.67	3.40	3.29	2.67
2	1	4.42	3.80	2.71	2.79
2	1	2.67	2.80	2.86	2.26
2	1	4.25	3.80	3.43	2.90
1	1	3.75	3.80	3.57	2.62
2	0	4.50	2.80	3.14	2.49
2	1	4.25	4.40	4.29	3.19
2	1	4.17	4.20	3.00	2.87
2	1	3.83	4.00	4.14	3.00
1	1	4.58	4.20	4.00	2.96
1	1	4.17	4.20	4.00	2.87
2	1	4.08	4.00	4.00	3.02
1	1	3.92	3.60	4.14	2.73
1	1	4.25	4.40	4.43	3.02
2	1	3.42	2.40	3.00	2.36
2	1	4.17	4.20	4.14	3.10
1	1	4.42	4.00	4.43	2.97
1	1	3.08	3.60	4.14	2.57