CAUSES OF SUB-STANDARD PRACTISES AND THE EFFECT ON SAFETY PERFORMANCE IN SOUTH AFRICAN GOLD MINES

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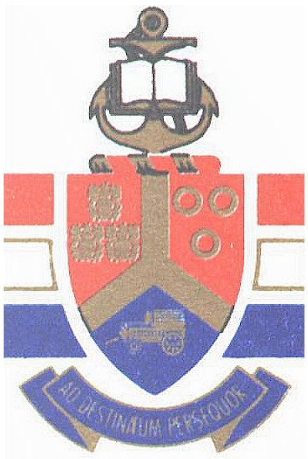
IN THE FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND INFORMATION TECHNOLOGY

DEPARTMENT OF MINING ENGINEERING

UNIVERSITY OF PRETORIA



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ABSTRACT

CAUSES OF SUB-STANDARD PRACTISES AND THE EFFECT ON SAFETY PERFORMANCE IN SOUTH AFRICAN GOLD MINES*GERARD KLEYN*

External Mentor: Mr. D. Scott

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University: University of Pretoria

Degree: B.Eng. (Mining Engineering)

Date: 07 October 2015

Sub-standard practices and their adverse effects on safety remain a challenge in the South African gold mining industry.The purpose of this study was to investigate the root causes of sub-standard practises and the effects thereof on safety in South African gold mines with the emphasis on underground production personnel at a gold mine in the Free State. The study included a behavioural survey, called Shadowmatch and a comparison to the results of a cultural study performed at what used to be the largest gold producing mining house in South Africa.

The methodology that was used to complete the study included personal interviews with underground production personnel that included a questionnaire. Data from the questionnaires was processed and analysed to obtain the required statistics with regards to sub-standard practises and safety.

The results obtained from the study at the gold mine, the Shadowmatch survey conducted on shift bosses and the comparison to previous studies was discussed in Chapter 3. It was found that sub-standard practises had a number of causes and the study pointed out the origin lies within the habits, attitude and behaviour of employees. However, it is important to realise that habits and attitude are not fixed characteristics such as personality and can be changed and influenced over time.

It was concluded that the lack of critical behavioural habits (such as team inclination, conflict handling, leadership, altruism, discipline and resilience) for the given work

environment and job title (in this case underground production employees with the focus having been on shift bosses) could possibly be the number one reason for the occurrence of sub-standard practices.

A number of recommendations, including incorporating basic education in training, improved on the job training and adopting the Shadowmatch tool to establish critical habits required within a certain occupation in a specific environment was recommended.

Keywords: Sub-standard practices, safety, behaviour, habits, Shadowmatch

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a) This project report is based on research done at a gold mine in the Free State. Permission to use the information, pictures and data provided is gratefully acknowledged. The opinions expressed in this document, are those of the author and do not necessarily represent the policy of the company.

b) Particular thanks go to all the employees for their cooperation and provision of information during the duration of this study.

c) The assistance and guidance of the CEBISA team during underground shifts is gratefully acknowledged.

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    c. Mr. Schalk Scheepers - Safety and Health Manager of Mining Operations

    d. Mr. Rudi Olivier - ETD Supervisor

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R:	South African Rand
Moz:	Million ounces
US$:	United States Dollar
oz:	Ounce
Mlb:	Million pounds
JSE:	Johannesburg stock exchange
NYSE:	New York stock exchange
%:	Percentage
km:	Kilometer
#:	Shaft
g/t:	Grams per ton

LIST OF APPENDICES

CHAPTER 1: MOTIVATION FOR STUDY

1. INTRODUCTION

1.1 Background and General Information

1.1.1 Brief History of Gold Mining in South Africa

Jan Gerrit Bantjes made the first discovery of gold on the Witwatersrand on the farm Vogelstruisfontein in June 1884. In September 1884, the Struben brothers uncovered the Confidence Reef near Roodepoort. The reefs discovered by Bantjes and the Struben brothers were however minor reefs. It is largely agreed that the discovery of more important gold reefs on the farm Langlaagte in July 1886 was attributed to George Harrison (South African History Online, 2015).

By August 1886, a mining camp with approximately 3000 inhabitants occupied the area which is now known as the central rand. The gold mining village in the area was named Johannesburg on 3 October 1886. The Witwatersrand Gold Mining Company was the first large company to exploit the reefs of the Witwatersrand. Towards the end of 1887, 14 mines producing a combined annual output of 19 080 ounces of gold was in production on the Witwatersrand (South African History Online, 2015).

According to Superior Mining, (2015) it is estimated that 98% of the country's gold was produced from the goldfields in the Witwatersrand basin. Approximately 42% of the total global gold production was produced from South Africa which equates to more than 1.8 billion ounces of gold (61 000 tonnes) at an average grade of 8.12 g/t (Superior Mining International Corporation, 2015).

Gold production in South Africa started showing a downward trend in 1994. South Africa however remained the world's number one gold producer up to 2007. The Chinese gold market was the first to surpass the South African gold market. The trend was largely attributed to low gold prices, decreasing reserves, reduction of grades, increasing mining costs and political factors (Superior Mining International Corporation, 2015).

According to the Chamber of Mines of South Africa, the gold mining industries of the country was valued at approximately US$ 4 billion and still provides consistent yield on investments.

1.1.2 Brief History of Gold Mining in the Free State

The history of gold exploration in the Free State dates back as far as 1885. Intensive exploration in the area only commenced in 1939 after a borehole was drilled on the farm Aandenk. In 1939, the Basal reef was discovered and led to further intensive exploration. The exploration results in turn led to a gold mining boom in the Free State (Sibanye Gold, 2015).

Exploration drilling for gold and uranium in the southern limb of the Free State Gold Fields began in 1969. In 1976, Union Corporation, a mining house, was bought over by General Mining Corporation Limited whose name later changed to Gencor Limited (Sibanye Gold, 2015).

Gold and its by-products (including uranium, silver and sulphuric acid) have been deemed the most economically important commodity in the Free State. A significant quantity of gold has been estimated to remain in the Free State gold fields; however the current gold price, increased production costs and deeper mines have resulted in a large amount of mines in the area facing closure due to being uneconomical (Vorster, 2015).

1.1.3 Mine Location

The gold mine where the study described in this document was performed (see Figure 1.1.3) is located on the southern rim of the Witwatersrand Basin in the Free State province of South Africa. The mine area is accessed via the N1 highway, driving south from Johannesburg to Kroonstad and then heading south west on the R134 (Gold Fields, 2009).

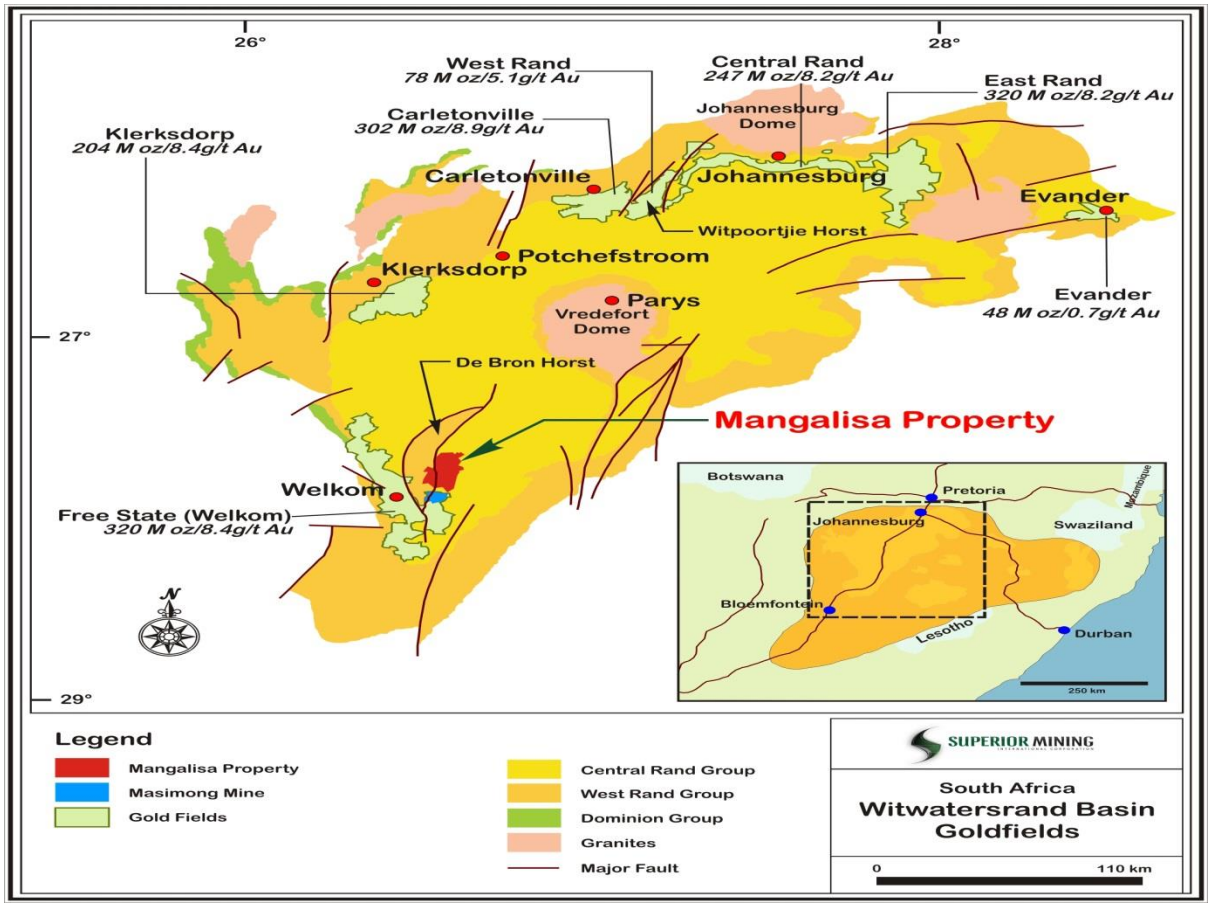


Figure 1.1.3: Gold Fields of the Witwatersrand Basin in South Africa (Superior Mining International Corporation, 2015).

1.1.4 Regional and Local Geology

The mine lies in the southern part of the Witwatersrand Basin. The area where the mine operates is underlain firstly by sediments of the Karoo Supergroup. These are in turn underlain by the volcanic rocks of the Klipsrivierberg Group. The Central Rand Group underlies the previously mentioned group and contains the gold bearing conglomerates that are exploited by the operation. These conglomerates are also termed “auriferous paleoplacers” (Sibanye Gold, 2015).

Figure 1.1.4a illustrates the sequential rock layers that underlie the area.

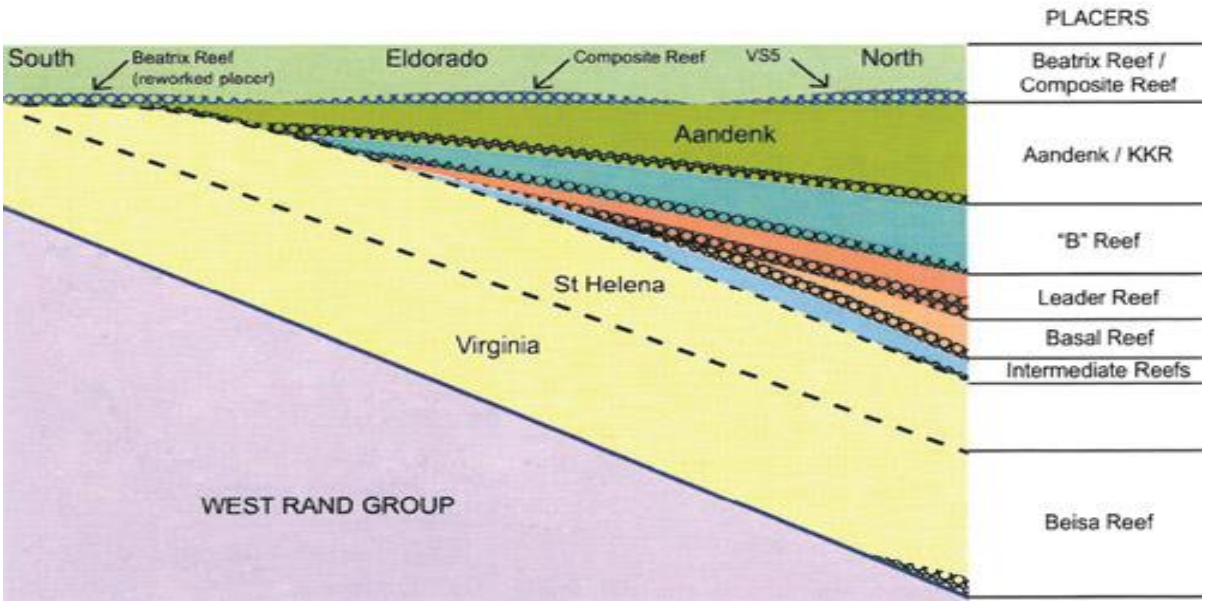


Figure 1.1.4a: A representation of the geological section taken through the depositional sequence in the Free State (Gold Fields, 2009).

One reef occurs at depths between 570m and 1380m while the other reef generally occurs at depths between 1800m and 2200m. Both reefs are characteristically channelised and are made up of multi-cycle, upward-fining conglomerate beds with sharp erosive basal contacts (Sibanye Gold, 2015).

Figure 1.1.4b shows a photograph of a piece of gold containing reef mined in the area where the study was conducted. Note that the gold coloured particles surrounding the white pebbles are actually pyrite minerals and not gold.

Figure 1.1.4b: A photo of a piece of gold containing reef (Gold Fields, 2009).

The majority of the operation lies within Zone 5 which extends to the south of the main channel. The main channel has a 500m to 800m wide east-west trending pay zone (Sibanye Gold, 2015).

The mineral reserve at the mine consists of two main contributing reefs. From a structural geology point of view, the Free State goldfield is located in a syncline which trends north-south. This syncline resulted in the formation of an apex in the south-western corner of the Witwatersrand Basin. A number of unconformities are overlain by successive depositional layers that make up approximately 2000m of the Witwatersrand basin in the Free State. This is an expanding depositional basin. The conglomerate reef that contains the gold often occurs at the bottom of each depositional sequence (Gold Fields, 2009).

The geology of in the area in the western region differs significantly from the geology to the northern and southern regions. Geological conditions towards the west are fairly complex because of an overfold structure that is present in the area. In addition to this, west dipping thrust faulting in the western area of the Witwatersrand Basin further complicate the geological setting of the area. A number of north trending faults with various throws are found in the flatter portions of the reef towards the east (Gold Fields, 2009).

According to Gold Fields, 2009 geological losses have been estimated to be around 5% in most areas and as high as 10% in the west.

1.1.5 Mining Method

Gold mines in the Witwatersrand basin mainly produce gold from underground; however a fraction of the mineral reserves is represented by surface rock dumps that have been accumulated during the course of operations. The mines range from shallow to ultra-deep level operations (Sibanye Gold, 2015).

A conventional breast mining method (see Figures 1.1.5a, 1.1.5b) is used on most operating shafts. This mining method accommodates the need for scattered and selective mining of the orebody. The lateral developments that serve the mining activities are developed approximately 50m below the reef horizon (Gold Fields, 2009).

Cross-cuts are usually spaced 120m apart on strike and all primary development is done by making use of twin haulages. Twin haulages accommodate the scatter mining layout and assists in reducing the methane associated risks at some of the operations.

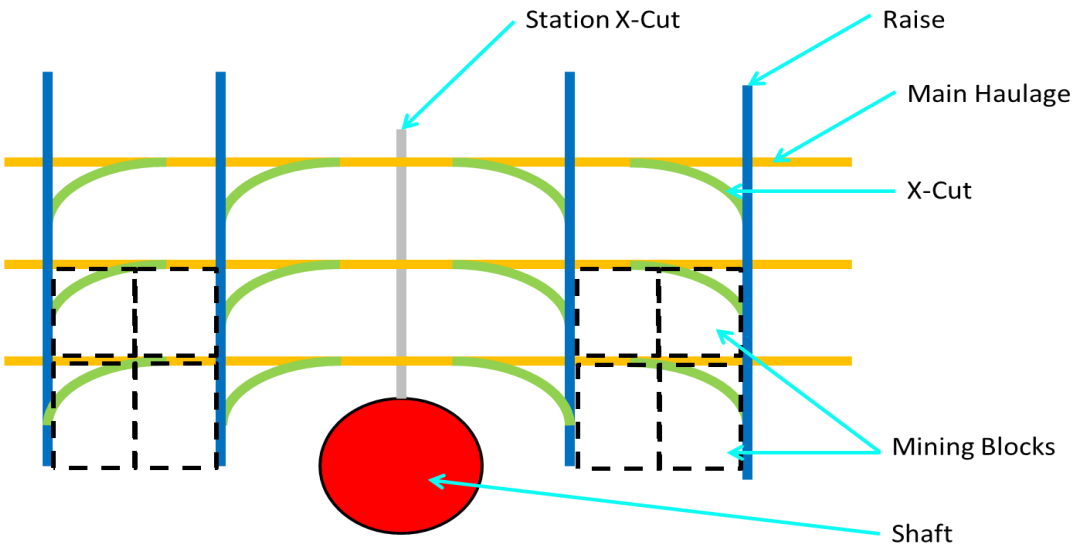


Figure 1.1.5a: A schematic illustration of the macro layout at a typical gold mine.

At some operations, on-reef raise developments tend to be extremely long due to the flat dip of the reef which often requires excessively long crosscuts. The back length of raises ranges between 200m and 500m. In order to mine the reef, access to the reef horizon is required. The reef is accessed as follows:

- An inclined travelling way is developed from the crosscut up to reef elevation.
- A raise is then developed to the level above to establish through ventilation.
- Ledging is performed in order to start the stoping operations.
- During stoping, the raise becomes the center gully.
- Advance Strike Gullies (ASG's) are blasted from the center gully.
- The stoping panels are approximately 30m in length.
- Ore is scraped from the face into the ASG's and then into the center gully from where it is scraped into ore passes.
- The crosscut below is equipped with a boxfront to regulate and control the flow of ore from the orepass to the hoppers that transport the ore.

- A locomotive attached to the hoppers hauls the ore to the shaft ore pass system from where it will undergo further transport process and eventually be conveyed to surface via rock hoists.

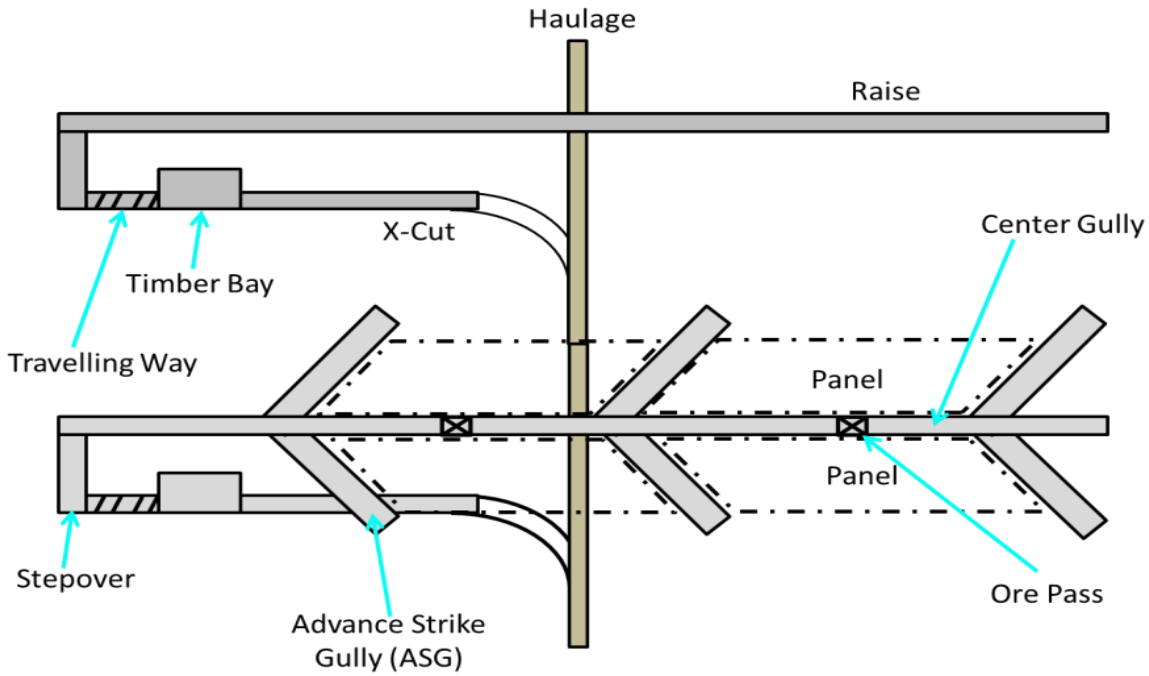


Figure 1.1.5b: Schematic representation of the conventional breast mining layout.

The mines make use of metallurgical gold plants to process the mined ore (Sibanye Gold, 2015). Gold that is mined and extracted at the mining operations is processed in order to produce a beneficiated product called doré. This product is then sent to Rand Refinery for further reification to a purity of 99.5%. (Sibanye Gold, 2015)

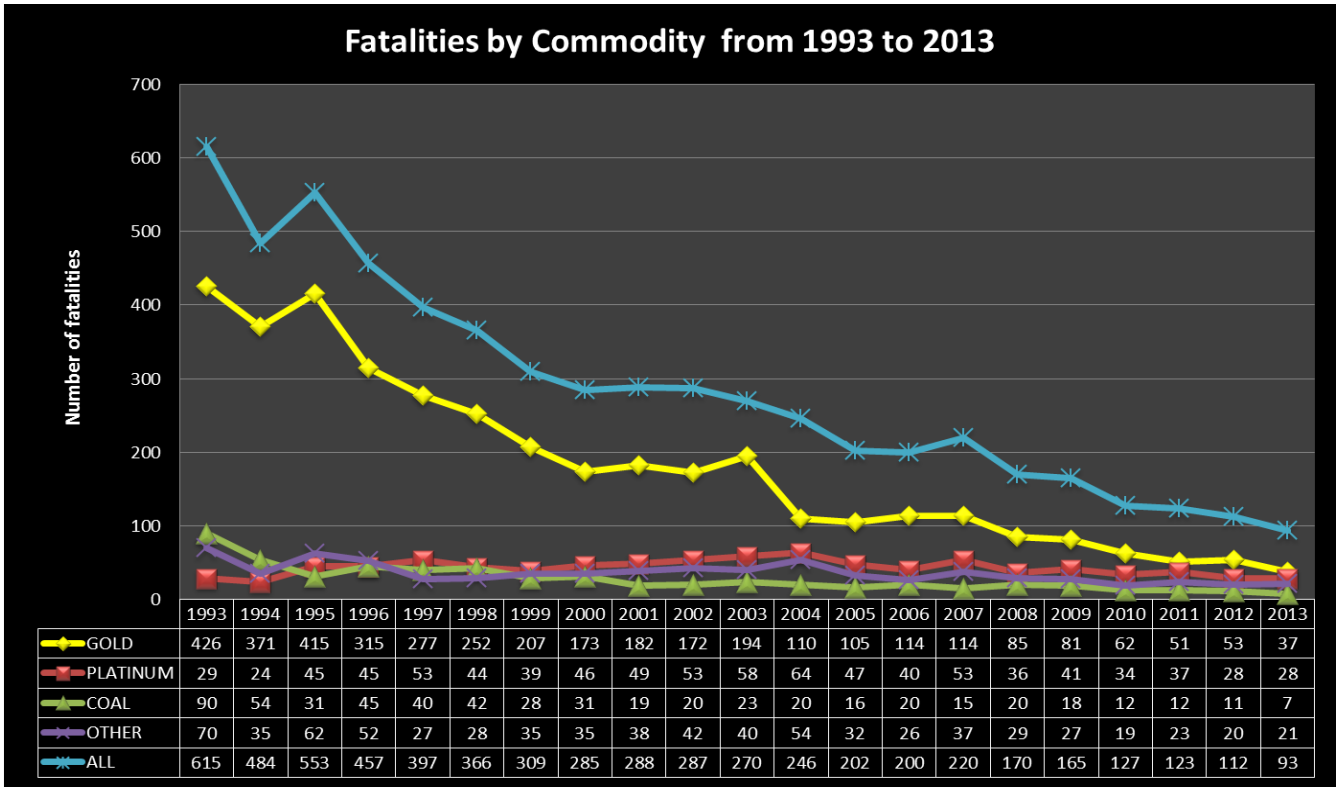
Figure 1.1.5c: An example of a gold plant (Goldfields, 2009).

1.2 Project Background

After the implementation of the Mine Health and Safety Act, 1996 (Act 29 of 1996) and the Mine Health and Safety Regulations, the South African mining industry has been striving to place great emphasis on adherence to mine standards.

The act requires employers in the mining industry to report accidents and dangerous events to the Regional Principal Inspector of Mines in their area. The data provided by employers is captured and analysed by the South African Mines Reportable Accident Statistical System (SAMRASS) and made available for public viewing (Department of Mineral Resources, 2011).

After reviewing the national mine related accident statistics over the past decade, it is clear that the South African gold mining industry is still facing major challenges. This includes meeting the Mine Health and Safety Milestones (Department of Mineral Resources, 2011). From Figure 1.2a below it is clear that the gold mining industry remains in the spotlight when it came to mine injuries and fatalities.

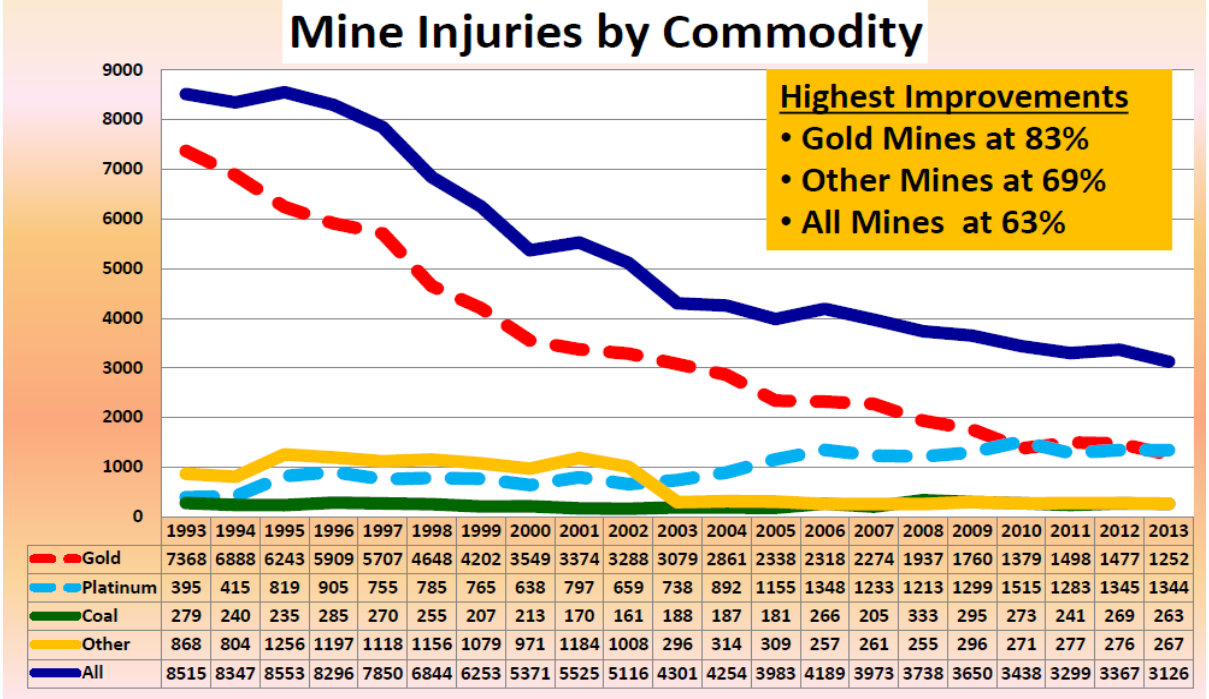


	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
GOLD	426	371	415	315	277	252	207	173	182	172	194	110	105	114	114	85	81	62	51	53	37
PLATINUM	29	24	45	45	53	44	39	46	49	53	58	64	47	40	53	36	41	34	37	28	28
COAL	90	54	31	45	40	42	28	31	19	20	23	20	16	20	15	20	18	12	12	11	7
OTHER	70	35	62	52	27	28	35	35	38	42	40	54	32	26	37	29	27	19	23	20	21
ALL	615	484	553	457	397	366	309	285	288	287	270	246	202	200	220	170	165	127	123	112	93

Figure 1.2a: Fatalities per commodity in South Africa for the years 1993 to 2013 (Mine Health and Safety Council, 2014).

Figures 1.2a and 1.2b illustrate that the gold mining industry of South Africa safety performance still requires improvements. This industry has been the worst performer (in South Africa when compared to other mining industries) for the past 10 consecutive years considering its performance in terms of total injuries and fatalities.

Figure 1.2b exhibits the same trend for injuries in the gold mining industry although this sector has shown the most improvement over time. It is only in recent years (2010-2013) that the platinum sector's injury curve merged with that of the gold sector.



	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Gold	7368	6888	6243	5909	5707	4648	4202	3549	3374	3288	3079	2861	2338	2318	2274	1937	1760	1379	1498	1477	1252
Platinum	395	415	819	905	755	785	765	638	797	659	738	892	1155	1348	1233	1213	1299	1515	1283	1345	1344
Coal	279	240	235	285	270	255	207	213	170	161	188	187	181	266	205	333	295	273	241	269	263
Other	868	804	1256	1197	1118	1156	1079	971	1184	1008	296	314	309	257	261	255	296	271	277	276	267
All	8515	8347	8553	8296	7850	6844	6253	5371	5525	5116	4301	4254	3983	4189	3973	3738	3650	3438	3299	3367	3126

Figure 1.2b: Injuries per commodity in South Africa for the years 1993 to 2013 (Mine Health and Safety Council, 2014).

In Figure 1.2c the percentages for surface and underground accidents for the operation is shown. The chart was drawn from data obtained during the course of the study. These statistics show that at the mine, the underground work environment is more hazardous and the source of most incidents.

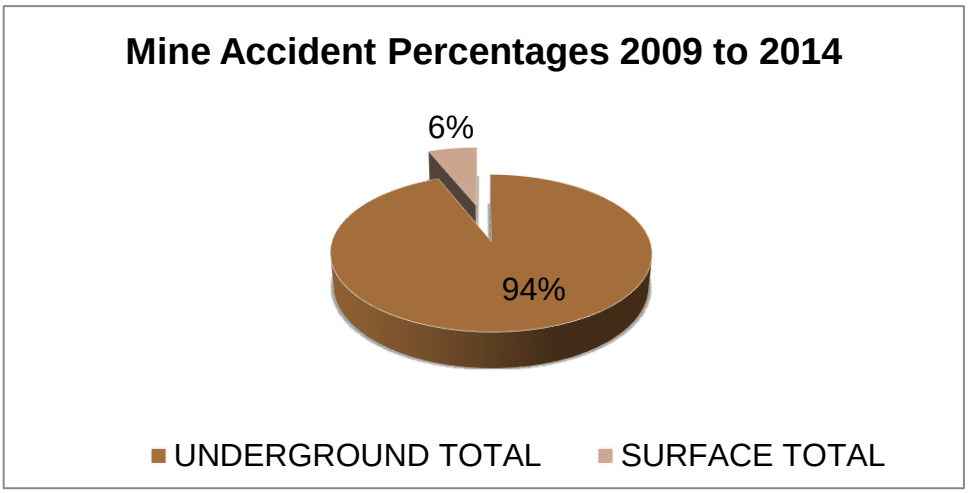


Figure 1.2c: Percentages of accident occurrences at the mine.

The question that management is perplexed about is why employees at the gold mine still engage in sub-standard acts and how this affects safety. It is this question that gave rise to an investigation into what the root causes of sub-standard practises at the mine were.

A 2003 article by Jenny Furness that was published in the *Mining Weekly* magazine stated the following: "***Unique Features:*** *The mine has an abundance of methane intersections, low seismic activity, and a highly motivated and stable workforce, while also being the lowest-cost gold producer in the South African mining industry, also boasting a strong safety performance"* (Furness, 2003).

In discussion with the previous general mine manager, he made it clear that the statement quoted above, is sadly no longer the case based on his observations. In fact, with regards to standards, the workforce is everything but highly motivated and stable based on his personal experience.

After discussion with the previous general mine manager, mine employees and personal investigation, the author's hypothesis is that sub-standard practises usually have multiple causes on different organisational levels and have an adverse effect on the safety performance of South African gold mines.

In order for this culture, where sub-standard practises have become the norm, to change, an investigation must be done to determine what causes employees to engage in sub-standard acts and how to change the behaviour at all levels from management down to underground employees.

Throughout the history of the mine, certain mine standards were developed and implemented to regulate mining activities and more importantly to protect employees and establish a safe working environment. New standards or changes to standards are often implemented after major incidents at the mine.

All employees at the mine are obliged to comply with these standards and implement specific standards in their respective working environments. Failure to comply may result in stopping work, disciplinary hearings and ultimately dismissal. In order to ensure this, the mine has implemented a full compliance policy. The sharp increase in sub-standard practises at the mine indicated that the policies implemented by the company have not resulted in the required safety performance.

Furthermore, a major concern is that the new generation of mine employees are adopting the culture where sub-standard practises are the norm. The language barriers that exists amongst the majority of the workforce, leads to a number of questions with regards to mine standards:

- Do employees really understand what the purpose of standards is?
- Is the employee aware of the hazards and the associated personal risks in his or her working environment?
- Do employees understand how sub-standard practises affect all downstream processes?

In order to address the question, the investigation covered the extent of sub-standard practises in the underground environment.

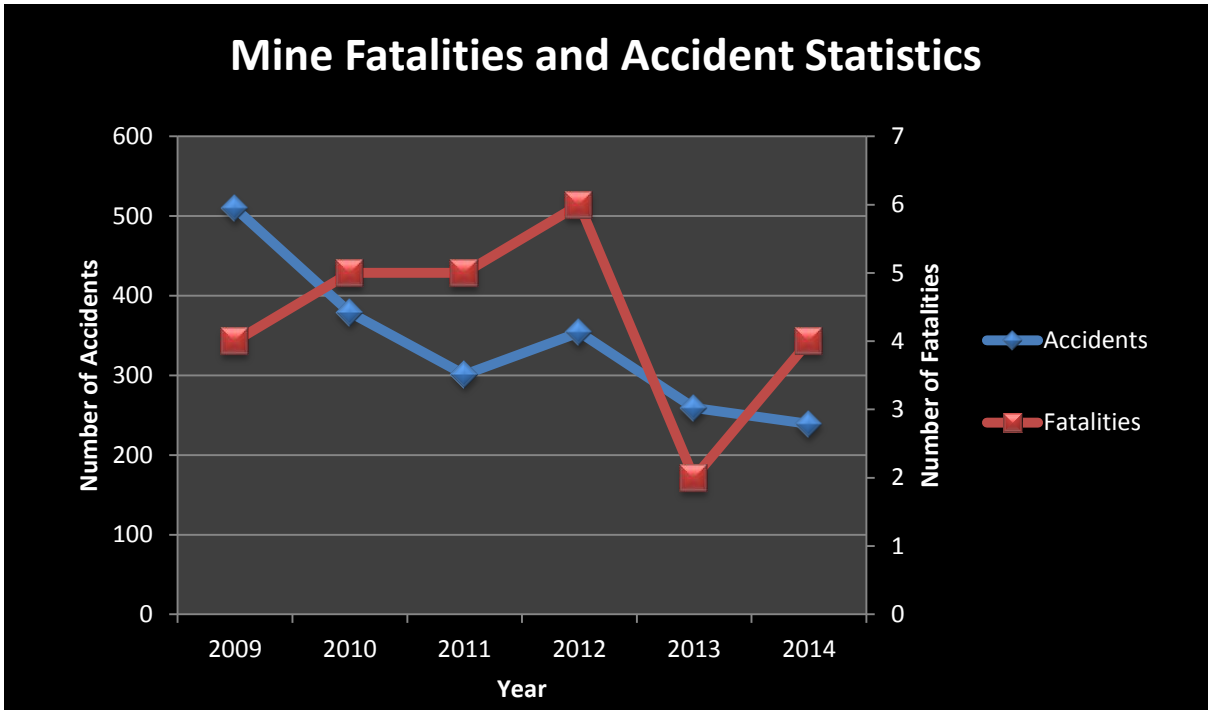


Figure 1.2d: Mine fatalities and accidents from 2009 to 2014.

Figure 1.2d shows the number of accidents and fatalities recorded at the mining operations over the past 5 years. The figure shows that there has been a steady decline in the number of accidents from 2009 to 2014. The reduction in the number of accidents though do not correlate with the fatalities at the operation and thus although the number of accidents is reducing the severity of it has not.

The ideal situation would be to see that the "zero harm policy" of the company comes to reality. Unfortunately, the fluctuations that are present in injury and fatality rates indicate a high probability of the presence of reoccurrences of accidents and fatalities. It is believed that the impacts of proactive standard implementation are of far greater value than the implementation of reactive standards.

1.3 Problem Statement

Current sub-standard practices lead to poor safety performance.

To address this, an in-depth investigation into the root causes of sub-standard practises and their effects on safety in the underground environment in South African gold mines with emphasis on a gold mine in the Free State was conducted.

1.4 Objectives

In order to address the problem at hand by means of an investigative approach, the following objectives were identified:

Objective 1: Carry out research on sub-standard work related accidents at the gold mine.

Objective 2: Identify the root causes of sub-standard practises in the underground working environment.

Objective 3: Determine the effects of sub-standard practises on safety.

Objective 4: Compare study at the mine to cultural study in gold mines in a different mining region.

Objective 5: Conduct a Shadowmatch survey on first line supervisors (shift bosses) and compare the results with the study at the gold mine.

Objective 6: Make recommendations for further study and research into the area of concern.

1.5 Scope of the Study

This study was conducted from late November 2014 to mid-January 2015 at the gold mine. Due to the frequency of underground incidents, a decision was made to focus on sub-standard practises in the underground work environment.

The main focus of this study was to determine behaviour of underground employees and how individual and team behaviour, attitude and mindset influence sub-standard work. The study identified all factors that can be classed as causes of sub-standard practises and identifies the major effects on safety.

Ethics and morals were not included as part of this study, since these fields of interest give rise to an entire study of its own. No underground visits were conducted at 4# due to the time constraints of the study. The majority of information that is discussed in this document was obtained from South Section, followed by North Section. The study does not cover sub-standard practises on surface.

With the focus being on the underground work environment, a comparison between mine standards and actual implemented standards was made. In order to obtain a high degree of accuracy with regards to the data obtained, the study included the following data distributions that were used for analyses of sub-standard practises occurrence:

- Sub-standard practise variety at different shafts (North and South Sections).
- Sub-standard practises according to shift (morning, afternoon and night shift).
- Employee age group distribution.
- Employee experience distribution at the mine.
- Type of occupation e.g. rock drill operator, safety representative, miner etc.

A Shadowmatch survey was completed to determine critical habits amongst successful shift bosses and to establish which habits in the study group were lacking and how they could be changed.

1.6 Methodology

This section describes the methodology that was used in order to satisfy the objectives that were set for the investigation. The methodology for the objectives will be discussed as well as the reasons for choosing certain methodologies in order to acquire the information needed for this study.

A number of difficulties were encountered during the course of this study which resulted in changes in the methodology used for the investigation. These difficulties included:

- Attitudes of employees.
- Cooperation of employees.
- A general lack of education in the labour force.
- Time constraints.
- Communication barriers with regards to language.
- The use of a questionnaire to obtain required information.

The methodology for investigating the problem was changed and a number of remedial actions were taken to address these issues. These actions included:

- Personally interacting with employees rather than using a questionnaire.
- Completing the questionnaire based on what employees said.
- Becoming part of the labour force to gain trust and respect.
- Making an effort to speak Fanakalo as far as reasonably possible.
- Using experienced employees from the CEBISA team to assist in communicating with underground personnel.
- Making notes out of sight or after a shift where the interviewed person was not present.
- Explaining why certain questions are being asked and creating an understanding of the importance of this study.

To obtain background information on the problem, a literature study was conducted on South African gold mine safety statistics and a previous cultural study that was performed at mines in the West Wits region. Safety data was obtained from the Safety Department. Graphs were drawn to represent the provided data and calculations were performed on the data in order to determine where the major area of concern was, with regards to sub-standard practices and safety. Safety department employees were interviewed for their personal opinions on the link between safety and sub-standard practices. Microsoft Excel was used to create all graphs that were used for the analysis of safety data.

A questionnaire was drawn up that was handed out to underground employees. An example of the questionnaire can be found in Appendix A. It was indicated from the answers provided in some questionnaires that the majority of employees did not understand the questions. It was explained to the employees that the questionnaires are completely anonymous for ethical reasons. Due to the lack of education and a questionnaire being time consuming for most employees, it was decided to rather have personal interviews with employees.

Personal interviews proved to be the best means of determining the factors that influence sub-standard practices. It was also found that when employees' were interviewed in their specific working environment, their opinions differed greatly from when interviewed on surface. It was therefore established that all interviews will be conducted underground in their working environments.

Production supervisors were also interviewed in order to compare how their opinions on sub-standard practices differed from those of the underground employees. Questions were asked in such a way as to determine how the attitude and behaviour of the work culture influences the implementation of mine standards. Towards the end of the study, a Shadowmatch survey was conducted on shift bosses from the North and South sections in order to determine benchmark attitudes and behaviour for this group of employees. The rest of the participants' habits were then compared to the benchmark and analysed. The Shadowmatch tool will be discussed in detail in section 2.7

Since most employees speak Fanakalo, an effort was made to communicate with them in this language. When it became difficult to explain technical details, an experienced mining employee who was fully proficient in both English and Fanakalo was used for interpretation of employees' feedback.

The analyses of safety statistics were done using statistical methods and visual interpretations of graphs on which certain trends were evident. A cultural survey performed by Dupont was obtained and analysed in order to determine previously known causes of sub-standard practices and their relation to employee behaviour.

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CHAPTER 2: LITERATURE REVIEW

2. LITERATURE REVIEW

The purpose of the literature review was to determine whether any work has been done in the field of interest and to what extent it had addressed the problem at hand. The literature that was found was critically reviewed to identify gaps in existing studies.

The literature review also aims to confirm the author's opinion that previous work that had been done in an effort to reduce or eliminate sub-standard practises in the South African mining industry, especially in the gold mining sector, was not sufficient to address the problem.

2.1 Mine Standards

Mine standards are as old as the mining industry itself. Mining standards and safety was discussed as early as the 16th century. Agricola described mining hazards in mining operations in the 16th century and said the following*: "Some of these evils, as well as certain other things, are the reasons why pits are occasionally abandoned"* (Hansen, 1973).

The SME Mining Engineering Handbook, (1973), states that all mining operations are required to adhere to local, provincial and governmental regulations that amongst other things specify mine safety regulations and standards, environmental protection and labour relations. The nature, scope and stringency of these regulations ultimately govern the mining operation.

Over the past century, the number and extent of mining regulations and governing authorities have dramatically increased on an annual basis. The major reason behind this is a continuous effort of governments to promote health and safety standards in the global mining industry (Hansen, 1973).

According to Hansen, (1973), a statistical study that was performed over the past 50 years showed that an awareness of the effects of sub-standard practices has resulted in a decreased frequency of accident occurrences. Mine standards include dealing with the identification of risks and prevention of accidents. It is mandatory that all mining companies employ a strategic policy which requires all employees, including contractors and management, to adhere to the standards that are set by the company.

The majority of mine health and safety authorities around the world agree that the major causes of mine accidents and fatalities are unsafe conditions, poor management and especially unsafe practices, which according to the SME Mining Engineering Handbook, is often cited as the primary source (The Society for Mining, Metallurgy and Exploration, 2011).

Due to a combination of sub-standard practices and hazardous conditions, one must consider not only the physical causes of sub-standard practices, but also elements such as training of employees, mental state of employees and employee behaviour (The American Institute of Mining, Metallurgical and Petroleum Engineers Inc., 1973).

The major shortcoming of the majority of the approaches that have been used to identify the causes of sub-standard practices is that the studies were usually based on hasty investigations, obvious physical factors and common causes of sub-standard acts.

Studies conducted in this manner revealed nothing more than what is already known. There exists a general tendency to exclude human behaviour in studies that investigate causes of sub-standard practises. Human behaviour however, is a detrimental factor in mine safety. This is evident from the cyclical re-appearance of repeat accidents that are commonly found in safety statistics. The shortcoming of statistical analysis of incidents in the mining industry is the following: these studies focus on safety performances and frequencies of incident occurrences, but neglect to determine the root causes of the incident which is linked to the incident's occurrence and safety statistics (The American Institute of Mining, Metallurgical and Petroleum Engineers Inc., 1973).

2.2 Challenges in the South African Mining Industry

The South African mining industry is constantly striving towards achieving reduced mining related deaths, injuries and health problems by implementing standards in order to achieve internationally comparable safety statistics (Department of Mineral Resources, 2011).

In South Africa, the Mine Health and Safety Act (MHSA), Act 29 of 1996 governs the protection of health and safety of employees in the mining industry. It also caters for

the protection of health and safety of those affected by mining activities in the country. The MHSA also aims to enforce health and safety measures and legislation in the South African mining industry (Department of Mineral Resources, 2011). The question remains: is the MHSA sufficient for creating a safety-wise culture in the mining industry?

According to the Department of Mineral Resources (DMR), (2011), the Mine Health and Safety Inspectorate (MHSI) was established in terms of the MHSA in order to amongst other things safeguard the health and safety of mine employees and affected communities. One of the key responsibilities of the MHSI is to promote health and safety in the minerals sector by establishing and applying mine safety standards (Department of Mineral Resources, 2011).

The Mining Qualifications Authority (MQA) is to a great extent responsible for the education and training of employees in the mining industry (Altech Autopage, 2015). Although there has been a steady decrease in accidents in the mining industry over the past 10 years, all stakeholders still agree that the fatality and injury rates are too high. This is especially true for the underground gold mining industry. A primary function of the MQA is to ensure that employees in the mining and minerals sector are competent by providing training to improve health and safety standards and procedures (This is gold, 2015).

The great majority of mining houses in the South African mining industry has adopted a “zero harm” policy in an effort to improve the health and safety of employees at mining operations. Following the 2003 Mine Health and Safety Summit, the following milestone was set with regards to the gold mining industry (Department of Mineral Resources, 2011):

“Achieve safety performance levels equivalent to current international benchmarks for underground metalliferous mines, at the least, by 2013.”

These milestones were revised in 2014 and a new set of targets for 2024 was set for the South African mining industry (Association of Mine Managers of South Africa, 2014). The new milestones that were set in terms of occupational safety are listed below (Association of Mine Managers of South Africa, 2014):

- *“Every mining company must have a target of ZERO FATALITIES.”*

- *“Every Fatality is one too many, we will eliminate fatalities by December 2020.”*
- “*Up to December 2016, 20% reduction in Serious Injuries per year.”*
- “*From January 2017, 20% reduction in Lost Time Injuries (LTI) per year.”*

The 2024 targets that were set after the revision of the 2014 milestones included new milestones for the implementation of the approved culture transformation framework (CTF). These milestones included the following (Association of Mine Managers of South Africa, 2014):

- *“By December 2020 there will be 100% implementation of:*
    - *The Leadership Pillar of the CTF*
    - *The Risk Management Pillar of the CTF*
    - *The Bonus and Performance Incentive Pillar of the CTF*
    - *The Data Management Pillar of the CTF*
    - *The Diversity Management of the CTF*
    - *The Leading Practice pillar of the CTF*

- *After December 2020 the remaining pillars will be implemented:*
    - *The Integrated Mining Activity Pillar of the CTF*
    - *The Technology Pillar of the CTF*
    - *The Inspectorate Pillar of the CTF*
    - *Tripartism Pillar of the CTF*
    - *Regulatory Framework Pillar of the CTF”*

In a 2013 presentation on behalf of the Department of Minerals and Energy, Mr. D. Msiza, Chief Inspector of Mines claims that 2013 was the best year yet with regards to safety in the mining industry since it had yielded the lowest number of fatalities in the history of South African mining. Mr. Msiza however also states that a collective effort is still required to reduce mine accidents, especially in the gold sector (Msiza, 2013). This information, however does not explore the reasons behind why fatalities are still occurring.

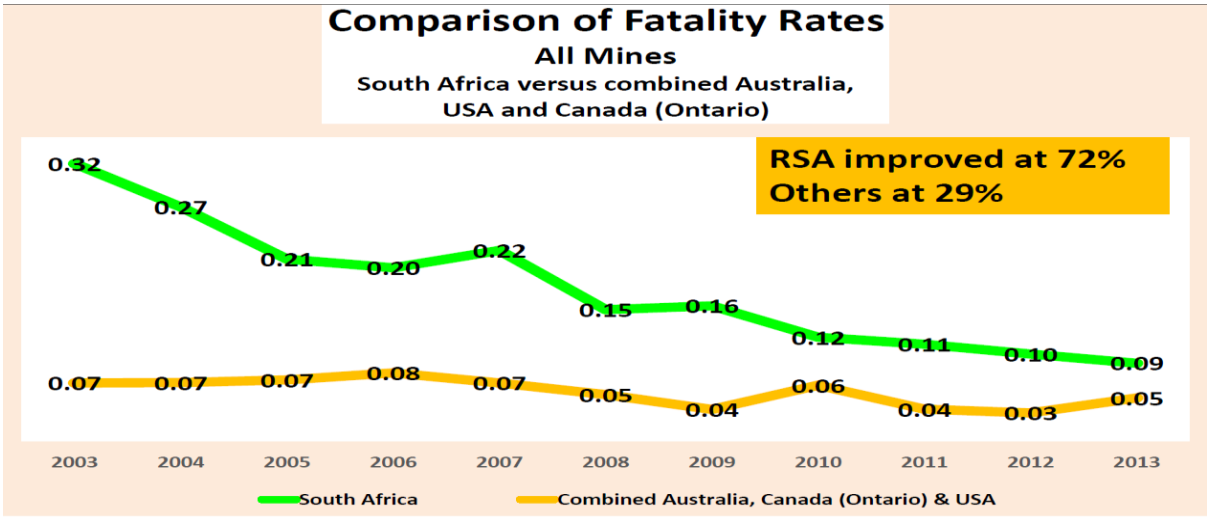

Figure 2.2a: South African fatality rates compared to international benchmark (Msiza, 2014).

From Figure 2.2a it is evident that the South African mining industry has a fairly steady downward fatality trend in comparison to the relatively stable international benchmarks. The international fatality rate benchmark is still lower than the current South African fatality rate.

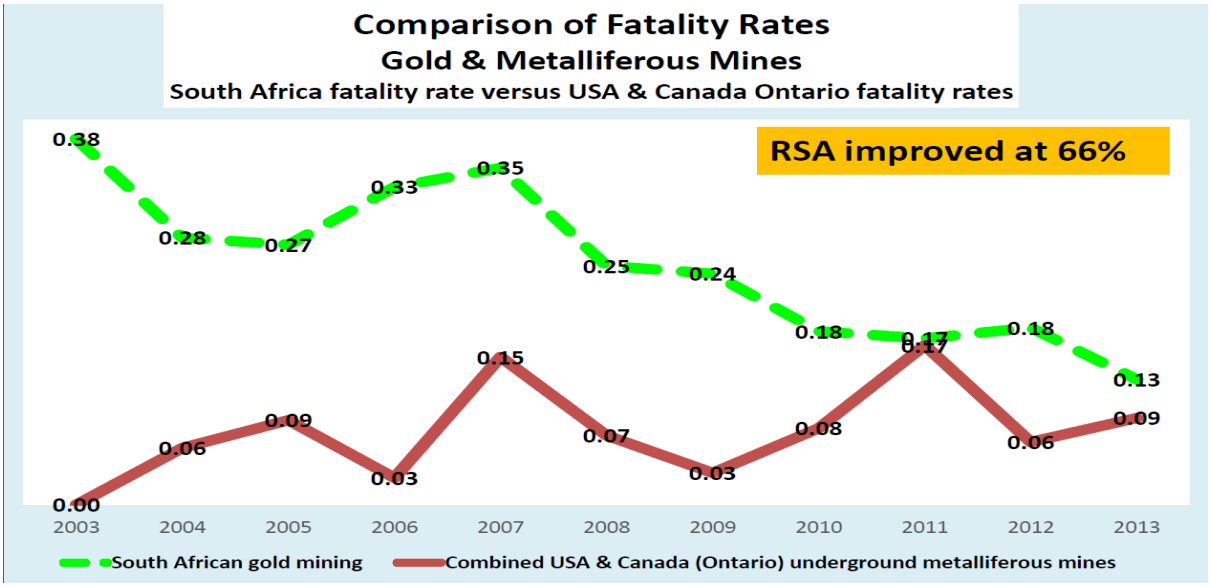

Figure 2.2b: South African gold sector fatality rate compared to international benchmark (Msiza, 2014).

Figure 2.2b shows the comparison between the fatality rates in the South African gold sector and the international benchmark. This fatality rate follows much the same trend as the fatality rates for all South African mines. Published fatality and injury rates often reveal a false picture of what is actually occurring in the mining industry. Deep level mining unfortunately comes with associated hazards and risks and requires commitment and adherence to health and safety standards (This is gold, 2015).

Based on the number of published mine related incidents and fatalities (Department of Mineral Resources, 2011), it is known that conditions in the underground gold mining environment can be extremely challenging. Since most gold mines in South Africa still mine conventionally (drilling and blasting in narrow reef stopes) it remains a highly labour intensive industry.

In order to ensure the health and safety of all employees, it is important that an active collaboration exists between management, employees and regulators. This structure should be supported by safety-related infrastructure, risk management, communication and most importantly, training (This is gold, 2015).

According to This is gold, (2015), mining was the first industry in South Africa to develop shared targets, objectives and action plans in the industry and sector levels to improve health and safety. Safety is the number one priority in the mining industry, especially in the gold sector. The majority of the hours spent on training in the industry are spent on safety training. The training includes specific training modules for occupations as well as on the job training. Every employee is exposed to safety training, induction and refresher training on annual basis (This is gold, 2015).

A number of authors (This is gold, (2015), van der Woude, (2013) and PWC, (2013)) claim that production bonuses in all levels of mining companies are strongly influenced by safety performances. It is common opinion that the safety performance is a key performance indicator of supervisors, managers and executives (van der Woude, 2013).

To achieve the mining industry's goal of zero harm, it is necessary to improve safety attitudes and procedures. A cultural transformation is required to address issues

such as racism, blame and leadership and to stress the importance of health and safety (This is gold, 2015).

2.3 Cultural Transformation in the Mining Industry

In 2008 a Leadership Summit that was organised by the Mine Health and Safety Council was held by the Tripartite Stakeholders in the South African mining industry. The purpose of this summit was to address the health and safety performance at mines by coming up with solutions to the high accident and fatality rates (Masekhoa, 2012).

The stakeholders agreed on an action plan that involved the following (Masekhoa, 2012):

- "*Strengthening the culture of health and safety at mines*"
- "*Promoting a learning industry and building capacity*"
- "*Making workplaces safer and healthier"*

The culture transformation framework was then approved by the Mine Health and Safety Council (MHSC). The MHSC then embarked on a project called "*Changing minds; Changing mines"* with the aim to develop a framework that will guide the South African mining industry to making a dramatic change towards the zero harm policy (Masekhoa, 2012).

According to Masekhoa, (2012), and the MQA, the phrase "health and safety culture" within this framework means the following:

- *"The extent to which individuals and groups will commit to personal responsibility for health and safety"*
- *"Act to preserve, enhance and communicate health and safety concerns"*
- *"Strive to actively learn, adapt and modify (both individual and organisational) behaviour based on lessons learned from mistakes and be rewarded in a manner consistent with these values"*

Based on the current injury and fatality rates, it is clear that the culture transformation framework has not achieved its full potential yet.

2.4 Studies on Root Causes of Incidents

The Council for Scientific and Industrial Research (CSIR) conducted a study in 2013 (Council for Scientific and Industrial Research, 2013) to come up with an accident investigation tool that can be used to determine the root causes of incidents and that provides better insight into the systematic factors that eventually led to the occurrence of the incident.

The survey that was conducted included 37 questions that were structured in such a way as to determine the effectiveness of current accident investigation tools and their ability to identify the root causes of the incident. The 37 questions were divided into 7 categories to address the scope of the study. Table 2.4a below shows the categories into which the questionnaire was divided into.

Table 2.4a: Categories that the questionnaire was divided into for drawing conclusions (Council for Scientific and Industrial Research, 2013).

Themes (Questions 1- 37)	Relevant Questions
[A] Investigation Duration Versus Incident Severity	Q2, Q3, Q4,Q5,Q6 & Q7
[B] Cause and Discipline	Q9, Q10, Q11, Q14, Q15 & Q16
[C] Trust and Biasedness	Q18 & Q20
[D] Investigation Skills and Resources	Q19, Q21, Q22, Q23, Q24
[E] Participation and Impact	Q25, Q26, Q27, Q28, Q29 & Q30
[F] System and Human Error	Q32, Q33, Q34, Q35, Q36 & Q37
[G] Repeats and Effort to Prevent Repeats	Q1, Q12 & Q13
[H] Ability to Identify Root Causes	Combination of Themes

The CSIR was of the opinion that the injured person is not the sole cause of the accident, but believes that a series of events lead to such occurrences and that supervisory and managerial aspects also contribute either directly or indirectly to such events (Council for Scientific and Industrial Research, 2013).

It is important to determine the human error aspect of an accident as well as the path that led to the incident's occurrence (The Society for Mining, Metallurgy and

Exploration, 2011). The CSIR hypothesised that accidents usually have multiple causes as opposed to a singular cause (Council for Scientific and Industrial Research, 2013).

According to the CSIR, (2013) a mine related accident investigation generally occurs in an emotionally sensitive environment. This type of environment is prone to intimidation, bias, blame and anger. These emotions impair the organisation's ability to determine the actual root causes of the event and in turn results in the necessary preventative measures not being put in place (Council for Scientific and Industrial Research, 2013).

The realisation must be made that the majority of incidents generally have at least one act and one condition that resulted in the incident. Contrary to the previous statement, the majority of mine related accidents generally have more than one condition or act that ultimately caused the incident. Provided that this fact is not taken into account, the opportunity is lost to determine the real root cause(s) of the incident.

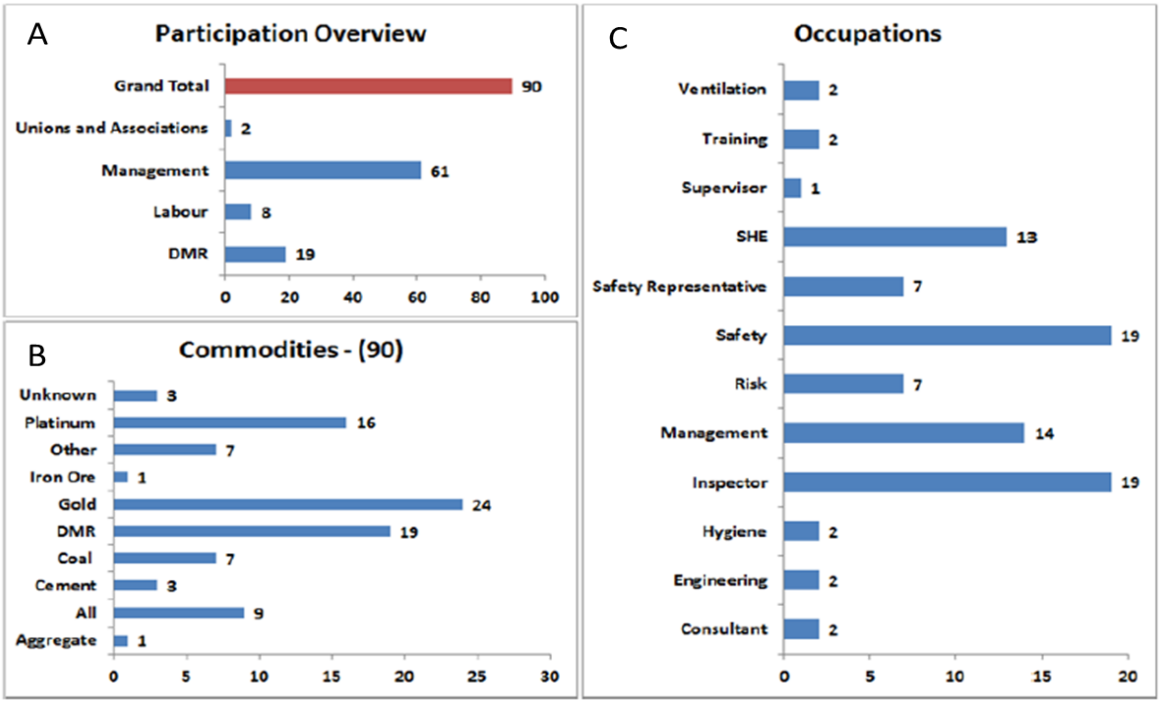

Figure 2.4a: Participation overview (A), commodities (B) and occupations (C) that took part in the 2013 CSIR accident survey (Council for Scientific and Industrial Research, 2013).

Figure 2.4a shows the participation statistics in the study conducted by the CSIR. A total of 90 individuals took part in the survey of which 24 were employed in the gold sector.

The first question in the survey was to determine what percentage of investigations into work related incidents identified the root causes of these incidents. Figure 2.4b shows the results obtained from this question.

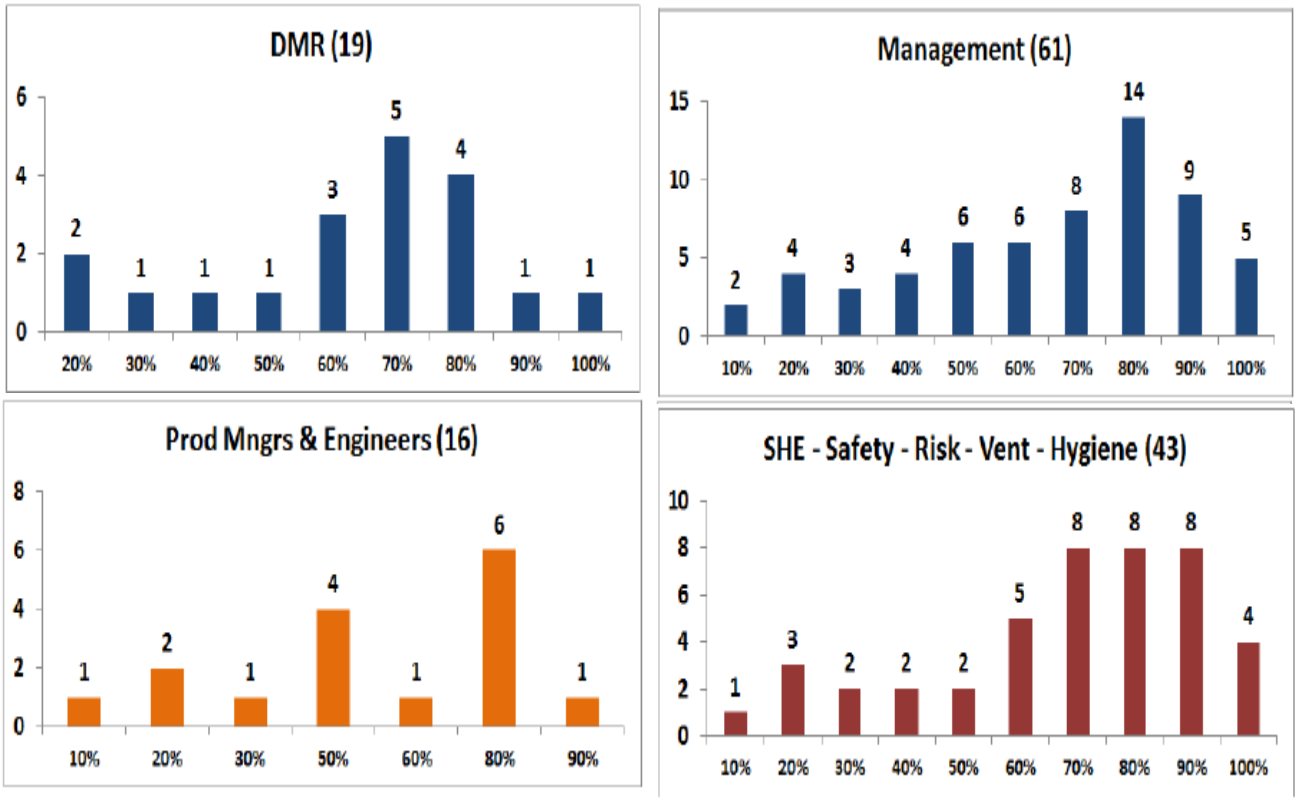

Figure 2.4b: Percentages of accident investigations that determined the root causes (Council for Scientific and Industrial Research, 2013).

Figure 2.4b shows that a relatively high percentage of individuals agreed that the majority of accident investigations determine the root causes of incidents. The DMR, however did not share this common view and were of the opinion that the greater majority of accident investigations did not determine the root causes of the incident.

According to the CSIR, (2013) the view that most investigations resulted in the determination of the root causes, was somewhat overstated.

Question 9 in the survey was concerned with which percentage of accidents or incidents were the solely the fault of the injured person. The results obtained from question 9 are shown in Figure 2.4c.

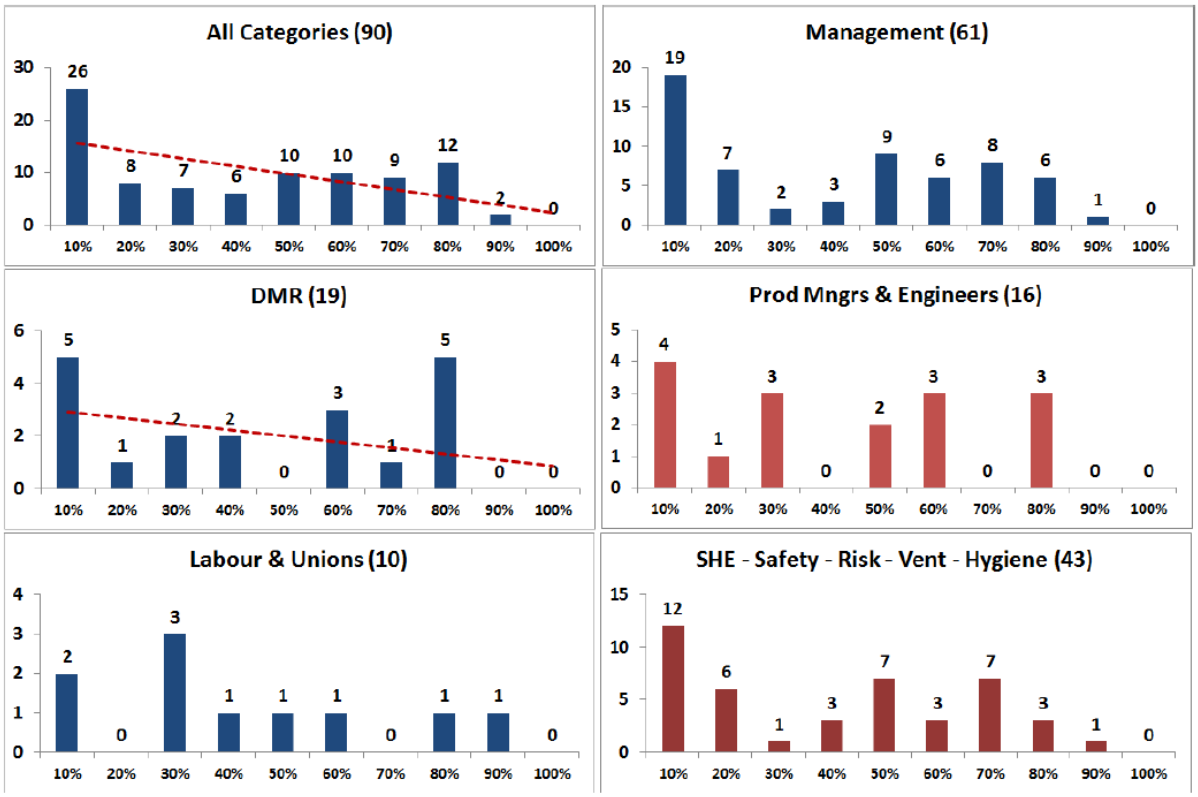

Figure 2.4c: Percentage of individuals that were of the opinion that the incident was solely the cause of the injured person (Council for Scientific and Industrial Research, 2013).

Figure 2.4c illustrates that there exists a fair amount of consensus between the different occupations that, in the majority of cases the incident was not solely the fault of the injured person. This confirms the statement of the author of the study who stated that usually a series of events lead to the occurrence of an incident.

The tenth question of the survey dealt with what percentage of incidents or accidents could mainly be attributed to some sort of supervisory failure, for example inadequate supervision etc. Figure 2.4d illustrates the results that were obtained from this question.

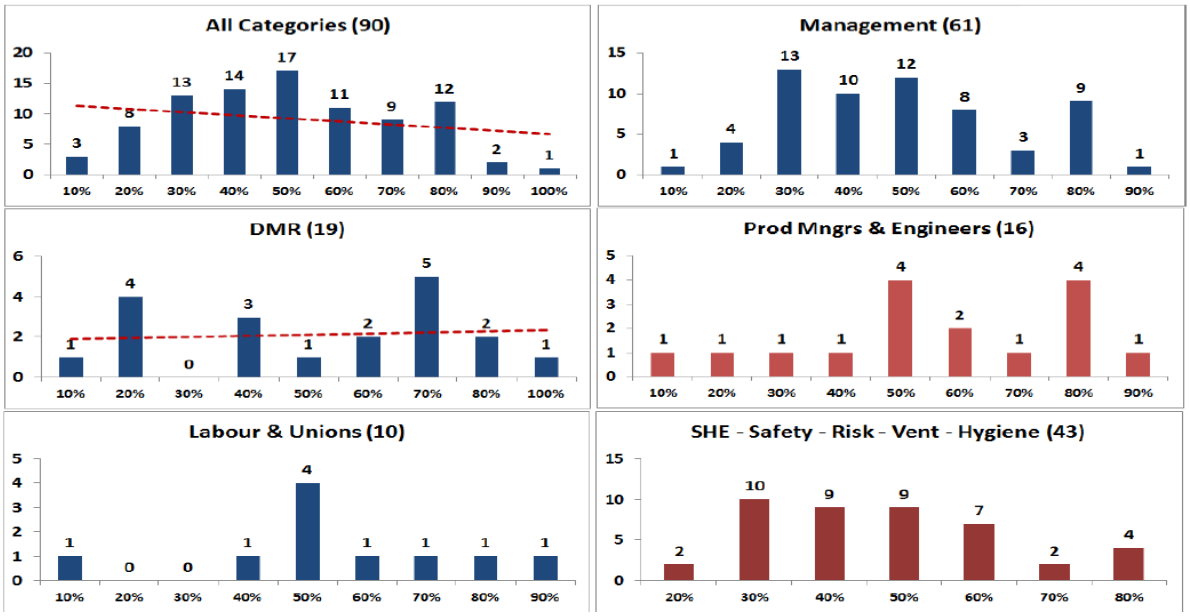

Figure 2.4d: percentage of participants that were of the opinion that the incident could mainly be attributed to supervisory faults (Council for Scientific and Industrial Research, 2013).

Compared to Figure 2.4c, there is a slight shift in the opinions of individuals in Figure 2.4d. The majority of participants were of the opinion that the greater amount of incidents occur due to some form of supervisory fault. The DMR especially holds this view.

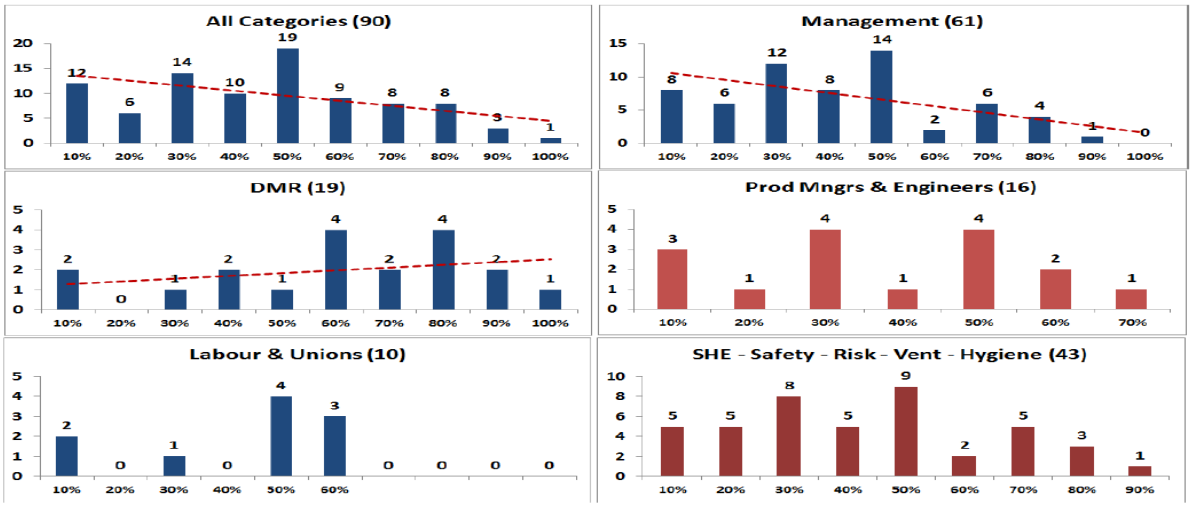

Figure 2.4e: Participants' view that managerial failure is mainly the cause of the occurrence of incidents (Council for Scientific and Industrial Research, 2013).

Figure 2.4e illustrates the results from the question: *"What percentage of incidents / accidents is MAINLY the result of some form of MANAGERIAL failure, i.e. inadequate tools / material / procedures etc.?"*

The DMR holds a strong view that the occurrence of accidents and incidents resulted from some form of managerial failure. Participants in the management category had the exact opposite opinion of the DMR. This view held a strong connection with apportioning blame to a certain line of management (Council for Scientific and Industrial Research, 2013).

The next area of concern is discipline. A number of questions investigated whether or not employees on all levels are disciplined after an incident and to what extent disciplining took place. The results are illustrated in the figures that follow.

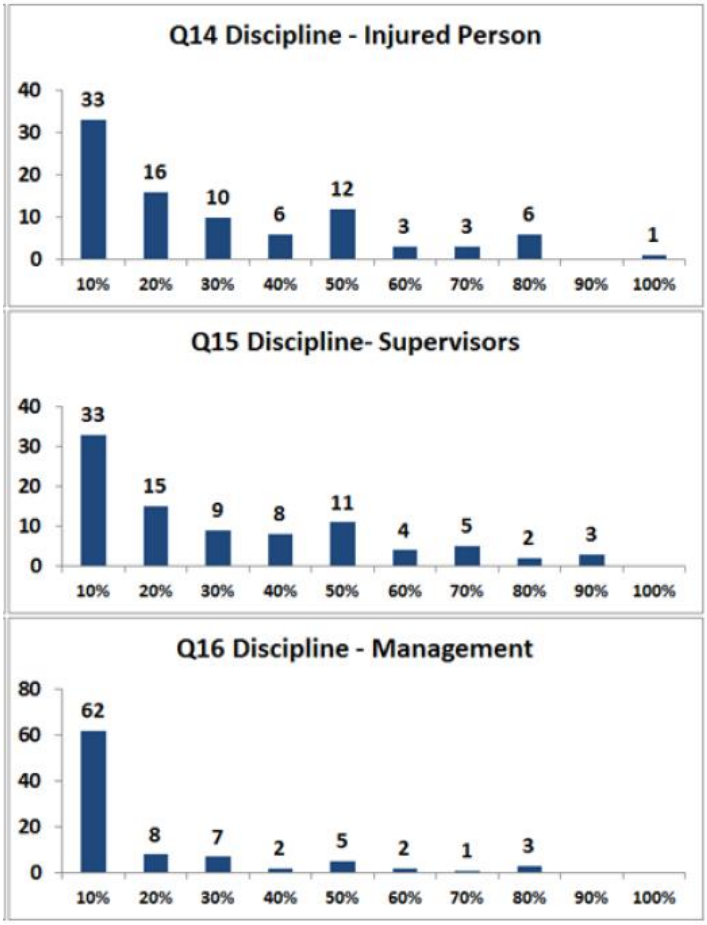

Figure 2.4f: Overall participation view on disciplining employees after incidents (Council for Scientific and Industrial Research, 2013).

Figure 2.4f shows the results obtained from the questions with regards to discipline. The general trend is that employees on all levels are very seldom disciplined after the occurrence of an incident. This was a key indicator in the reoccurrence of certain incidents or accidents.

Honesty during an accident or incident investigation is a core component of determining the root causes of an incident. The survey included evaluating the level of trust and honesty during an accident investigation.

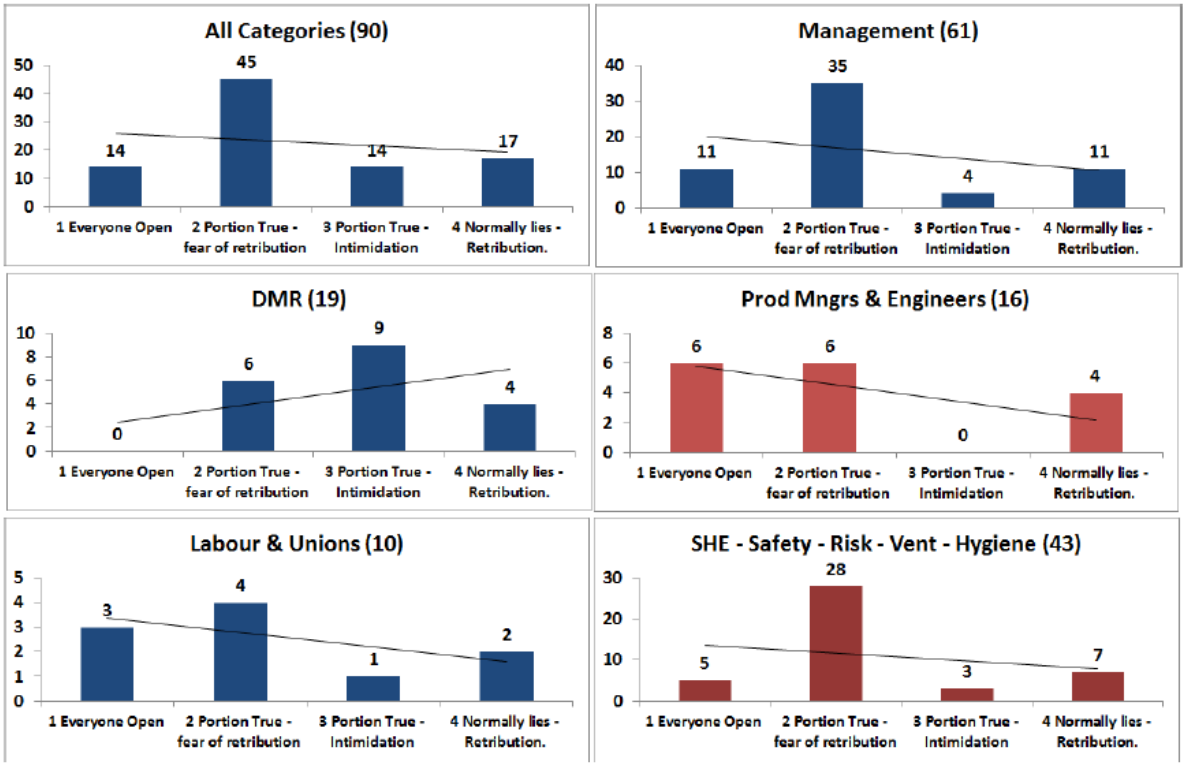

Figure 2.4g: Results of trust and honesty during accident investigations (Council for Scientific and Industrial Research, 2013).

Figure 2.4g shows that the common opinion of participants was that during accident investigations, employees normally only provide a portion of the truth. The reason behind their response was in most cases a fear of retribution and intimidation. The major problem with honesty is that often the root causes of the incident cannot be determined and that in turn results in ineffective risk control measures being put in place.

Employees often blame labour shortages for the occurrence of incidents since they feel that they have to perform sub-standard practises in order to finish the work that

was allocated to them within the duration of the shift. The same argument is valid for safety personnel. It is often the opinion of employees that there was not enough safety representatives employed in order to have prevented the incident from occurring. The results from the survey however indicated the opposite.

The participants agreed that an adequate number of safety personnel, investigators and safety representatives are employed to deal with and assist in accident investigations (Council for Scientific and Industrial Research, 2013). The participants also agreed that safety representatives had had a positive influence on employee behaviour.

Risk management is a vital first step in controlling the frequency of occurrence and severity of an incident. Sub-standard acts are closely related to gaps in the risk management programme. The study revealed that failures in the risk management process were fairly frequent and could have possibly either directly or indirectly led to the occurrence of the incident (Council for Scientific and Industrial Research, 2013).

A number of other reasons behind sub-standard acts and their root causes were investigated. These included:

- Analysing shortcomings in the organisation's managerial structure and style. These failures were found to be less common than failures associated with shortcomings in the risk management system.
- The general opinion of management and the DMR was that accidents usually had more than one cause that can be defined as a series of events that led to the accident.
- The study found that the DMR and production supervisors were of the opinion that the direct or indirect cause of an incident was either the due to an unsafe act or unsafe condition, but never a combination of these factors. Management strongly disagreed with this opinion.
- After an investigation, the causes are classified into common categories of human error including slips, lapses, mistakes and violations. The study found that the incidents are categorised, but seldom address the human behaviour that could have possibly led to the incident.

2.5 Culture Transformation Study

An integrated diagnostic review of the South African culture transformation was performed at the West Wits Gold Mines in 2012. The purpose of the study was to determine employee attitudes and behaviour within the company and the factors that resulted in a certain attitude or behaviour (Gold Fields , 2012).

The study required a number of different analysis tools in order to identify all the cultural issues and to ensure that all the levels of employment within the organisation were covered. The methodology that was used is described below (Gold Fields , 2012). A total of 9000 employees participated in the study.

Survey: 30% of the frontline employees had to complete electronic survey or a 1.5 hour in-person survey session.

Focus groups: The focus groups consisted of small groups that participated in 4 hour verbal surveys.

Interviews: Interviews were held on a one-on-one basis to discuss the past, present and future culture.

Internal data: Data such as safety performances and bonus payments of the company were analysed.

Past surveys: The results from past surveys, regional and mine specific, were compared to the survey for similarities and differences.

Table 2.5a and 2.5b shows the statistics of the survey that was done at West Wits. A total of 3848 employees from a certain West Wits area and a total of 4097 employees from a different West Wits area participated in the survey. The results obtained from this cultural survey were similar to the results obtained from the study done at the gold mine in terms of age categories and years' experience.

The study performed by Mandala Consulting was done across all age groups which were categorised into 3 categories namely:

- Generation Y (20-29 years)
- Generation X (30-49 years)
- Baby boomers (50-69 years)

The study included the years' mining experience that ranged from less than one year to greater than 30.5 years. The data obtained is valuable in terms of comparing the distribution of unsafe acts across the different age categories as well as the years' mining experience.

The data from the categories mentioned in the previous paragraph could be used to determine which age categories were performing the highest amount of unsafe acts. It could also be used to indicate how the years' mining experience influenced employees' behaviour with regards to unsafe and sub-standard acts.

Analysis of the statistics listed in Tables B1 and B2 in Appendix B could result in the identification of so called "problem areas" in terms of the age distribution and years' mining experience.

The scope of the study included the language distribution of employees, ethnic groups and grading.

The results of the cultural survey was analysed in terms of Figure 2.5a. In order to obtain the required information, the questionnaire for the survey was structured in such a way as to avoid apportioning blame.

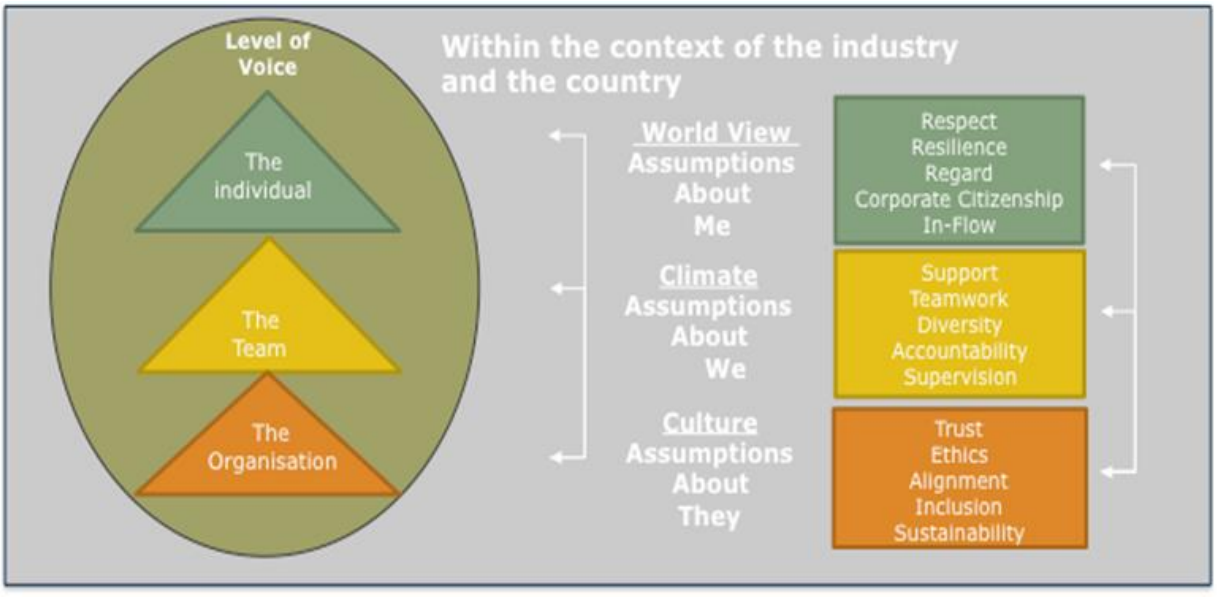

Figure 2.5a: Hierarchy on which cultural survey was based (Gold Fields , 2012).

In terms of Figure 2.5a, the different aspects that influence behaviour and attitude were identified and grouped into categories such as the individual, the team and the organisation. It is important to make the realisation that behaviour and attitudes may differ in each of the categories.

A number of anonymous quotes were published in the study that provided possible underlying reasons why employees performed unsafe or sub-standard acts.

The first quote that was mentioned showed that employees expect management to "practice what they preach": "*Management do not live the values, so why should I?"* This clearly shows that employees expect management to live up to the commitments of the company and not just expect employees to adhere to the company values. Employees look up to management and therefore an example should be set by the management team.

The corporate citizenship of employees was analysed to determine how employees felt about the company and their role in the company. The results are displayed in Figure 2.5b.

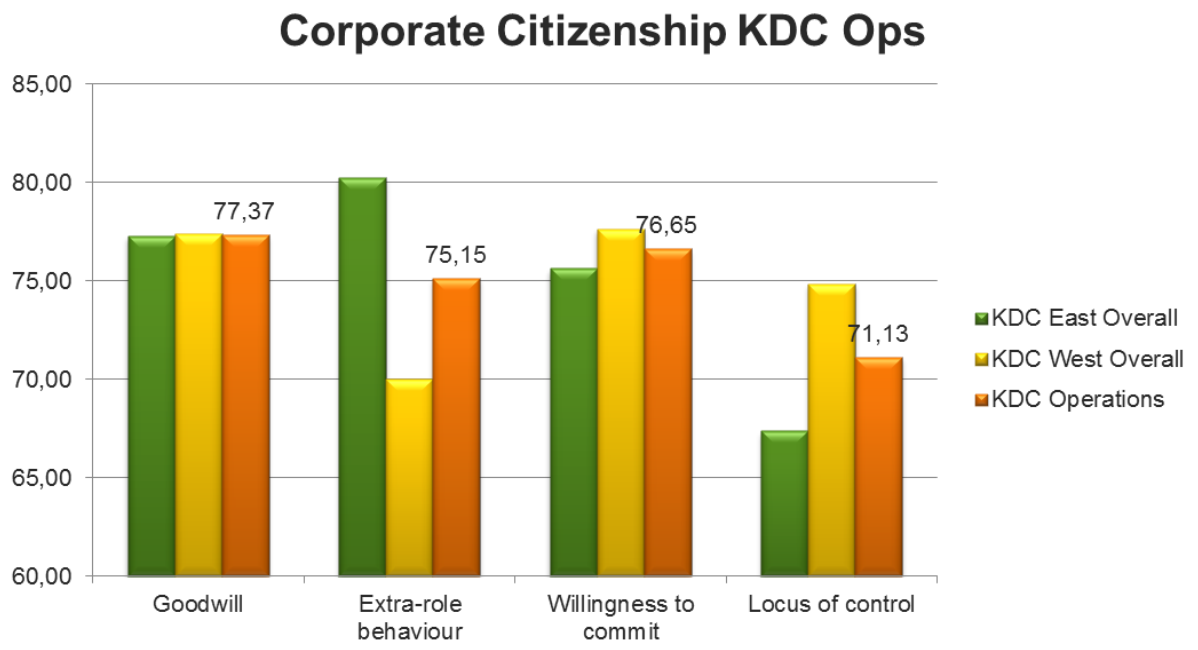

Figure 2.5b: Corporate citizenship results from West Wits cultural survey (Gold Fields , 2012).

Corporate citizenship refers to an individual's level of ownership that he/she takes within an organisation in order to actively contribute to the organisation's successes. Corporate citizenship is driven by enablers. Enablers refer to individuals' intents and perceived positive views on the organisation and their specific role within the organisation. Figure 2.5b shows that corporate ownership at the West Wits Gold Mines was relatively high.

The assumption was made that individuals within the company, who exhibited high levels of corporate citizenship, would act like owners of the company and reflects this behaviour in all endeavours that they undertook.

The resilience of a company is reflected by the resilience of its employees. A highly motivated, stable and committed workforce would exhibit high levels of resilience. According to Mandala Consulting, (2012) resilience is the ability of an organisation and individuals within the organisation to effectively handle challenges and recover from setbacks. This measures the ability of employees to preserve a positive attitude under pressure.

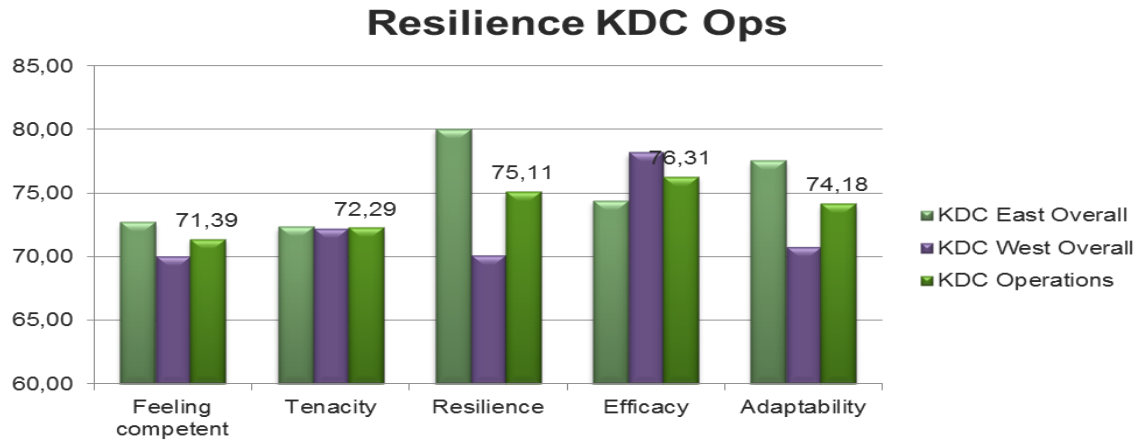

Figure 2.5c: Employee resilience results (Gold Fields , 2012).

Figure 2.5c shows the resilience of employees at the West Wits operations. The lowest scores were competency and tenacity. Employee incompetence is a major reason for unsafe acts and relates to the tenacity of employees. When employees show a low level of tenacity, it is likely that employees will feel less competent to

perform their tasks. The survey revealed that employees had high levels of adaptability and efficacy. Mandala Consulting (Mandala Consulting, 2012) believes that the higher the overall resilience of employees, the more likely the company is to cope with pressure and sustain itself over the long term.

The enabler of the extent of responsibility employees were willing to take for safety was analysed to determine how safety-orientated employees were. The results are shown in Figure 2.5d.

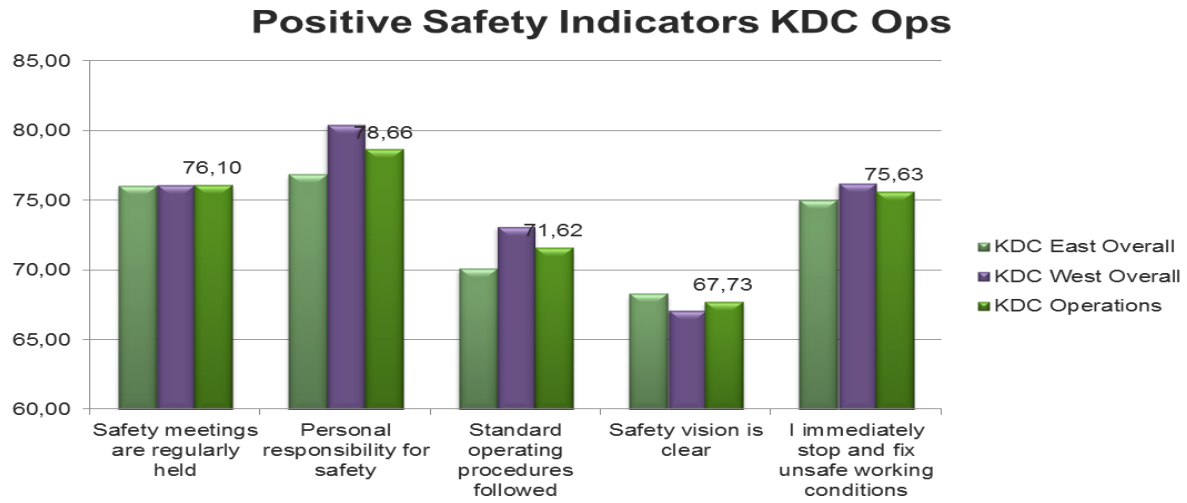

Figure 2.5d: Results obtained from safety indicators (Gold Fields , 2012).

The conclusion that was drawn from the safety indicators was that the way people viewed and interpreted safety principles, was what drove their behaviours. Figure 2.5d shows that safety meetings are regularly held, but that the safety view of the company is fairly unclear to the majority of individuals.

Another interesting observation was that the majority of employees agreed that unsafe working conditions were immediately revoked, but that standard operating procedures were not followed approximately 29% of the time.

The Benchmark of Engagement Quotient (BeQ) survey found that the company had focused their attention only on certain areas of safety. Figure 2.5e shows the different areas of safety that was analysed during the survey.

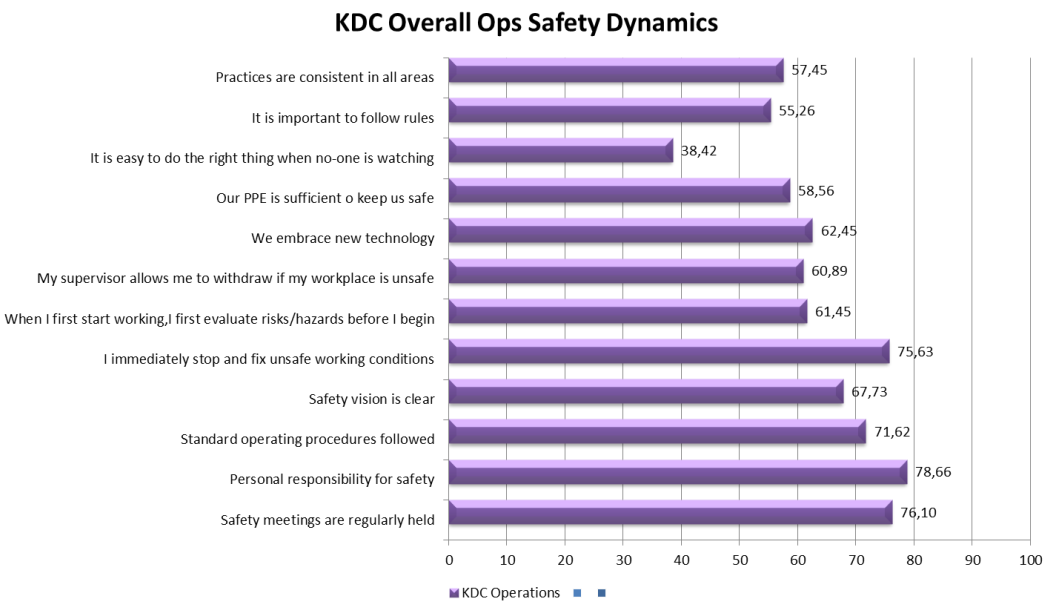

Figure 2.5e: Safety dynamics analysis results (Gold Fields , 2012).

The first point of interest in Figure 2.5e is that practises are not consistent in all areas. When an employee moves from one section to another, this fact might create a problem due to competence. Practises are supposed to be consistent everywhere throughout the operation.

45% of employees disagreed that it was important to follow rules. The underlying assumption is that unsafe acts often result from not adhering to the rules, which could lead to an accident. A staggering 72% of employees found their tasks to be difficult without supervision. This again shows that employees are not competent to perform work without proper supervision.

PPE is considered as a last resort to protect people in the hierarchy of risk control methods. However, approximately 59% of employees believed that PPE was sufficient to ensure their safety. This is not true and shows that employees do not understand the risks and hazards associated with their tasks.

40% of employees said that supervisors did not allow them to withdraw from unsafe working conditions. Over the long term supervisors were creating the idea amongst the majority of employees that it was acceptable to perform work in unsafe conditions in order to get the job done. This behaviour became the norm for

employees and is consequently transferred to the lower age groups with less mining experience.

Approximately 37% of employees said that they did not embrace new technology. The underlying problem with this factor is that often new technology is employed to improve safety, but because employees do not embrace new technology, older practices, which are often unsafe, are rather followed.

Only 38% of employees that participated in the survey performed risk evaluations before they commenced with work. Employees are trained in risk management, yet fail to identify, evaluate and control risks which create room for human error that can result in injuries and fatalities.

28% of employees claimed that they did not follow standard procedures. The question that needs to be answered is why and what factors influence the decision not to follow standard procedures in the working environment.

Since mining is considered as an operation that requires teamwork throughout all levels of employment, the behaviour of employees in terms of teamwork was analysed. The results obtained from the BeQ analysis are shown in Figure 2.5f.

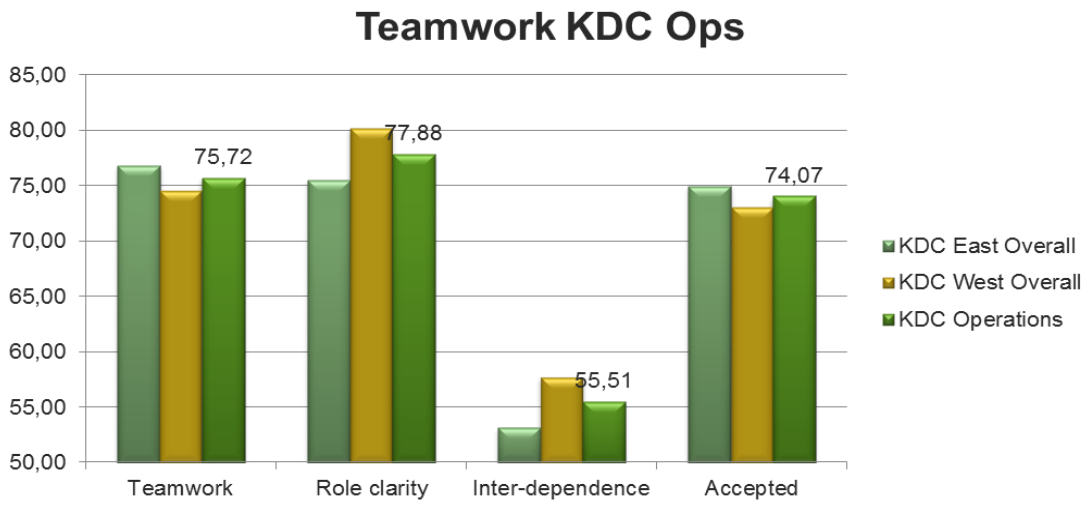

Figure 2.5f: Teamwork related behaviour results (Gold Fields , 2012).

The main concern in Figure 2.5g is that employees do not agree that they are inter-dependant on each other for successfully performing teamwork. A lack of communication and language barriers are often presented as the causes of poor team performance.

Dupont, (2010) identified a number of culture compromisers at the West Wits operations. Their findings are listed below (Dupont, 2012):

- "*We do not live the Values; we don't walk the talk".*
- *"We are not clear where the company is headed – unsure of the future, strategy and vision not clear".*
- *"Our teamwork is compromised by lack of trust amongst members".*
- *"Our frontline supervisors are not good leaders – lack key skills".*
- *"We do not feel we are in control / are enabled / allowed to make decisions and don't get information on important issues".*
- *"We tolerate under-performance".*
- *"We do not recognize or celebrate work well done".*
- *"We still discriminate based on differences in thinking, age ethnicity and gender".*
- *"We take safety risks for the sake of production".*
- *"We want the opportunity to grow but lack the resources and support (TBC)".*

The majority of employees at West Wits felt that they were unsure where the company was heading in terms of its strategy and direction (Mandala Consulting, 2012). This aspect led to employees having mixed feelings with regards to their future in the company. This in turn resulted in a demotivated workforce where pride is no longer a driver of performance.

Employees said that they had made an effort not to tolerate bad behaviours, but found it difficult to enforce discipline since the company itself was notorious for tolerating the bad behaviour of some employees. Employees acknowledged that they were informed about the company's code of ethics, but "*those things are just on paper, they are not implemented or practiced".* 68% of employees said that they knew what the company's values were, but only 53% lived the values at work.

Some employees felt that supervisors were making it difficult for them to perform teamwork due to gossip. An anonymous employee said that supervisors gossip with employees and stir trouble which caused employees to fight amongst themselves. This behaviour demotivated employees to engage in teamwork.

Threats were also found to be a major cause of sub-standard and unsafe acts. Employees said that they could not speak out, since production supervisors or miners often threaten to move them to other sections or to get them fired if instructions were disobeyed.

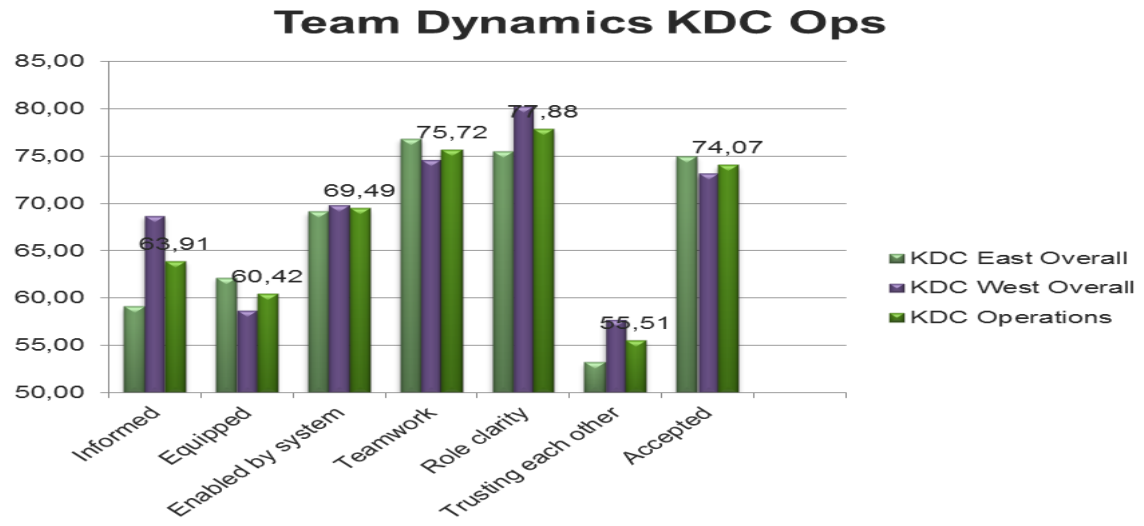

Figure 2.5g: Analysis of teamwork dynamics at the West Wits Gold Mines (Gold Fields , 2012).

Figure 2.5g shows that employees have great difficulty in trusting each other when working in teams. Communication is lost due to a lack of trust. Employees were also of the opinion that they were not completely informed and equipped to perform their individual duties within a team.

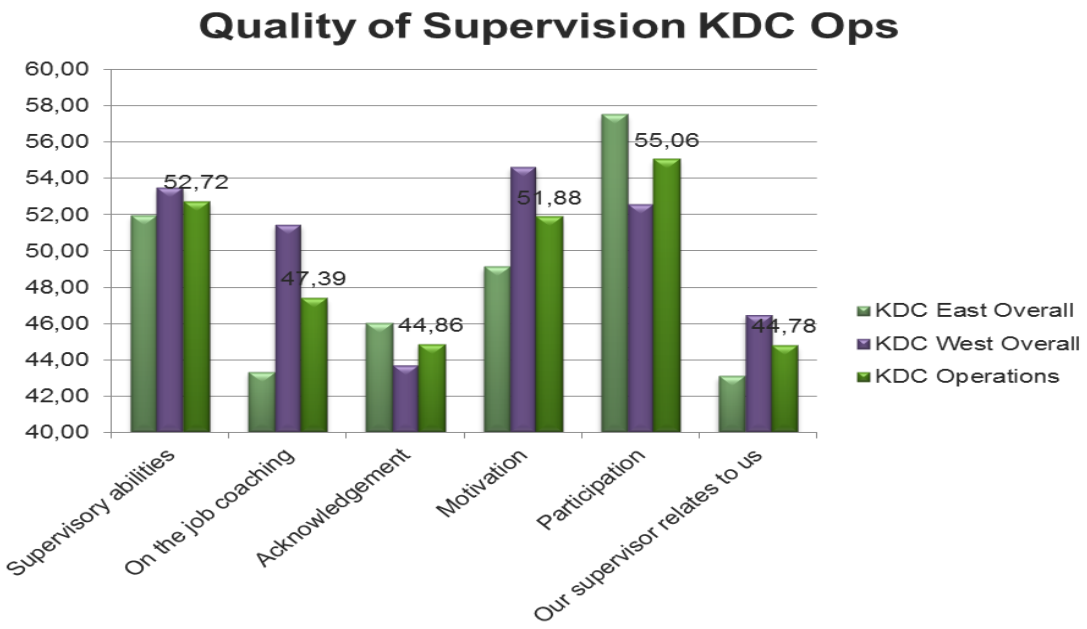

Figure 2.5h: Supervision analysis at West Wits (Gold Fields , 2012).

Figure 2.5h shows the different aspects of supervision that were explored as possible reasons for employee behaviour. 52% of employees said that they did not receive quality on the job coaching. Acknowledgement is extremely important to employees since it motivates employees to perform up to standard and follow procedures. The level of acknowledgement for a job well done is however very low which supports the opinion of employees that supervisors seldom relate to the employees and their circumstances.

Employees said that managers often instructed them to perform certain tasks instead of consulting with them and employees were expected to follow the lead, leaving no space for growth in terms of leadership skills of the employees. Employees felt that managers did not possess the necessary conflict resolution skills and that managers were often biased.

An employee claimed that many employees felt afraid to voice their reasons for unsafe and sub-standard acts because managers were bribed. The employee stated that certain employees were favoured by management when a dispute arose since the managers "*were bought car tyres for favours".* Employees told lies to satisfy management out of fear of losing their jobs. Mandala Consulting, (2012) found that if there was no investment in training, production would continue on a downwards trend.

Employees admitted that when a person is on leave or absent from work, the employees or supervisors often perform work which they are not fully trained for, for example a production supervisor driving a winch. The employees also confirmed that they were aware that sub-standard practises endangered their own lives as well as the lives of their colleagues. On the job training is not sufficient since employees are left to learn by means of trial and copious amounts of error.

The 2012 cultural study (Gold Fields , 2012) found that underperformance was tolerated at West Wits Gold Mines. The organisation took long to replace employees who were retrenched or resigned which other employees believed put a large burden on them due to the increased workload. Equipment shortages as the reason for performing unsafe acts were mentioned on a number of occasions. Employees said that they were told to make a plan when they had complained about shortages of equipment.

Finally, an issue that is often heard in the mining industry was analysed. Putting production before safety is often the first reason provided by employees for not performing up to standard. The crews are more concerned about production than safety. Production supervisors were accused of demanding high production figures which resulted in neglecting safety principles.

An anonymous employee said that they were accused of stopping work and wasting time when they were busy addressing dangerous conditions. The example provided was when employees alert seniors about high temperatures; the response would be that the employee was trying to waste valuable production time.

The conclusions from this study were the following (Mandala Consulting, 2012):

- Inconsistencies and not leading by example was a major cause of breaking down trust and loyalty.
- Employees' will to want to do the job was decreasing due to unfair treatment and a feeling of "being just another number".
- Apportioning blame for incidents was very high compared to taking personal responsibility for standards and safety.
- Employees felt that they were worthless and not seen as adding value to the operation.

- It was recommended that stronger teams had to be built and that competent supervisors were required to lead teams in order to boost morale.

2.6 Accident Causation Theories

Based on the personal interviews with mine employees at the gold mine and the results of the 2012 cultural survey executed by Mandala Consulting, (2012) it came to light that accidents and fatalities are in the majority of cases not caused by a single event.

An accident or fatality is usually the outcome of a number of sub-standard practises that ultimately led to the occurrence of the event. The probability of the occurrence of the unwanted event (accident or injury) and the severity of the event are negatively influenced by sub-standard practises. As the number of sub-standard practises increase, the probability of occurrence and the severity of the event also increase.

It is therefore important to look at accident causation theories in order to link the current situation in the South African gold mining industry to sub-standard practises and their causes.

After reviewing the available literature on accident causation theories, it is clear that they all have a number of common goals namely:

- Identifying risks
- Identifying influencing factors on the occurrence of the accident
- Attempt to explain why the accident occur
- Identifying the root causes of the accident
- Used to predict and prevent accident occurrences

The majority of authors, (Guttierez, 2010), (Mol, 2002), (Raouf, 2011), (Saari, n.d.) and many more agree that there are several theories available on accident causation, and that one single theory is often not enough to establish the true cause of the incident.

The different accident causation models often show conflicting perspectives when it comes to establishing the cause of the incident. A number of accident causation theories will be discussed below in order to link them with the results obtained from

the gold mine and the hypothesis of the author. It is important to understand that there exists no single accident causation theory that is applicable to the mining industry, universally speaking. Some models however enjoy preference due to their simplicity and perspective of what ultimately led to the accident.

A number of researches from varying fields of science and engineering have attempted to develop models that address the cause of accidents, isolate them and remove the factors that increase the probability and severity of such events (Raouf, 2011).

2.6.1 The Domino Theory

The Domino Theory was developed by W.H. Heinriech in 1929 in an attempt to explain accident causation. The theory consists of five metaphorical dominoes that are organised in a certain sequence of events. (Sabet, et al., 2013) Figure 2.6.1 shows a graphical representation of Heinriech's accident causation theory.

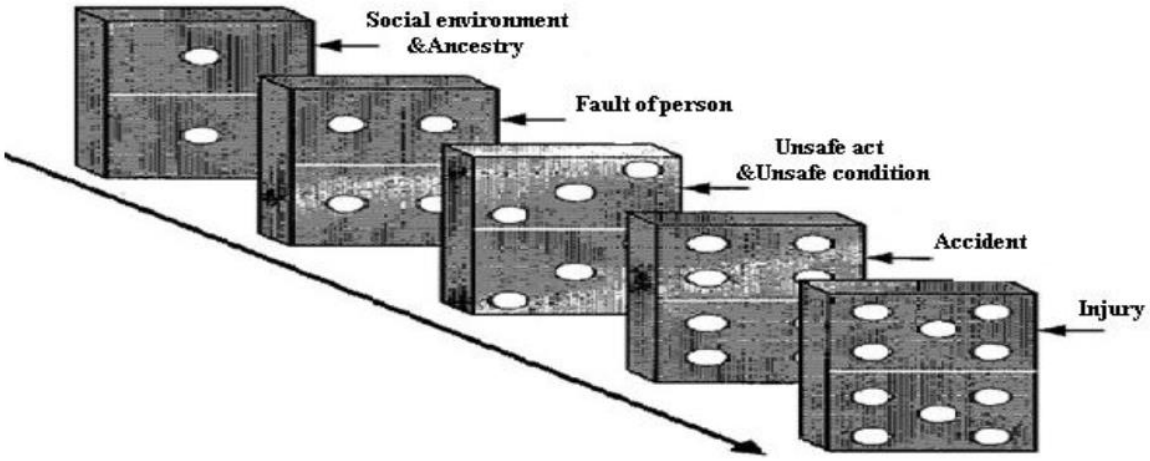

Figure 2.6.1: The Domino Theory accident Causation Model (Sabet, et al., 2013).

Heinriech's Domino Theory basically states that the accident occurs as the inevitable result of a number of events. If any single domino had to be removed from the chain of events, it would change the outcome. This theory states that the severity of the event is however entirely dependent on chance rather than intention.

In a study performed by Heinrich where he examined 75 000 industrial accidents, he found that 88% of the accidents were caused by unsafe acts of people, 10% of accidents were caused by unsafe conditions and 2% of all accidents were caused by

so called “acts of God” which were unavoidable (Guttierez, 2010). The Domino Theory is based on the principle that if the first domino falls, it triggers the next domino to fall and so forth. When a domino leading to the event is removed, the accident can be prevented.

The significance of the five dominoes is as follows (Sabet, et al., 2013):

Domino 1 (Social environment and ancestry): The 1st domino deals with the characteristics of the person such as recklessness, greed and temper issues. These characteristics either originate from a social environment or are inherited.

Domino 2 (Fault of the person): The 2nd domino represents the inherent faults in a person such as unacceptable manners, ignorance of safe practises and so forth. This behaviour may constitute the decisions made by a person to commit an unsafe act.

Domino 3 (Unsafe act and unsafe condition): The 3rd domino is deemed as the most significant domino in the theory. If this domino is removed, the incident can be prevented from occurring in the first place. It includes behaviour such as not adhering to safety standards, horseplay, entering areas that are barricaded off etc.

Domino 4 (Accident): The accident is the unwanted event that results when the previous 3 dominoes tumble over.

Domino 5 (Injury): The physical damage to the person or machinery/ equipment due to the occurrence of the unwanted event.

The domino theory is very applicable to the mining context due to the way in which the dominoes are structured, but is does have an inherent weakness: apportioning blame mainly to the person involved in the accident, without taking into account the fault from management or supervisors within the organisation.

2.6.2 Multiple Causation Theory

The Multiple Causation Theory is said to have branched out from the Domino Theory, but instead of seeing one initial event as the cause of the accident, it explores multiple routes through which the event could have occurred in which a number of situations have to be simultaneously true for the event to occur (Saari, n.d.).

An example where the multiple causation theory might be applicable is the following situation:

A miner is standing under a boxfront. The hydraulic pipes controlling the radial door of the boxfront are damaged and leaking, causing the door not to close properly. Blasting is being done in close proximity of the orepass that causes excessive vibrations. The excessive vibrations led to the radial door failing, causing the material in the orepass to fall on the miner standing below the boxfront.

The Multiple Causation Theory divides the influencing factors into two categories (Raouf, 2011):

- **Behavioural factors:** The mindset of the employee, lack of education, lack of skills etc.
- **Environmental factors:** Improper implementation of safety standards and procedures deeming machinery and working places hazardous objects or areas.

2.6.3 The Swiss Cheese Model

The Swiss Cheese Model of accident causation is very much alike to the Multiple Causation Theory. The model suggests that accidents are caused by a series of events at different levels within an organisation. The different levels or layers within the organisation are represented by slices of cheese with holes in them.

All the slices of cheese together represent a certain system. The holes in the slices of cheese represent inherent or external possible failures that might occur. For an incident to occur, the holes in each slice of cheese must line up (de la Rosa Ducut, 2011).

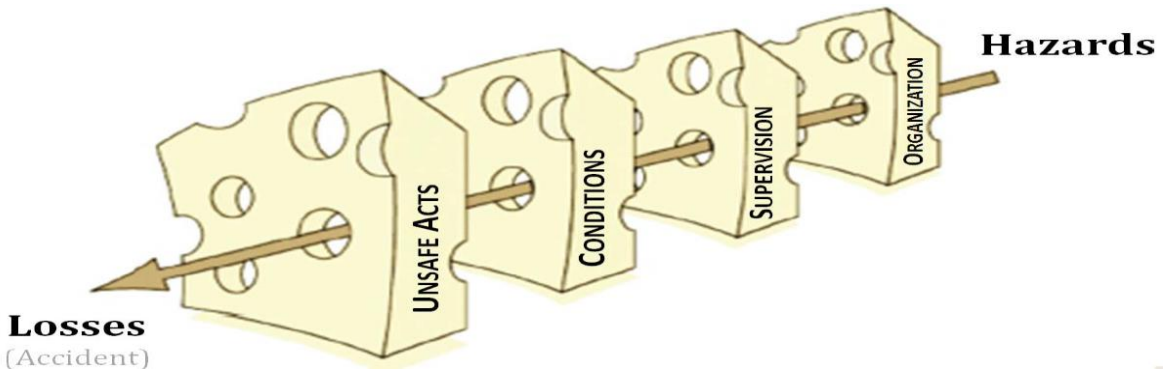

Figure 2.6.3: The Swiss Cheese Model of accident causation (de la Rosa Ducut, 2011).

2.6.4 The Risk Homeostasis Theory

When one examines the literature available on accident causation theories, a vast majority of peer reviewed articles are found that discuss the physical and environmental factors pertaining to accident causation. However, in recent years the focus has shifted towards the behavioural and psychological aspects of accident causation (Saari, n.d.). The theory of risk homeostasis focuses on the psychological activity behind the decisions of risk-taking behaviour and behavioural based safety.

The theory of risk homeostasis states that humans become accustomed to a certain acceptable level of risk that they have either set for themselves or that is set by some form of legislation. When a person is then required to reduce a risk that they are exposed to, they will incur another risk in order to increase the current level of risk up to the level of risk that they have become comfortable with (Saari, n.d.).

For example, when an operator of a vehicle is required to wear a safety belt, he will tend to drive faster in order to achieve the same level of risk that he has become accustomed to.

2.6.5 Bird and Germain's Loss Causation Theory

Bird and Germain built their accident causation theory on the Domino Theory. They developed a model that was an updated version of the Domino Theory and it took into account that management plays an important role in the causes and effects of accidents.

This theory suggests that management needs to prevent and control the occurrence of accidents and that accidents are often complex situations due to the advancements in technology (OHS Body of Knowledge , 2012).

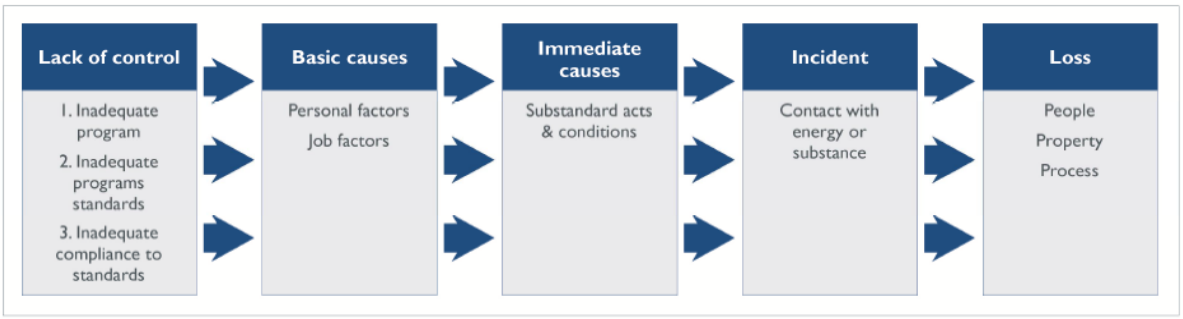

Figure 2.6.5: A modified version of Bird and Germain's Loss Causation Model. (OHS Body of Knowledge , 2012)

2.7 Shadowmatch

Research has found (De Villiers, 2009) that many individuals occupy job positions in which they are extremely unhappy. This was also the case with regards to the working environment that they found themselves in. The associated problem lies in this: it results in negative implications not only for the individual, but also a negative impact on the working environment and fellow workers.

The Shadowmatch system was developed to prevent the above mentioned scenario by allocating the individuals to environments that best suit them in order to preserve harmony between the individual and the environment. The Shadowmatch system can also be used for the identification of employees that best suit a specific working environment and specific job. The system possesses the capability to provide personal development programs for individuals that require specific habits in order to be successful in their occupation (De Villiers, 2009).

This process is completed by comparing the habits of the concerned individual to the habits of employees who are deemed successful based on the performance management system of the company in performing a specific task within the same organisation (De Villiers, 2009).

The vast amount of research available showed that human behaviour had become an interesting topic of research. This area of research is however extremely complex. According to De Villiers, (2009) the largest challenge in human psychology and human behavioural studies was that there are multiple definitions for single human behaviours and the associated conditions.

The question that often gave rise to the majority of research was whether understanding how and what people think, was an exact science that could be understood. Researchers from Shadowmatch showed an obsession with simplifying the way we view others, their behaviour and whether it was possible to predict success. The aim was the creation of a framework that provides relevant content on a person.

De Villiers, (2009) stated that Shadowmatch was developed as a result of the following question: *"What makes people successful?"* A company needs to determine whether a potential employee will be successful in a job for the benefit of

the individual as well as the company since negative impacts could result in long term consequences.

De Villiers, (2009) defined a successful person as *"someone who performs a task in such a way that the outcome matches the outcome and regularly exceeds the expectation"* The research performed by Shadowmatch identified three elements that have to be aligned in order for an individual to be successful and become a top performer (De Villiers, 2009):

- The task or work to be completed.
- The context (environment) where the work has to be performed.
- The skills, qualifications and behavioural preferences of the concerned individual.

The Shadowmatch research team identified a number of aspects that ultimately define the work environment (a detailed description of each can be found in the Shadowmatch e-book available at: www.shadowmatch.com):

- Physical environment.
- Social environment.
- Emotional environment.
- Operational environment.

The research done by the Shadowmatch team was performed in a multi-culture environment. A list of motivators was identified in an effort to establish what motivates the behaviour of people. The list of motivators is indicated below:

- Caring.
- Revenge.
- Survival.
- Biological needs.
- Ego.
- Fulfillment.
- Obsession.
- Greed.
- Fear.

- Enjoyment.
- Responsibility.
- Group behaviour.
- Upbringing.

Behaviour, being a complex field of study, can be motivated by more than one motivator and a number of motivators may be present within a single one. Most people are uncertain of *why* they behave the way they do (De Villiers, 2009).

According to De Villiers, (2009) the only way to determine whether an individual would be successful and sustainable in a certain context and job, was to determine a pattern of behaviour which he called benchmark habits and compare the habits of the concerned individual to the benchmark habits. It was thus established that habits were a key driver in human behaviour (De Villiers, 2009).

2.7.1 The Importance of Understanding Habits

An extremely reliable method to predict the behaviour of people lies in the determination of the habits by which the individual lives. The reason behind this was found to be that habits are reliable, show recurrence patterns and could be predicted with a high level of accuracy (De Villiers, 2009).

A behavioural pattern may result in a habit. Some important findings with regards to habits are listed below:

- Repetitive behaviour that shows a lack of or no planning could be a habit.
- Habits are learnt behaviour.
- Habits form through repetition.
- It is difficult to break a certain habit.
- When habits cannot be lived out freely, the individual struggles to function.
- Not all habits are equally well established.
- Habits are attached to a goal or purpose.
- Habits can form pairs.

Before the development of Shadowmatch, no instrument existed that could measure the match between an individual's habits, the task to be performed and the working environment. The study that was conducted identified the habits of successful

students and isolated the critical habits in order to establish a benchmark profile that represented habits of successful students. The system was then found to be the only credible benchmark to compare people to a benchmark in order to determine their propensity to succeed.

The critical points with regards to habits established by the Shadowmatch research team was as follows (De Villiers, 2009):

- When selecting a benchmark group, extreme caution must be exercised since no generic benchmark group exists.
- Creation of a map of habits is essential.
- Benchmark profiles are not fixed and are variable, thus it must be updated once a year.

A certain set of criteria to select top performers was also suggested by De Villiers (2009):

- An individual must be working in the organisation and specific job position for more than 8 months.
- They must be consistent top performers in their organization.
- They must be positive influencers among their work group and be motivators.
- The must be highly skilled and knowledgeable individuals in their organization.

2.7.2 The Working of Shadowmatch

The Shadowmatch system is computer based and determines the best match between behavioural habits, working environment and tasks that an individual needs to perform. The habit map that the system draws up is done by the completion of a worksheet in which the individual answers a series of questions online. The questions are of a nature that places the individual in normal day to day situations. The answer that the individual chose reflects the way in which the person would behave in that situation. A fuzzy logic calculator processes the answers to the questions and identifies behavioural patterns (De Villiers, 2009).

The habits that were identified are then weighed against patterns of recurrence and as well as the strength of the indicator of a specific behaviour. The calculations that are performed to identify habits in the individual's behaviour determine how well

embedded the habits were in the person's life. A graph that reflects the established habits is then drawn up from the data.

The Shadowmatch system classifies habits and attitudes based on a points system and the embeddedness (strength of each habit) can be interpreted as follows (De Villiers, 2009):

- A score of < 30 for a certain attitude cannot be described as a habit.
- A score of between 30 and 50 indicates a relatively well formed habit.
- A score of between 50 and 70 shows a behaviour that is well embedded as a habit.
- A score of > 70 is a strong habit that is applicable to a variety of contexts and highly consistent.

A detailed description of the habits that Shadowmatch identifies can be found in the Appendix C.

2.7.3 Attitudes

The Shadowmatch system classifies attitudes into 4 categories. Figure 2.7.3 shows a detailed description of each category.

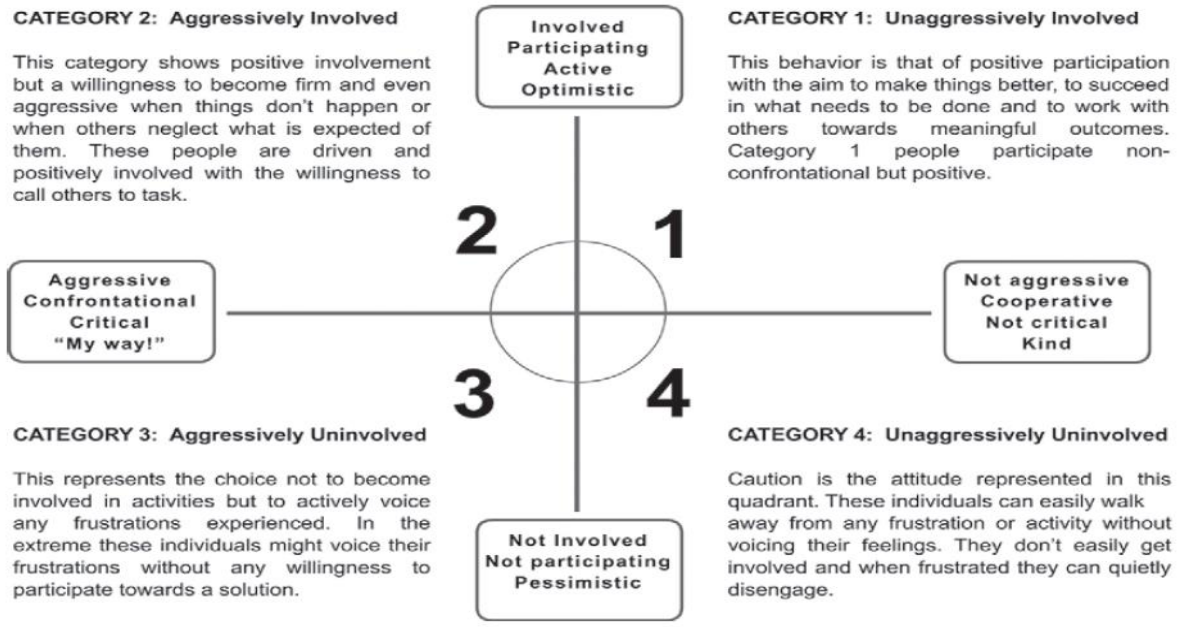

Figure 2.7.3: The four categories of attitude as defined by Shadowmatch (De Villiers, 2009).

2.7.4 Forming and Changing of Habits

A habit that was established over a long period of time (in excess of one year) is often very difficult to change. However, it is not impossible. Not all habits are formed equally strong in the behaviour of an individual. A behavioural change is not a single event; it is often the inevitable result of a process.

De Villiers, (2009) stated that no single hypothesis existed that answers the question to whether habits could be changed or stopped. Habits are seldom the result of a decision that an individual made, or the result of a discussion with another individual.

A number of key elements are necessary for the formation of a habit (De Villiers, 2009):

- The behaviour exhibited was associated with a purposeful goal that the individual had in mind.
- The behaviour must be seen as successful in some way by the person who developed the habit.
- The habit shows a number of repetitions.

In order to change a habit, a process is required that incorporates certain mechanisms to facilitate change. The detailed descriptions of these mechanisms can be found in the Shadowmatch e-book.

The Shadowmatch system recommends and provides an individual with a guided mentorship program to assist him/her in developing the behavioural habits based on their individual match with the benchmark.

2.8 Literature Review Conclusions

There exists an enormous amount of accident causation theories in the relevant literature. The five theories described are some of the most well-known theories in the field of accident causation studies. A number of new theories have been proposed by scientists and engineers, but their complexity requires them to be dealt with in a separate report which is not the focus of this study.

The importance of recognising that there are a number of accident causation theories available in the literature lies in the following:

- An accident is a complex event an often results due to a number of non-linear situations that lead up to the event.
- The complexity of accidents increases the difficulty of understanding how and why the accident occurred and to identify the root causes of such events.
- Accident models assist investigators in establishing the links between human behaviour, dangerous conditions and faulty systems.
- Certain accident causation models are more suited to certain contexts than others, due to their origin and objectives.
- There is no single accident causation theory that is applicable to all situations; a combination of a number of different accident causation theories seem to provide the best set of results.

The literature that was reviewed proved the author's hypothesis that accidents often do not have a single origin and are not necessarily the result of a linear chain of events. The literature has shown that accidents can affect an organisation on any level, with adverse effects on the safety culture of that organisation.

The cultural survey performed by Mandala Consulting, (2012) confirmed the majority of findings at the gold mine that the author hypothesised about. The correlation in results show that sub-standard practises and their effects on safety is not necessarily a mine-specific issue, but rather an industry related matter that urgently needs to be addressed in order to conform to international standards.

Some of the major findings of the literature review include the following:

- There exists a lack of information with regards to behavioural based safety in the mining industry.
- Researchers who have conducted studies into the root causes of sub-standard practises were found to often disagree with findings due to external influences such as a lack of honest information and employees' fear to speak out.
- The majority of root cause identification studies were found to be inconclusive.
- Safety within an organisation often lacks a theoretical basis on which the safety culture should be structured.

- Employees often feel that they lack an adequate amount of training to perform their task in the real life situation.
- Management plays a large, if not the largest role in the prevention of accidents and implementation, monitoring and control of standards.
- Accident causation theories alone are not sufficient for understanding the occurrence of accidents.
- The trend is to move away from physical factors and concentrate on the psychological factors that influence human behaviour and the antecedents that ultimately results in a human being's decision to perform an unsafe act.
- Unsafe acts do not occur in isolation to other factors such as the environment, social factors, culture etc., but forms an integral part in an interconnected chain of events.
- It is highly unlikely that a single universal model could explain the causes of sub-standard acts for a number of different scenarios, especially because human psychology is such an abstract factor to study and obtain the desired results from.

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CHAPTER 3: RESULTS, ANALYSIS AND DISCUSSION

3. RESULTS, ANALYSIS AND DISCUSSION

This chapter of the report will concentrate on the results obtained from the investigation at the gold mine as well as the cultural study done at Gold Fields in 2012 (see section 2.5). It will consist of 6 sections in which each critical aspect of the findings will be addressed individually.

Section 3.1 will address the results that were obtained from the investigation at the gold mine, including the parameters of the results of the interviews such as number of employees interviewed, age distribution, shift distributions etc.. Section 3.2 will contain the results that were obtained from the specific questions as per Appendix A.

Section 3.3 will analyse and evaluate the comparison of the results of this study and the 2012 West Wits Culture Transformation Study as per section 2.5. The results obtained from the Shadowmatch survey will be discussed in section 3.4. In section 3.5 the effects of sub-standard practises on safety will be discussed.

Section 3.6 will suggest the possible root causes of sub-standard practises in the underground working environment based on the literature review and the findings of this report. The last section (section 3.7) will suggest possible solutions to the problem based on the findings.

3.1 Interview Result Parameters

As discussed in the previous sections, the majority of results were obtained from personal interviews with employees at the gold mine and then documented. The results were then digitised using Microsoft Excel for representation in tables and graphs.

Table 3.1a: Number of employees interviewed from different occupations.

	OCCUPATION	AMOUNT
1	ROCK DRILL OPERATOR	16
2	WINCH DRIVER	7
3	SAFETY REPRESENTATIVE	6
4	TEAM LEADER	6
5	RIGGER	2
6	MINER	13
7	SHIFT BOSS	12
8	MINE OVERSEER	4

	OCCUPATION	AMOUNT
9	MINE MANAGER	1
10	FITTER	3
11	ELECTRICIAN	1
12	LOCO DRIVER	10
13	LOCO GUARD	3
14	TIP ATTENDANT	3
15	BOESMAN OPERATORS	2
16	INSTRUCTORS	14
17	TRAMMING SHIFT BOSS	3
18	STUDENTS	7
19	WORKSHOP PERSONNEL	2
20	OTHER	20
	OVERALL TOTAL	135

Table 3.1a shows that a total number of 135 employees were interviewed during the investigation at the mine. The focus of the study was mainly on underground production personnel and therefore a greater number of underground employees were interviewed as opposed to surface employees.

The majority of the duration of the study was spent in stopes under the supervision of Mr. M.M. Macamo, thus the greatest pool of information was obtained from rock drill operators, winch drivers, team leaders, miners and shift bosses. It was highlighted by the previous general mine manager that the area of concern with regards to sub-standard practises and unsafe acts were the production personnel at the mine.

The general opinion of management at the mine was that the younger employees were often the culprits with regards to sub-standard practises and unsafe acts. It was therefore decided to test this opinion by dividing the interviewed employees into different age categories in order to compare the results of the interviews.

The mode of the age categories was found to be 46-55 years old (see Figure 3.1b). Within the number of employees that were interviewed, it is shown in Figure 3.1b that the greater amount of employees that were interviewed formed part of higher age categories.

The data set that was compiled during the investigation at the mine was used to determine how many employees in total were interviewed from each of the four

operating shafts. In addition to this, the interviewed employees were divided into the shifts that they work, e.g. morning, afternoon or night shift. Tables 3.1b and 3.1c respectively display the distribution of employees that were interviewed by shaft and the employees that were interviewed by shift.

Table 3.1b: Number of employees interviewed per shaft.

SHAFT	NUMBER OF EMPLOYEES
1	75
2	35
3	22
4	3
OVERALL COUNTER	135

Table 3.1b shows that the greatest number of employees interviewed, was employed at 1#.

Table 3.1c: Number of employees interviewed per shift.

SHIFT	NUMBER OF EMPLOYEES
MORNING	118
AFTERNOON	11
NIGHT	6
OVERALL COUNTER	135

The final parameter that was included in the interviews was the years' experience of employees. This is one of the most important parameters since the general belief is that the more experience an employee is, the less likely he is to perform an unsafe act or be involved in an accident.

Table 3.1d: Number of employees by years' experience in the mining industry.

CATEGORIES	NUMBER OF EMPLOYEES
LESS THAN 3 YEARS	13
3-5 YEARS	17
6-10 YEARS	38
11-15 YEARS	31

CATEGORIES	NUMBER OF EMPLOYEES
16-20 YEARS	18
21-25 YEARS	13
26-30 YEARS	4
31-35 YEARS	1
MORE THAN 35 YEARS	0
OVERALL TOTAL	135

Table 3.1d shows the years' experience of employees that were interviewed. From this table it can be seen that the majority of employees that were interviewed had between 6 and 10 years' experience in the mining industry at the time of the interview.

Figure 3.1a shows the distribution of employees interviewed by occupation.

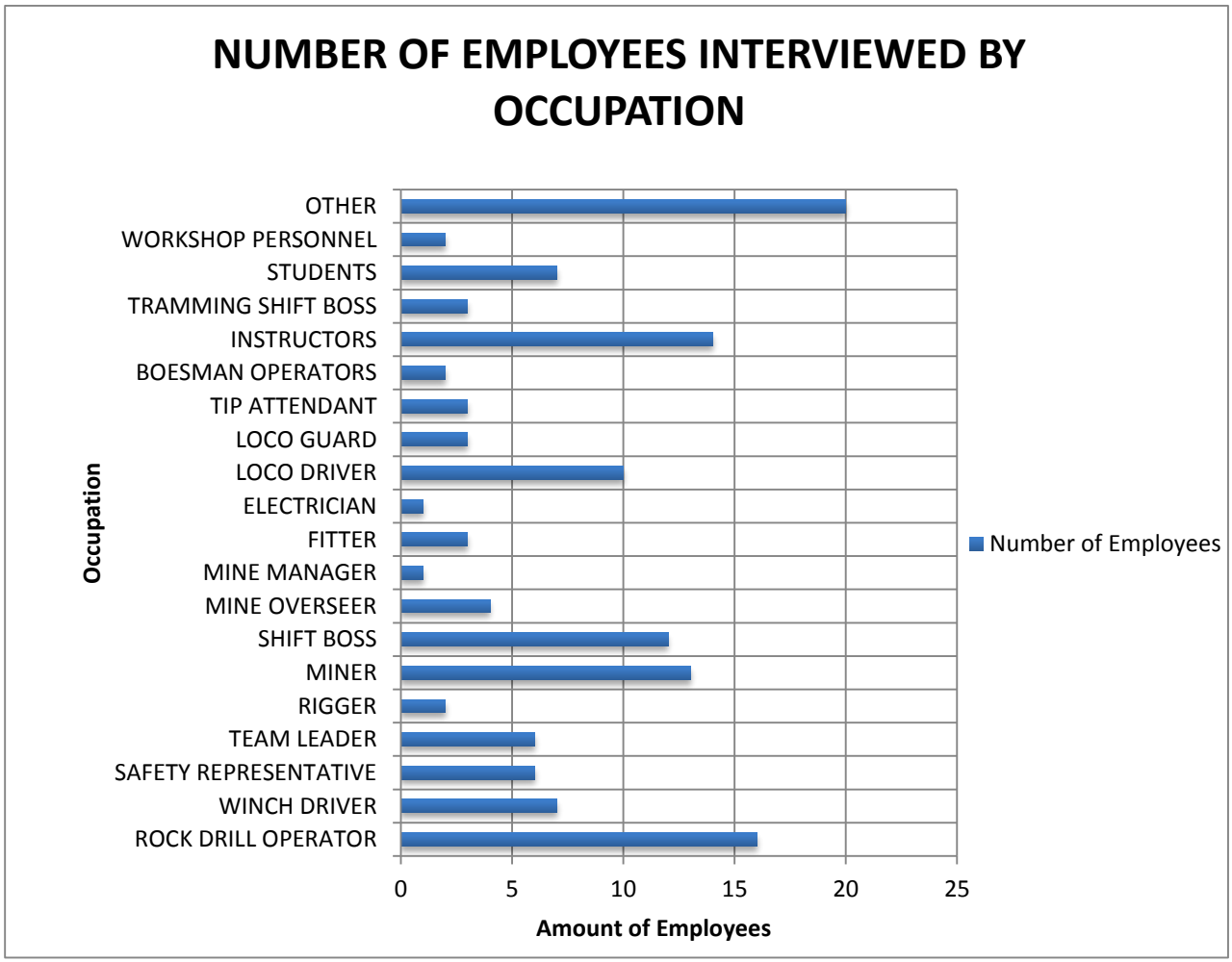

Figure 3.1a: Distribution of employees interviewed by occupation.

Since the focus of the study was on underground production personnel, an attempt was made to get as much as possible interviewees who were directly involved with production. From Figure 3.1a it can be seen that the categories chosen for interviewees were suited for the purpose of this study since each of the categories are directly or indirectly related to production.

The category labelled “OTHER” (see Figure 3.1a) includes employees from all the other categories. The interviewees from this category did not want to mention what their occupation was due to a fear that the author would cause trouble for them with the mine manager that would result in them losing their jobs.

This behaviour brings the discussion of the results to an important question. If employees were too scared to disclose their occupation to the author, how accurate and honest is the information that they have provided in the questionnaires and during personal interviews?

Honesty and a fear of losing employment seemed to be a major problem at the mine. On multiple occasions during the investigation period, employees would ask the author by whom he was sent to ask questions and what the reason for his investigation was. Employees were found to be extremely anxious to talk or voice their opinions while in the presence of their colleagues. On other occasions, some of the “new ones” (as new employees are referred to underground) were often silenced by the elder employees when an interview was taking place.

The reason for mentioning the type of behaviour described in the paragraphs above is the following: it influences the accuracy and credibility of the information obtained from the investigation at the mine. The interviewees’ behaviour during interviews also opens a gap for speculation that employees are hiding certain things from management as well as their supervisors. It raises the question of complete honesty, some interviewees might have lied and others were maybe too scared to answer the questions honestly. One can thus not say that the results of this study is 100% accurate, due to the external influencing factors in the working environment and observed fluctuations in behaviour.

Despite the odd behavioural patterns and trust issues, it was possible to notice certain trends in the way that the majority of questions were answered which will be discussed later. This fact gives a certain level of confidence with regards to the data obtained.

Since the general opinion of production management was that younger employees were the problem when it came to sub-standard practises, it is necessary to look at the age distribution as well as years' of experience of interviewees. Figure 3.1b on the following page shows the age distribution of interviews.

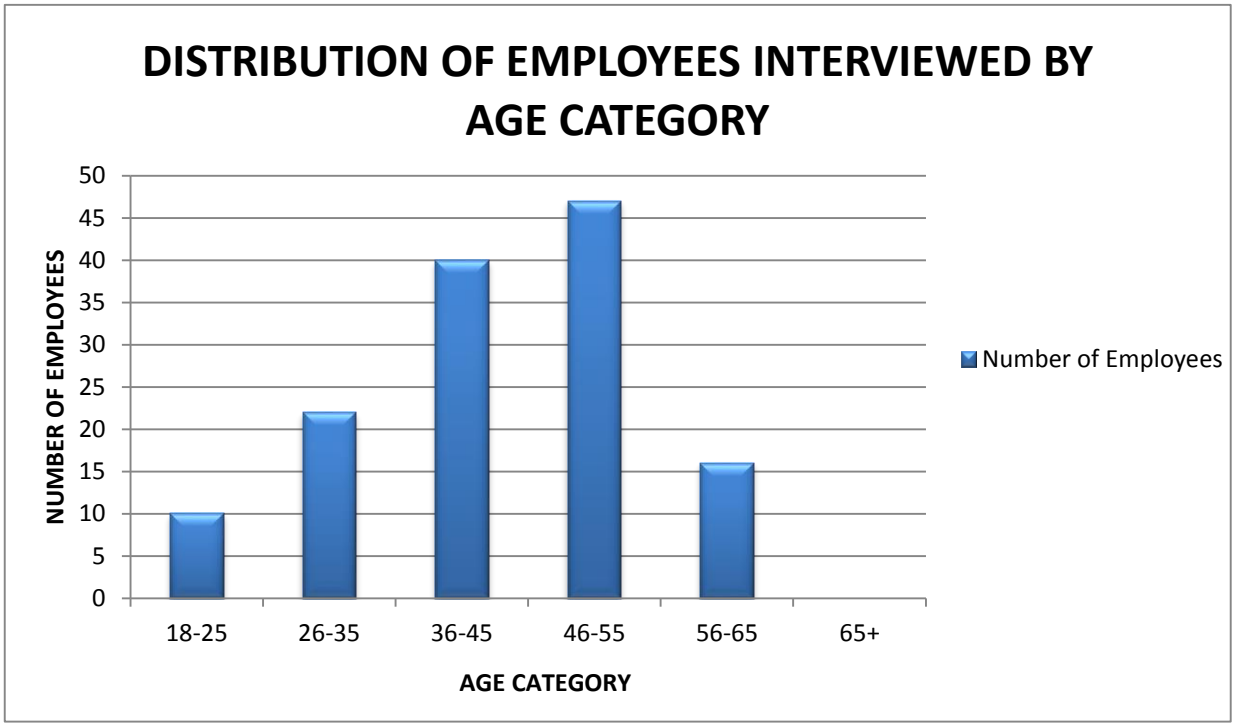

Figure 3.1b: Age distribution of interviewees.

From a statistical point of view, it could be argued that the data in Figure 3.1b displays a close to normal distribution, with a slight skew to the right distribution. What this means is that the greater amount of employees that were interviewed, were in older age categories.

Figure 3.1c shows the distribution of interviewees by years' mining experience. The general tendency would be to expect that the data would be skewed to the right due to the distribution of data in Figure 3.1b. This was however not the fact. The data in

Figure 3.1c shows a skewed to the left distribution. This means that more of the interviewees fell into categories of less years of mining experience.

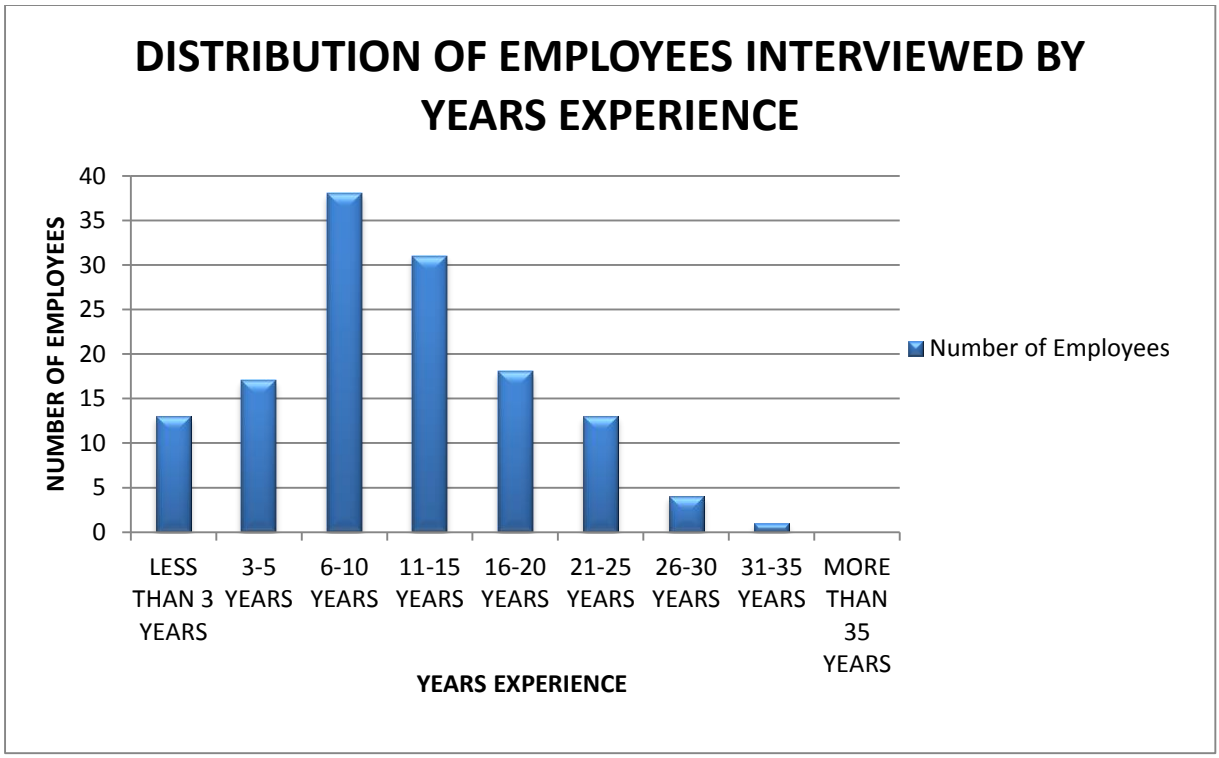

Figure 3.1c: Years' mining experience of interviewees.

From the data set of interviewees it is clear that a greater number of older employees were interviewed than younger employees. The data showed no correlation between age and years' experience which could resemble one of two situations:

- The mine currently has a large amount of young employees who do not have many years' experience in the mining industry.
- Elder people have been appointed in certain occupations in the mining industry, without a great amount of previous mining experience.

Both of the two situations mentioned above could have influenced the findings with regards to sub-standard practises. After discussion with Mr. André van Zyl, a psychologist specialising in public health, it was established that in the mining

industry, the following behaviour is expected with regards to age and years' experience in the mining environment (van Zyl, 2015):

- Younger employees are more likely to exhibit risk taking behaviour such as engaging in sub-standard practises due to the nature of the younger person's thought patterns.
- Elder employees are the least likely to exhibit risk taking behaviour due to thought patters commonly associated with age such as being more careful in the work environment.
- The less experience an employee has, the more likely he or she would be to engage in sub-standard practises since the memory bank of the person has no recollection of dangerous situations or loss of life that has been witnessed by the person before.
- Contrary to the previous statement, elder employees are seen as the more responsible person in terms of rather implementing standards as opposed to risk taking behaviour. They are more likely to be focused on issues such as health, job security and avoiding dangers.

It is therefore clear that at least four "types" of employees could be expected in a mining environment: (listed in descending order of being prone to engage in sub-standard acts)

1. Young employees with no previous mining or minimal mining experience.
2. Young employees with some mining experience.
3. Elder employees with no previous mining or minimal mining experience.
4. Elder employees with many years' mining experience.

There are however a great majority of factors that could have influenced any employee from any age category and any level of experience. These factors include mental health, job satisfaction, remuneration, stress and education to just mention a few.

In order to establish and analyse certain trends in employee behaviour with regards to sub-standard practises, some of the questions of the questionnaire were grouped together in order to analyse them for similarities and conflicting answers. The findings are discussed in the following section.

3.2 Results from Questionnaire

As discussed in the methodology, a questionnaire was used to obtain data from employees. This questionnaire was also used for the personal interviews with employees. An example of the questionnaire can be found in Appendix A.

The questionnaire was set in such a way to prevent discrimination and biasness in terms of occupation, race, gender and level of expertise. The questionnaires were therefore kept anonymous to obtain honest information from employees.

The composition of the questionnaire was as follows:

- 15 questions in total.
- A section for comments and suggestions.
- 7 yes/no questions (questions 1, 3, 4, 5, 7.1, 7.2 and 11).
- One frequency based question (question 6).
- One rating question on a scale of 1 to 5 (question 10).
- The rest of the questions were opinion based questions with regards to sub-standard practises and safety.

Due to the nature of the questions that were based on personal opinions and experience of employees this chapter will only include some quotations from employees' answers to these questions.

Each yes/no question of the questionnaire will be addressed individually below.

Questions 1 and 3 were grouped together in order to determine whether employees truly understood what sub-standard practises were. Question 1 dealt with whether employees had encountered sub-standard practises and question 3 dealt with whether employees understood what standards were and the necessity thereof.

Question 1: Are you aware of any sub-standard work being performed in your working place or under your supervision?

Table 3.2a: Results of Question 1**.**

	NUMBER OF RESPONSES	PERCENTAGE OF TOTAL (%)
YES	105	80.15
NO	27	22.90
NOT APPLICABLE	3	

Table 3.2a shows that the majority of employees (80%) are aware of sub-standard practises in their section or are ware of sub-standard acts being performed under their supervision.

Question 3: Have you been trained in such a way as to understand why certain standards are required and need to be upheld?

Table 3.2b: Results of answers to Question 3.

	NUMBER OF RESPONSES	PERCENTAGE OF TOTAL (%)
YES	120	91.60
NO	15	11.45

Table 3.2b shows that 91.6% of employees that were interviewed felt that they were trained to understand why standards were required and needed to be upheld. The result is quite ironic since from personal experience and in discussion with management the point arose that employees often do not understand the implementation of standards.

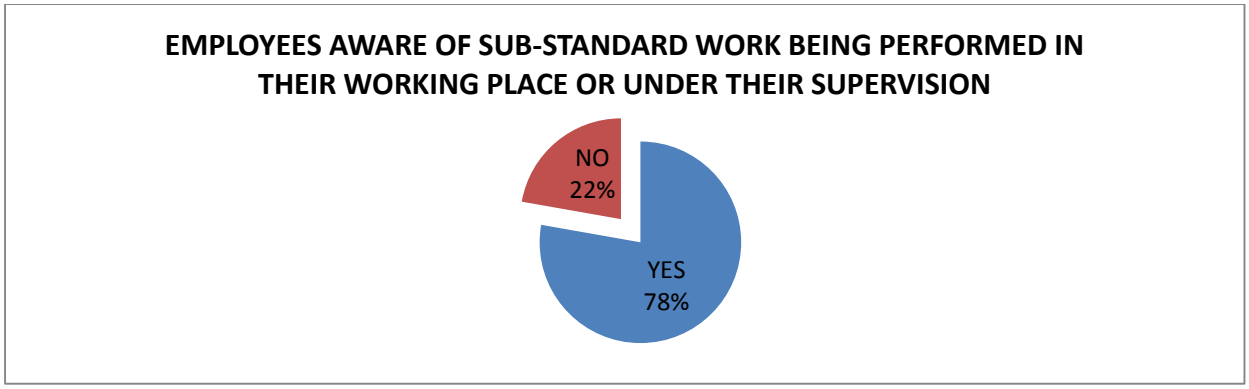

Figure 4.1d: Employees' awareness of sub-standard practises.

Figure 3.1d shows that employees had a very high awareness of sub-standard practises in the underground working environment albeit in the general environment or directly under their supervision. This might show that employees were very aware of what sub-standard practises meant in terms of their occupations.

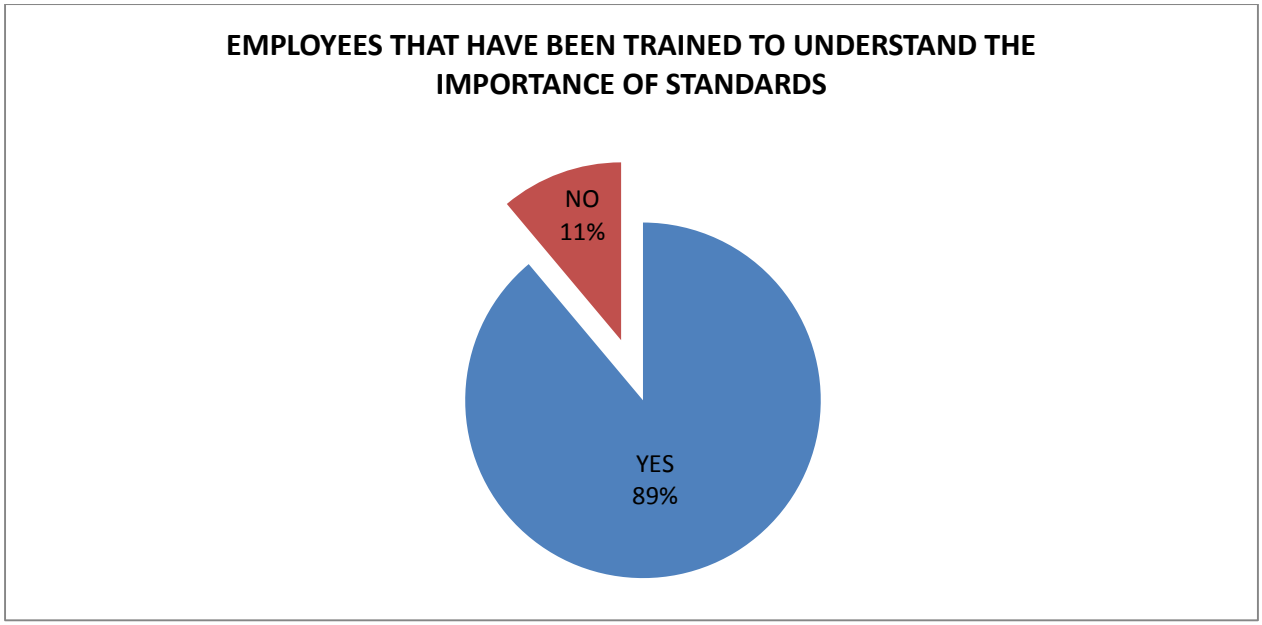

Figure 3.1e: Employees' understanding of standards and their importance.

Figure 3.1e above shows that 89% of the interviewees had a good understanding of standards and their importance. The correlation between Figures 3.1d and 3.1e is that if employees understood what standards were and why they are important in the working environment, employees should also be able to identify sub-standard practises without difficulty.

The 22% of employees that said they were not aware of any sub-standard practises (see Figure 3.1d) could have felt this way due to the following:

- A fear of losing their job by providing an honest opinion and a fear of being bullied by others in the work environment due to providing information.
- Not understanding the question (most unlikely reason).
- Not understanding what the standards at the mine are.

11% of the interviewees were of the opinion that they were not adequately trained in understanding the standards. This correlation shows that there was a strong opinion amongst employees that a lack of training and education on standards is a root cause of sub-standard practises. It is clear that if an employee did not understand a standard, he or she would be highly likely to firstly implement the standard incorrectly

and secondly not being able to identify sub-standard practises due to a lack of understanding the standard.

In an attempt to determine whether employees did in fact receive adequate training, question 4 addressed the issue of understanding consequences of sub-standard acts. When a person understands the consequences of a certain act, those consequences being of a negative nature, he or she is likely to follow the correct procedure in order to prevent any form of loss.

Question 4: Do you understand the consequences of sub-standard work?

Table 3.2c: Results of Question 4.

	NUMBER OF RESPONSES	PERCENTAGE OF TOTAL (%)
YES	116	88.55
NO	19	14.50

Table 3.2c exhibits the same trend as Table 3.2b. It seems that the majority of employees are aware of the consequences of sub-standard practises.

14% of the interviewees claimed that they did not understand the consequences of sub-standard practises. During the interviews, a number of employees often apportioned blame on the “new ones” for performing sub-standard acts. The problem here might lie in a lack of underground experience. The majority of interviewees were concerned about the consequences since they have experienced consequences themselves, witnessed it or heard accounts of serious injuries from colleagues. Lack of experience in the work environment proved to be a major concern with regards to sub-standard acts.

Figure 3.1f on the following page shows that 86% of employees claimed to understand the consequences of sub-standard work. These results however do not correlate with those in Figure 3.1g. Although 86% of employees claimed to understand the consequences of sub-standard practises, a shocking 46% of them were still prepared to perform sub-standard acts if the opportunity had to present itself.

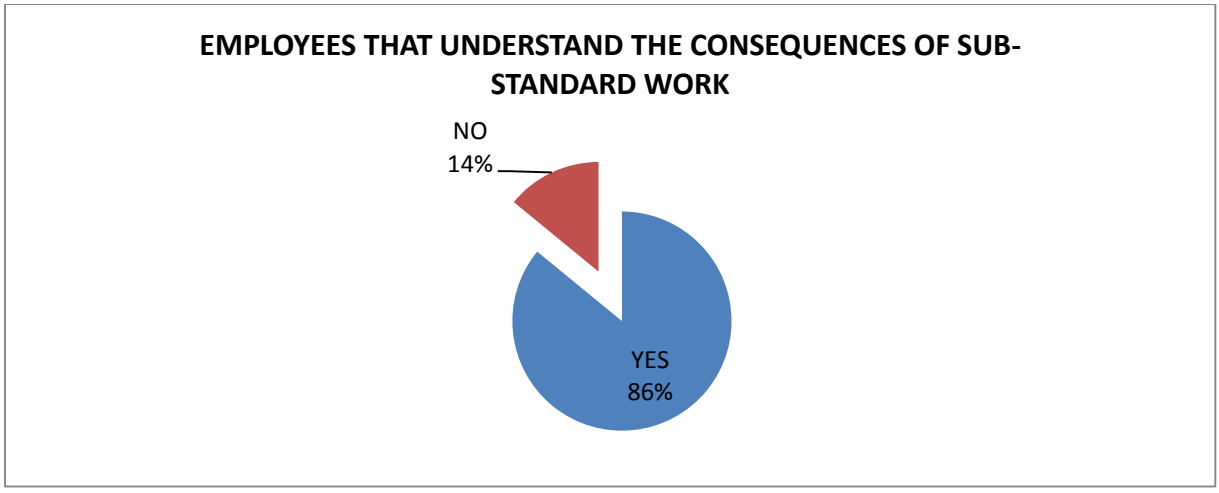

Figure 4.1f: Interviewees' opinion of understanding the consequences of sub-standard acts.

Question 5: If you answered yes in question 4, have you done, or are you still sometimes prepared to do sub-standard work?

Table 3.2d: Results of Question 5.

	NUMBER OF RESPONSES	PERCENTAGE OF TOTAL (%)
YES	62	47.33
NO	73	55.73

The results shown in Table 3.2d are the turning point in the investigation. If employees answered “yes” to question 4, why would they answer “yes” to question 5?

46% of interviewees that said they understood the consequences of sub-standard practises said that they were still prepared to perform sub-standard acts. The question that arises from these results is why would employees be willing to take the risk of incurring a loss, if they understood the probability and severity of the loss? The answer to this question lies in the behaviour and mindset of underground production personnel. Some of the quotations from interviewees’ answers in Tables 3.2l and 3.m strongly support the above statement.

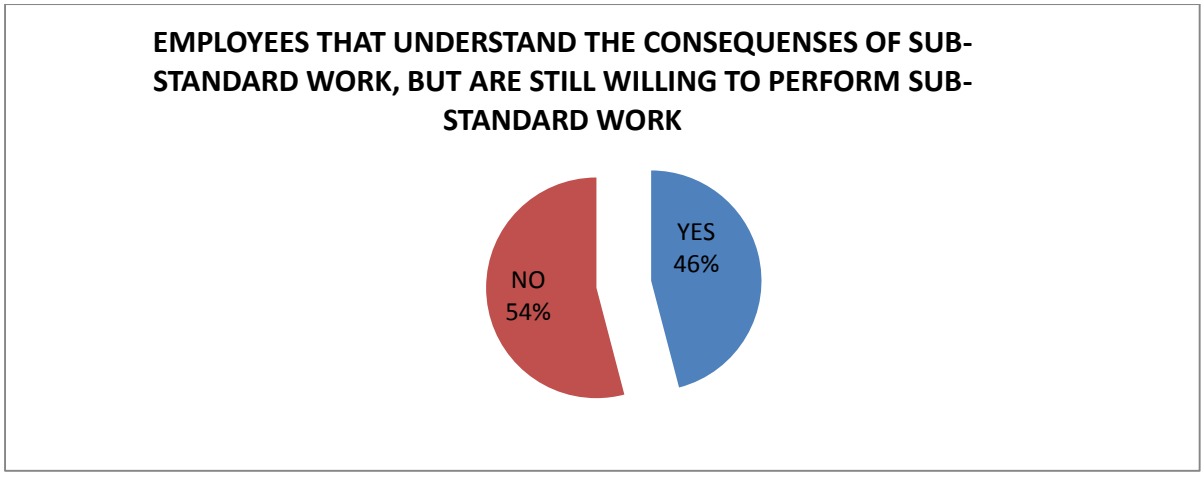

Figure 3.1g: Employees that understood the consequences of sub-standard acts, but are still prepared to perform sub-standard work.

Supervisory skills seemed to be lacking in the majority of working places that were visited. Due to a lack of respect and no fixed structure of authority, there was no control over employees' behaviour. It was also found that teamwork skills were not favoured underground. Every employee had the mindset of "*I'm here only to do my job".* Sub-standard practises were therefore closely related with communication gaps, lack of teamwork and apportioning blame to younger employees, instead of accepting fault.

Question 7: Have you ever performed sub-standard work yourself (7.1) or instructed someone to perform sub-standard work (7.2)?

Table 3.2e: Results of Question 7.1

	NUMBER OF RESPONSES	PERCENTAGE OF TOTAL (%)
YES	73	55.73
NO	62	47.33

Table 3.2e shows that more employees have, at some point in their careers, performed sub-standard work.

Table 3.2f: Results of Question 7.2

	NUMBER OF RESPONSES	PERCENTAGE OF TOTAL (%)
YES	43	32.82
NO	93	70.99

From Table 3.2f it can be seen that approximately 33% of employees have not only performed sub-standard work themselves, but also instructed other employees to do so.

Question 11: Would you feel confident to let an inspector of the DMR into your current working place?

Table 3.2g: Results of Question 11.

	NUMBER OF RESPONSES	PERCENTAGE OF TOTAL (%)
YES	45	34.35
NO	84	64.65

The disagreements and agreements between certain questions of the yes/no set of questions will be analysed in the following sections.

Question 6 was specifically asked in order to test the employee's degree of observation and to compare these answers with the yes/no questions in order to establish a link between certain questions.

Question 6: How often do you encounter sub-standard practises in the underground work environment?

Table 3.2h: Results of Question 6.

	NUMBER OF RESPONSES	PERCENTAGE OF TOTAL (%)
DAILY	43	32.82
WEEKLY	49	37.40
MONTHLY	32	2.43
YEARLY	11	8.40

Table 3.2h shows that most of the employees who were interviewed, encountered some form of sub-standard practise on a weekly basis. Surprisingly, some employees felt that they only encountered sub-standard practises on a yearly basis, which is hard to believe based on the author's personal experience at the mine.

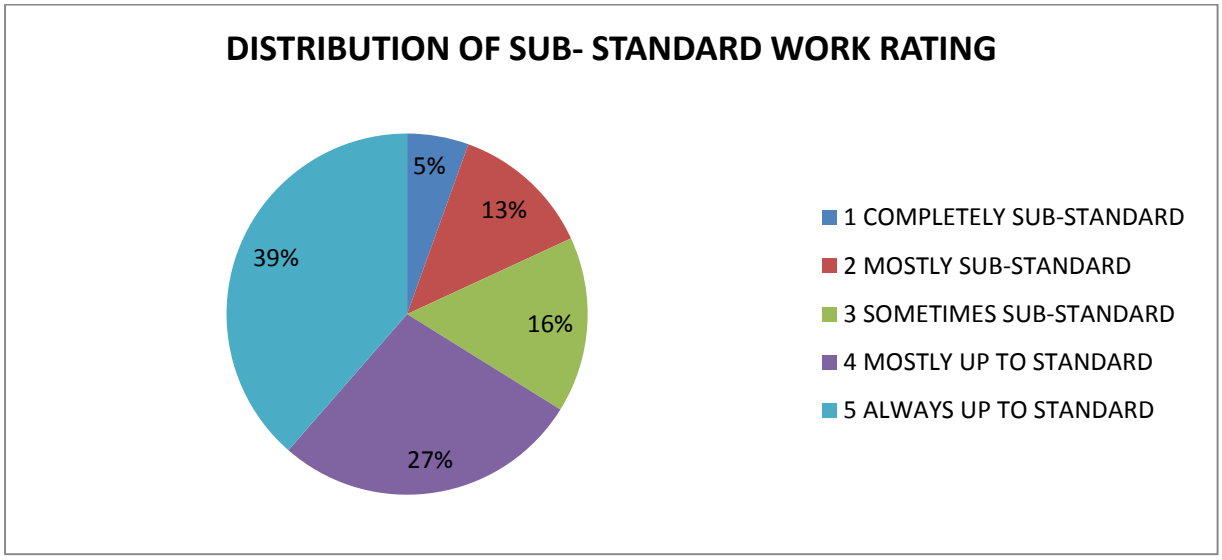

Figure 3.1h: Sub-standard work ratings.

Figure 3.1h shows that 39% of employees said that their work was always up to standard, while only 5% said that their work was completely sub-standard. In order to test the validity of these results, a question was asked to determine how confident employees would feel with a DMR visit in their current working places.

Question 10 in the questionnaire addressed the employees' thoughts of themselves regarding sub-standard practises. Employees had to rate themselves on a scale of 1 to 5 in order to indicate if their work is never up to standard or always up to standard.

Question 10: On a scale of 1 to 5, where 1 is completely sub-standard, 2 is mostly sub-standard, 3 is sometimes sub-standard, 4 is mostly up to standard and 5 is always up to standard, what rating would you give yourself?

Table 3.2i: Results of Question 10.

RATING	NUMBER OF RESPONSES	PERCENTAGE OF TOTAL (%)
1	7	5.34
2	16	12.21

RATING	NUMBER OF RESPONSES	PERCENTAGE OF TOTAL (%)
3	20	15.27
4	35	26.72
5	49	37.40

Table 3.2i shows that 37.4% of employees felt that their work is always up to standard. The result of this question shows fairly contradictory results to the actual situation in the underground working environment. If the majority of employees feel that their work is always up to standard, then why is there a problem with sub-standard practises?

Question 11: Would you feel confident to let an inspector of the DMR into your current working place?

Table 3.2j: Results of Question 11.

	NUMBER OF RESPONSES	PERCENTAGE OF TOTAL (%)
YES	45	34.35
NO	84	64.12

Table 3.2j shows a very interesting contradicting statistic. The majority of employees that said that their work is always up to standard did not feel confident to let an inspector of the DMR into their working place.

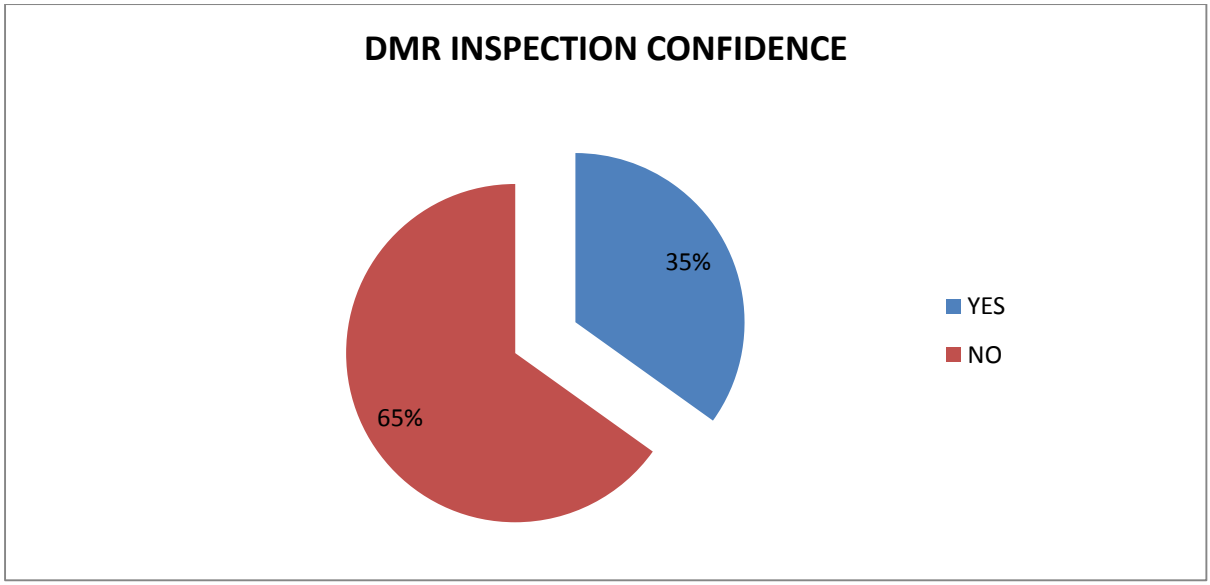

Figure 3.1i: Interviewees' confidence on a DMR inspection.

It was found that the results of Figure 3.1i completely contradict the results shown in Figure 3.1h. Although a total of 68% of employees said that their work was always or almost up to standard, 65% of the employees would not have felt comfortable with the current state of their working places during a DMR visit. These results thus confirmed the suspicion that employees were hiding information with regards to sub-standard practises and were often not completely honest in their answers.

The results that follow were the answers obtained to the written questions of the questionnaire that were based on employees' opinions. The tables below include some quotations from each of the written questions' answers. The longer questions of the questionnaire which focused mainly on determining the root causes of sub-standard practises and remedial actions, yielded some interesting results.

Question 2: Briefly describe the type of sub-standard work that you have encountered, e.g. wrong procedures followed, winches not to standard etc.

Table 3.2k shows some of the results of question 2.

Table 3.2k: Results of Question 2.

"No procedures for entering cages followed"
"Pinchbar used to put explosives in hole"
"T-sprags never in place"
"People walk on the rails"
"RDO is operating winch"
"Early morning entry exam not done"
"*Winch driver operates winch without doing checklist"*
"*Miner carries the fuses in his overall pocket"*
"*Team leader drags explosives with rope in the stope"*
"Maintenance not done on winches and scrapers"
"Lo spacing ka lo pak yena mubi"
"Shifbosses tell us to drill and blast even if the stope is not safe"
"There is no ladder or rail in the travelling way"
"RDO is drilling without jacks and net"
"Loco driver is sleeping and pulls no stof"
"The new ones play on the chairlift"
"Some man steal the tools"
"People walk while the loco is going past them"
"The scraper rope scrapes the Hangingwall"
"The team leader never test for methane"
"Some people sleep in the stope"
"We do not carry explosives correct, because there is no elephant bag"
"The stope where I work it is too hot and the shift boss he say it is ok"
"Sometimes we must work fast and I do not wash the sockets"
"The loco is running too fast"
"Sometimes you can find that afternoon shift will put 10 hoppers by 1 loco"
"The X-cut is flooded and no one makes a plan, we must walk in the water to the travelling way and every day it is worse"
"My miner says we do not do drilling control"

"Many of us in the stope do not put PPE because it is too hot for us to do the job"

According to the results that were obtained, the sub-standard acts that were encountered by employees were widely varying with some types of sub-standard practises mentioned more frequently than others. The general type of sub-standard work that was encountered, included, but was not limited to the following:

- Incorrect procedures when entering and exiting man carriages.
- Incorrect tramming procedures followed (speeding, leaving locos running without an operator inside, attaching too many hoppers etc.)
- T-sprags almost never in place and ventilation doors always open since it interferes with tramming according to loco guards.
- Unequipped travelling ways (no steps, footwall not cleaned, no handrails or rope guides, sometimes not sufficient support)
- Incorrect explosive storage, transport and handling procedures.
- Improper rigging practises.
- No supervision.

The above mentioned examples of sub-standard acts, procedures and installation are but a few compared to the great amount of sub-standard practises that were encountered during the investigation.

Question 8: If you ticked yes in any of the two tick boxes above, please provide a reason.

Table 3.2l: Results of Question 8.

"There is a shortage of labour in my stope"
"The younger employees do not respect us and do not follow instructions"
"I have been waiting for materials for support for 2 weeks now"
"The shift boss forces us to produce"
"Some miners tell you not to worry because the standards is no problem, your job is your job"
"I am here to get paid at the end of the month and to do my job"
"I am very tired when I come to work and the family is giving me problems"

"The stope is far from the shaft, when I get there, the work is hard because I'm tired of walking"
"Standards won't give me bonus"
"The people are not proud of their job"
"We do not understand the standards always"
"Some of us did not train nicely, because we had to come underground quickly"
"Lo standards ka lo training centre aikona lo standards ka ngodi"
"The RDO thinks their job is the most important one"
"Some supervisors they get angry when we spend lots of time on making our stope safe and with standards"
"We do not get bonus for making the standards"
"I did the standards in training centre, but underground they are difficult to do"
"We want to choose our own teams, some people struggle to work with the others"
"Management just cares about production, they will ask you if you have blasted because is the only thing that is important"
"We put the standards in, but the mining is difficult sometimes you find a dyke or fault and the standard doesn't go with it"
"The managers tell us we must make a plan to produce even if we don't have materials or the peoples for the job"
"I am the team leader and the young guys must listen to the instruction"
"We need to finish the job quickly so that we can blast the face"
"I am scared to lose my job if we do not listen to the shift boss"
"Supervisors tell us what to do and we just listen"
"The miner he shouts us and is angry when we waste time on making the standards"
"We need bonus because the pay is small"
"The managers don't mine, we are the stoping team and standards are difficult to put in place underground"
"The team leader says that no one will notice if we take shortcuts"
"I struggle to finish the work if I have to do the standards"
"We have worked like this all the time, it is difficult to change now"
"The mine must test the standards first because sometimes we don't understand it clearly"

"It is not my job to look at the standards"
"Some guys they fight about the standards because they want to take the early cage"
"I told them to not follow the standard because the shift boss say we must start mining"
"The RDO tells us that he will not work when we tell him many stories about standards"
"Sometimes we short labour, and someone must do the person's work"

Table 3.2l shows the responses of employees that answered "yes" to questions 7.1 and 7.2. It seems that the employees that answered positively to this question were not scared to voice their opinion on why they made the decisions that they made with regards to performing sub-standard work and also instructing others to perform sub-standard work.

When employees answered the questions on why they had performed sub-standard work or instructed someone else to perform sub-standard work, it became clear that engagement in sub-standard practises was definitely a behaviour based issue at the gold mine. The majority of employees showed an inclination towards taking matters into their own hands when plans did not go according to their personal plan. It was observed that everyone wanted to be leaders, and seldom followers even when it was necessary.

Many experienced employees were extremely set on respect. If they felt that they were not respected, they would not assist in the task or deliberately work slow in order to annoy the person who had assumed seniority in the situation. A lack of soft skills is definitely a major cause of sub-standard practises. Teamwork is inevitable in the mining industry and interpersonal skills are essential; something that employees at the gold mine need to be trained in.

Ignorance was found to be a major driving force behind sub-standard acts. Employees believed that because they have never been involved in an accident, it will never happen to them. They have been working sub-standard for so long that they are now accepting it as the norm. It was clear that revenge also played a major role in sub-standard procedures and acts. The belief amongst interviewees was that

if a colleague has done them wrong, he must pay for it. Sub-standard acts are often the result of payback to try and regain status by being rebellious.

Question 9: What do *you* think, are the reasons behind sub-standard work?

Table 3.2m: Results of Question 9.

"There is not enough labour"
"Materials take a long time to get to the stope"
"The money is not good. No bonus for standards"
"People are not motivated"
"It is the way people think, their mindset is not good"
"The problem is with management"
"I don't think the training is enough, the people just do what they want"
"The attitude of the employees is not good" *"The management must help with the standards"* *"The guys are not proud anymore"*
"People are angry underground. I don't know why"
"It is the money" *"We just hear we must drill and blast"* *"Miners do not care about the safety"* *"We are still doing the old standards"*
"Managers do not always see what we do underground, they think the job is easy but it is not so easy"
"The standard is one way today, when come underground or you go to another section, the person tells you the standard is different now"
"Nothing happens to someone who performs sub-standard work. That is why they will keep on doing it without having to worry"
"If the shift boss does not come to the stope every day you will find that people start to do just what they want"
"Many of my colleagues are selfish. They care only about themselves but not about the others. They don't understand what will happen if we do not implement standards"
"People are very lazy. There is too many managers underground. Everyone wants to be the boss."

"Some guys like to play they do not take the job seriously and they are not scared to get hurt when something happens"
"Many employees just want to collect their payslips at month end. They do not understand that we need standards so that the job can be done correctly. They only care about money and bonus."
"The manager must come underground more often. Then we will start seeing results"
"The old guys set a bad example for the new ones. They do not follow the standards of the mine and then the new ones also think that that is the way to do it"

As can be seen from Table 3.2m, there is a great amount of variation in the answers that employees had on question 9. The results confirmed that production supervisors were often the culprits themselves by not practising what they preached to their gangs. This behaviour resulted in a shared anger by production personnel, which caused a less motivated work culture. Employees felt that they could do as they please, since production supervisors did not care.

Although one might not have expected a factor such as the location and working conditions of stopes to be a driving force behind sub-standard practises, the results clearly showed the opposite.

Many employees complained about the distances that had to be travelled on foot in a short amount of time in order to reach the working place early enough so that enough time was still available for completing mining activities. Fatigue resulted in employees performing work that was of poor quality since they lacked the energy to perform the task correctly.

Other employees were of the opinion that they did not have the correct tools available to perform the given tasks up to standard. A combination of fatigue, incorrect tools and limited time resulted in sub-standard acts.

Question 12: Briefly state *your* opinion on why sub-standard work has become part of the working culture at the mine.

Table 3.2n: Results of Question 12.

"The problem is in people's heads"
"We have been doing it for so long now, that it does not look like something is wrong

anymore”
“Extremely poor supervision and lack of motivation”
“A no-care attitude that results in just getting the job done and not caring about the quality of work”
“People feel that they don’t get rewarded for doing work according to standard”
“There is no control over what we do underground”
“The supervisors are responsible for not doing maintenance and not ordering materials for us to be able to do our jobs”
“I think the majority of employees set a bad example and then the rest just follow them or do as they are told”
“We need to be rewarded for doing a good job. It is difficult working conditions and the pay is not great”
“Some shift bosses pick someone as their favourite. The other employees then get angry and do not want to do the job correctly because they feel they are not valued”
“Shift bosses gossip with employees that cause trouble when someone finds out about it”
“People cannot do a job that they do not fully understand and are not adequately trained for”
“People think it is okay to work sub-standard as long as no one will catch them. They are not scared of the supervisors because they are many against one”
“The problem comes from management. If no systems are implemented to maintain the standards, you cannot expect the workforce to perform as expected”
“People are not aware of the effects that sub-standard work has on safety and production. They do not understand that standards will actually help them to work safer and that the job will be easier if we keep to the standards”
“The education of people plays a big role. Some employees never finished school and struggle to read or write. It is hard for them to understand and implement the standards that we learn in the training centre”
“Shift bosses turn a blind eye to sub-standard work. As long as the people blast, it is OK. They must understand that some people do not always know what is wrong and they need the shift boss to show them the correct way of implementing standards”
“The standards change often, but we do not know about it underground, only when

we go on leave we find out about a new standard and then we realise the work that we have done before is not correct"
"It is a psychological problem that is experienced throughout all levels of the company. It is not something that started a day ago, it was always there but it looks like no one cares enough to solve the problem"

Table 3.2n shows very mixed opinions on why sub-standard practises have become part of the working culture at the mine. There are however a number of trends that can be observed from the responses to question 12.

Question 13: What remedial actions do *you* think need to be taken in order to address this situation?

Table 3.2o: Results of Question 13.

"A reward system for rewarding work that is up to standard"
"Increase the salary"
"Implement a penalty system that will penalise a whole team if someone is doing sub-standard work"
"Better supervision over production personnel"
"Improved training in a language that the person can understand"
"I think what will help is if people receive more on the job training underground and less time in the training centre"
"The managers must sit together and decide how they can help us to improve our working conditions so that we want to do the work correctly"
"More inspections by the DMR to make sure that the employees are doing what is required of them"
"Make sure there is enough labour for a job so there is no excuse to do sub-standard work"
"Evaluate employees' mental well-being and assign a mentor or life coach to employees that are facing a lot of problems"
"Do something to help us understand the standard and how does it work"
"Maybe we can have monthly refresher courses to evaluate the competence of our

employees and if they are not competent enough, we provide extra training"
"People must start thinking before they do something. The mine can teach people how to make better decisions by helping them to understand why they must think"
"The company can make a competition for standards. When a gang has good standards, they must get a prize"
"The guys from CEBISA can help us. They know how the standards work and they know how to fix problems"
"The situation must be addressed as soon as it arises, otherwise it creates gaps for more and more sub-standard practises"
"We must change our attitude and be proud of our jobs"
"The manager must make us feel good about our work because we look up to him"

The responses to question 13 seem to have a number of general ideas regarding the remedial action against sub-standard practises. The suggested actions to take control of the situation can be summarised as follows:

- Improved training.
- Reward for implementation of standards.
- Mental wellbeing of employees.
- Address attitude related issues.
- Education on standards and their importance.

Question 14: How would *you*, personally be encouraged not to perform sub-standard work?

Table 3.2p: Results of Question 14.

"If I get rewarded for doing the job to standard"
"When I feel like I am important to the mine and that my team needs me"
"If I understand the standard and why it is necessary and not just a waste of my time to do my job"
"The shift boss must tell me that he is proud of the job we are doing here"
"If I can see the need for a certain standard"
"Some motivation will be nice"
"Not getting shout at and told to blast when I know that the standards are not correct"

"For the whole team to agree and not to argue because of what they think is right"
"If I know that it will impact my salary" *"When someone gets hurt because they did not follow the standards"*
"The shift boss must be with us so he can see we are not playing when we say that something is wrong"
"Materials must arrive on time" *"My workers must be motivated"* *"I would like for my team to follow my instructions"*
"I don't want the stress to blast every day and to produce because the shift boss is angry"
"The working conditions must improve. Water is very far from the stope and we have complained it is too hot, but no one is fixing the problem"
"Management must make an effort from their side to implement programmes that help to maintain standards and encourage employees to put standards in place"
"Night shift must start to do their job"
"Motivation" *"Rewards"* *"Having a hard working team"* *"Respect for one another"*

It can be seen from the quoted answers in Table 3.2p that employees at the mine seem to lack motivation in terms of performing their jobs. They want to feel part of something larger than themselves and be rewarded for performing a good job.

The degree of education of employees influences the training methods to a great extent. Interviewees felt that on the job training in the underground environment would be more suited to their level of education than theoretical training in a training centre. The general feeling was that there exists a major difference between executing tasks in the training centre and executing the same task a few hundred meters underground.

Employees showed a tendency of fear and intimidation when asked questions about management. However, the results revealed that interviewees were not afraid to apportion blame for sub-standard acts on management. Employee's that were

interviewed felt that management had to make an effort to prevent, minimise and control risks underground and revise their strategies on a regular basis. The tendency that was found is that employees want to receive acknowledgement for good quality work, especially by management. They showed a sense of wanting to be part of the bigger picture and having improved relationships with supervisors and managers.

Question 15: What do *you* think is the origin of sub-standard work?

Table 3.2q: Results of Question 15.

"The older employees that influence the new ones"
"The problem is with management and not so much the workers"
"It is the money"
"Stress about the job, health, family and money"
"The supervisors that do not treat people well make them to not want to follow standards"
"It comes from the head when you have other problems at home"
"I think the origin is in the person's mind and his attitude"
"Management does not care about the people underground"
"It started long time ago and then one person copies the other one"
"I believe that it does not originate from one single factor, the origin of such behaviour differs from one person to another and each situation should be treated individually"
"I am not sure what the real reason is, but I think it has to do with the way that people think when they are underground"
"Working conditions are not nice"
"A lack of trust and good relationships with fellow employees"
"Psychology"
"Not really understanding why there are standards and why we need to use them"
"Poor communication" *"Not caring about instructions"* *"Thinking that you are the manager"*

Table 3.2q again shows great variation on the origin of sub-standard practises. Some employees believe that it is more of a psychological and behavioural problem, while others tend to blame management and direct supervisors for the issue.

The investigation at the mine indicated a number of potential issues that can be further investigated to determine the root causes of sub-standard acts and the effects thereof on safety. Perhaps the most interesting question yet to be answered is if sub-standard acts are largely a result of human behaviour and mentality of the individual. This question will be addressed in the analysis of the results from the Shadowmatch survey. The next section focuses on summarising the most important identified root causes of sub-standard practises in the gold mining industry of South Africa.

3.3 Comparison between 2012 West Wits Cultural Transformation Study and Findings of This Study

This section aims to discuss some of the key similarities and differences between the 2012 Cultural Study performed at the West Wits Gold Mines and the similar study performed at the mine. It will also discuss the findings of the 2013 CSIR accident causation study (see section 2.4) in relation to the findings at the gold mine under consideration.

From Tables B1 and B2 in Appendix B, the majority of employees employed in the gold mining sector analysed are male. This was also the case at the gold mine study. One could argue that due to the nature of maternal instinct, women were less prone to risk taking behaviour and engagement in sub-standard practises.

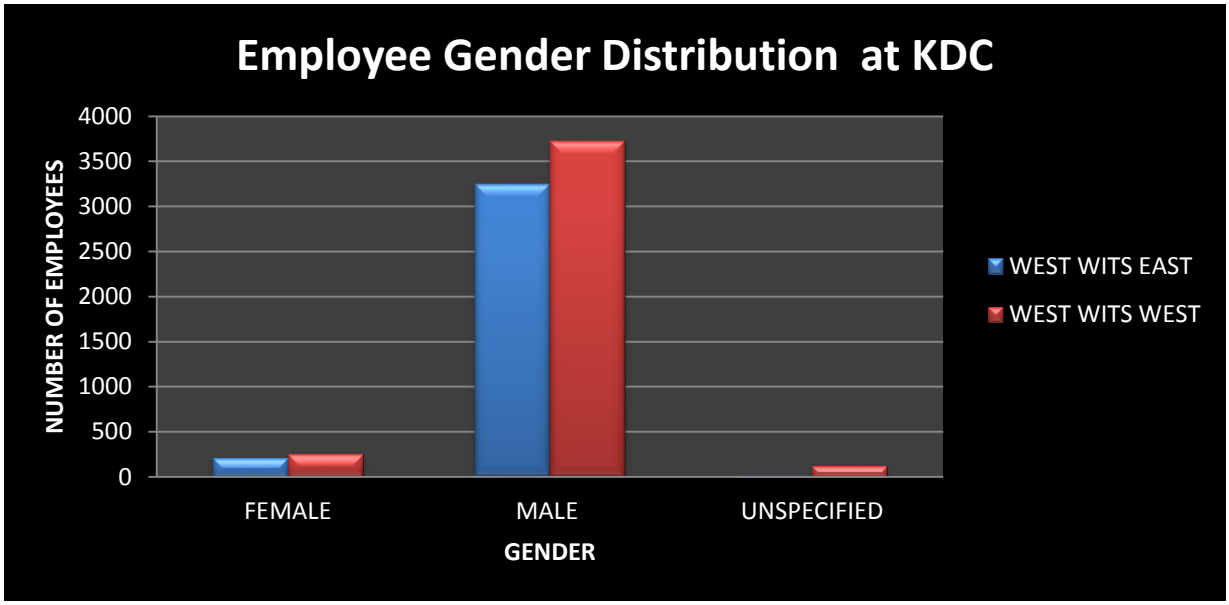

Figure 3.3a: Employee Gender Distribution at West Wits Gold Mines. (Mandala Consulting, 2012)

Figure 3.3a shows that the male number of male employees in the gold mining sector far outweighs the number of female employees. This shows that the majority of jobs in the gold mining sector are performed by men.

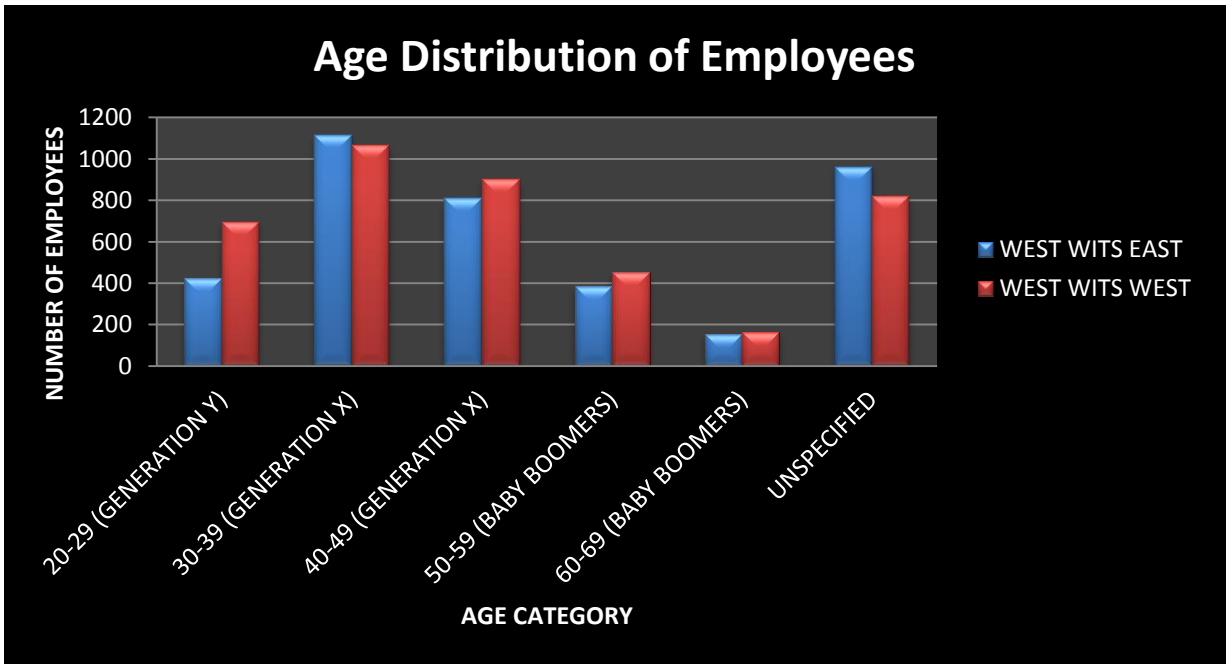

Figure 3.3b: Age Distribution of Employees at the West Wits Gold Mines. (Mandala Consulting, 2012)

The age distribution of employees at the West Wits Gold Mines shows a data set that is skew to the left, provided that the “unspecified” category is ignored (see Figure 3.3b). This trend is the opposite of the results from the gold mine. At West Wits, the majority of employees fall into younger age categories while at the gold mine it was found that more of the employees fell into older age categories. The reason for this difference could be the size of the data set.

The dataset from the West Wits Gold Mines included a total of 7945 employees as opposed to the 135 employees that were interviewed at the gold mine. It can be argued that the larger number of interviewees at the gold mine may have influenced the study outcome and identified trends.

Figure 3.3c shows the distribution of employees at West Wits by years’ experience.

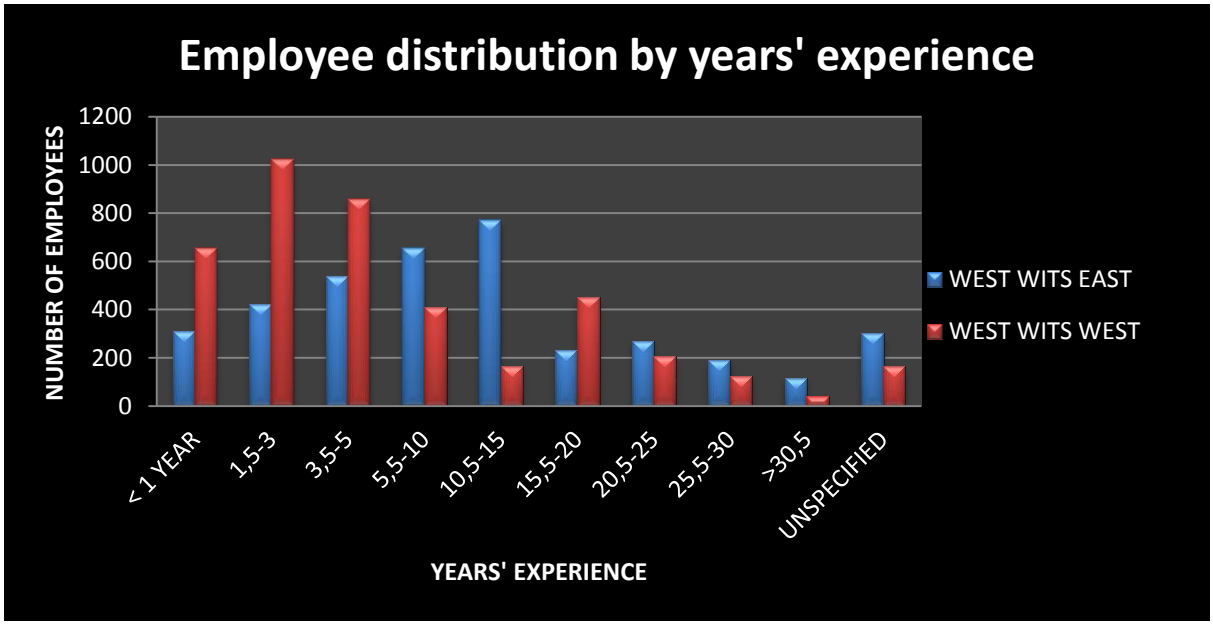

Figure 3.3c: Employees' distribution by years' experience (Mandala Consulting, 2012).

Figure 3.3c shows two conflicting trends. The distribution of employees by years’ experience that are employed at West Wits East shows data that is skew to the right. This means that the majority of employees at the West Wits East have a high number of years’ experience. The trend of West Wits West shows a data set which is skew to the left. This represents the fact that most employees at West Wits West do

not have a high number of years' experience. One would thus expect the gold mine study to show a similar type of trend.

The data obtained from the gold mine showed a skew to the left distribution: a trend that corresponds to the trend observed in the data from West Wits West. The significance thereof is that it seems that the gold mining industry of South Africa currently employs more unexperienced personnel than experienced personnel.

The 2012 Cultural Transformation Study (as per section 2.5) included language, ethnicity and remuneration grading as part of the study. The study at the gold mine did not include these factors and will therefore not be included in the discussion.

Most importantly, the results with regards to safety and sub-standard practises between the previously mentioned studies had to be compared. The findings are discussed below.

A number of responses to questions in the gold mine study revealed that employees were often just there to get the job done, not willing to go the extra mile with regards to their job descriptions, lacked a feeling of corporate ownership and often did not take control of conflict situations.

The cultural transformation study at the West Wits Gold Mines yielded the same results. About a quarter of the employees that took part in the study, were not interested in doing more than what was expected of them. About 70% of employees did not want to take control of situations which resulted in conflict. This showed that conflict resolution skills was lacking with most employees.

It was found that employees that took part in the cultural study at West Wits also did not feel competent to perform work at some time. The results also showed that adaptability, tenacity and resilience was often a problem for employees. These findings strongly agreed with the results obtained at the gold mine.

Two factors stood out in the "Positive Safety Indicators at the West Wits Gold Mines":

- The safety vision is clear (only 67% of employees said that the safety was clear)

- Standard safety procedures are followed (29% of employees indicated that these procedures were not always followed)

One can thus see a strong similarity in the safety culture at the gold mine and the West Wits. Employees did not understand the safety vision clearly and did not always follow standard procedures. It can then postulate that the gold sector shows a general trend of disregards for safety and standards in the underground working environment.

The safety dynamics at the gold mine and the West Wits showed numerous similarities. The findings are summarised below:

- Safety and standard practises are not consistent in all areas of the operations. West Wits Gold Mines and the gold mine employees strongly agreed on this matter.
- Nearly half of the employees at West Wits and the gold mine that participated in the survey said that it was not important to always follow the rules.
- On average, approximately 60% of employees at West Wits and the gold mine reckoned that they would engage in sub-standard practises when no supervision was present.
- Unfortunately, a common belief exists at the gold mine and West Wits that PPE is sufficient in the protection against dangers. This came up quite frequently in the study at the gold mine as a reason for performing sub-standard work.
- Many employees blamed supervisors as the reason for sub-standard acts. The West Wits cultural survey confirmed this by showing that approximately 42% of production supervisors did not allow their employees to withdraw under dangerous conditions. This proves what employees at the gold mine said with regards to being forced to produce under unsafe conditions.
- Only half of the employees interviewed at the gold mine and West Wits showed that they were, first of all, competent in conducting risk assessments before commencing with a task and secondly, agreed that only in approximately 40% of situations were risk assessments done since they are seen as “time wasters”.

Accepting teamwork as an inevitable factor to the success of mining and safety, showed exactly the same trend at the West Wits Gold Mines and the gold mine. Almost half of the employees believed that inter-dependence during teamwork played no role in the quality of work and relationships. The trend is that employees preferred working individually, although it is almost impossible in the production environment.

When performing teamwork, employees showed great difficulty in trusting each other. This was the case at both the gold mine and West Wits. However, trust was not the only underlying issue. Many employees also felt that they were not fully equipped for performing teamwork and that they were often not informed on their specific role within the team.

From the results obtained at the West Wits Gold Mines, it was evident that the gold mine that was studied was not the only operation that pointed out quality of supervision as a major problem. It was shown that employees did not possess proper supervisory skills, nor did the supervisors themselves. A lack of on the job coaching, lack of motivation and acknowledgement and relationships with supervisors again came up as a cause of sub-standard practises.

The studies performed at the gold mine and West Wits showed that there were almost no differences in the culture with regards to safety and sub-standard practises. In fact, most of the influencing factors that were investigated showed a great extent of similarities that could be used to say that the findings might be applicable to the entire gold mining industry of South Africa.

3.4 Results Obtained from Shadowmatch Survey at the Gold Mine

A total number of 88 shift bosses were selected by senior management of the company to participate in the Shadowmatch survey. Included in this number, was a benchmark study group of 10 shift bosses. These 10 shift bosses were selected based on performance in terms of safety and production. The benchmark group was used to determine the habits exhibited by successful shift bosses.

The purpose of the benchmark group was to be able to compare the profiles of the other shift bosses to the benchmark group in order to determine the habits that are

problematic for certain individuals that may result in sub-standard practices and a poor safety record.

The study group consisted of employees from 7 different mining units. Shift bosses were divided into different categories as shown in Table 3.4a.

Table 3.4a: Division of Shadowmatch participants according to section and shift.

SECTION	DAY	AFTERNOON	NIGHT	TOTALS
STOPING	28	0	18	46
DEVELOPMENT	9	0	8	17
TRAMMING	6	4	12	22
VAMPING	3	0	0	3
TOTALS	46	4	38	88

As shown in Table 3.4a, the majority of participants were day shift stoping shift bosses. The day shift vamping shift bosses were the smallest group within the data set. Five of the participants had no shift allocated to them and it was assumed that these employees were day shift stoping shift bosses.

A total of 74 out of the 88 invited participants were present during the survey. One benchmark participant was removed from the data set due to a negative influence on the benchmark strength.

3.4.1 Benchmark Group Analysis

The Shadowmatch results that were obtained from the benchmark group for the most embedded or critical habits exhibited by successful shift bosses were identified and are listed below (see Figure 3.4.1):

1. Team inclination with a score of 63.
2. Conflict handling with a score of 59.
3. Discipline with a score of 58.
4. Resilience with a score of 57.
5. Altruism with a score of 57.

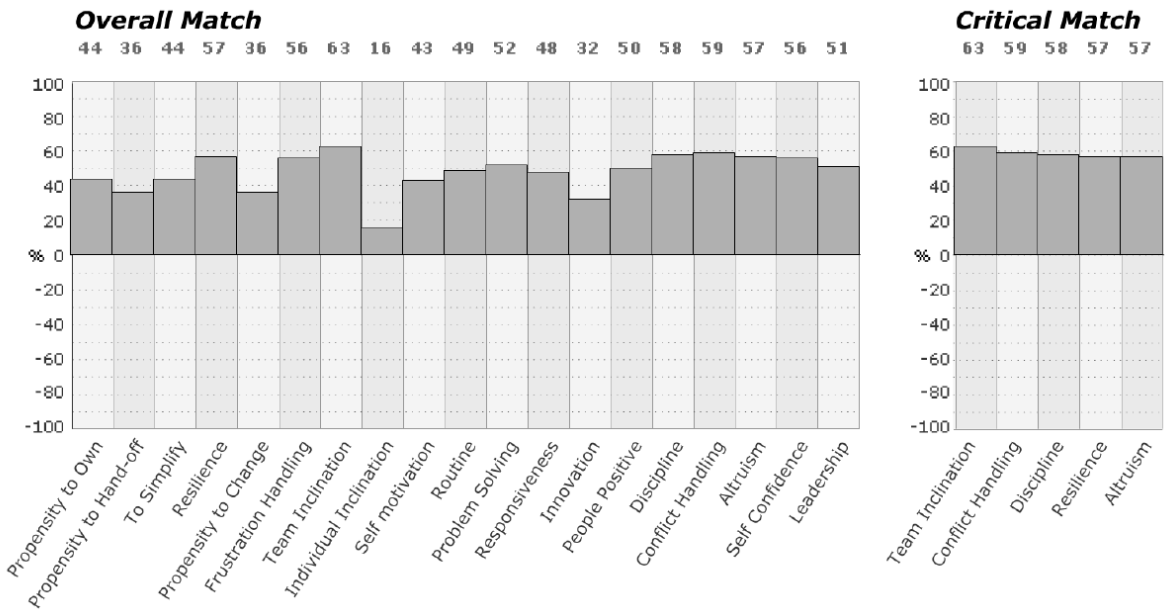

Figure 3.4.1: Overall and critical habits of the identified benchmark group.

These critical habits that were identified correlate well with the problematic areas as discussed in sections 3.2 and 3.3 and shows that the study performed at the gold mine delivered accurate results with regards to the identification of the root causes of sub-standard practises.

The benchmark group obtained the highest score for **team inclination**. This habit shows that successful shift bosses at the gold mine prefer to perform work as part of a team, rather than applying an individualistic approach to problems. The benchmark group scored a low 16 for individual inclination showing that these shift bosses were more comfortable with working in a team than working alone.

Conflict handling, as pointed out in section 3.2, was found to be problematic at the gold mine. The benchmark group showed a relatively high score for conflict handling. This score indicates that shift bosses in the benchmark category had good conflict management skills and chose to deal with conflict in a positive manner. They chose to deal with conflict and not avoid it, which often results in long term solutions to problems.

Discipline was found to be lacking at the gold mine. However, the benchmark group showed that discipline is a critical habit in achieving goals successfully. The score obtained by the group shows that they are willing to work in a highly disciplined

environment where it is of utmost importance to adhere to rules and regulations and stick to time frames.

The critical habit of **resilience** that was identified in the benchmark group showed that these employees did not easily give up when faced with a difficult task. These employees were able to overcome challenges in their working environment despite the difficulties that are often associated with mining. The habit of **self-confidence** of the group was also high showing that the group was able to take responsibility for decisions that they made because they were confident with their skills and abilities.

The benchmark group obtained a score of 57 for **altruism** which showed that these employees had developed a strong to radically strong habit of helping others without expecting something back. This correlates well with the habit of team inclination.

The benchmark group showed relatively low scores in the following habits:

1. Individual inclination with a score of 16
2. Innovation with a score of 32
3. Propensity to hand off with a score of 36
4. Propensity to change with a score of 36

Successful shift bosses definitely preferred to work in teams as indicated by the low score of 16 for individual inclination.

Based on the results obtained from the behavioural study performed at the gold mine, it was anticipated that employees would obtain a low score for innovation in a Shadowmatch survey. The reason behind this is that employees at the gold mine showed a strong inclination towards performing tasks the way they were used to and not to embrace new technology or innovative solutions to problems.

The benchmark group showed that they do not have a strong habit of innovation since they do not find new ways of improving current working methods. The group showed a thinking style opposite to an out of the box thinking style. As mentioned in previous sections, this type of behaviour could hamper safety performance due to the fact that new ways of performing tasks were often deemed as additional work or unnecessary change.

The propensity to hand off score of 36 is lower than the propensity to own score of 44. The benchmark group of shift bosses showed that they preferred to take ownership of problems and handle challenges themselves as opposed to getting another individual to deal with the problem. This habit in the opinion of the author should actually be much higher since it reflects the shift bosses' ability to take control of a situation.

The Shadowmatch results with regards to propensity to change confirmed the findings from the study at the gold mine as well as the West Wits study. In all of the studies, shift bosses found it difficult to adapt to change in their working environment. They were not comfortable with new methods of performing work, new environments and new technologies.

3.4.2 Attitude Analysis

The Shadowmatch attitude analysis delivered results that strongly correspond to the critical habits that were identified within the benchmark group. The majority of participants in the benchmark group formed part of categories 1 and 2 (see section 2.7 for a detailed description on the Shadowmatch Attitude Categories) while an equal amount of participants formed part of category 3 and 4. The significance of the attitude distribution is as follows:

- Categories 1 and 2 exhibit a shared habit of involvement.
- Categories 2 and 3 share habits of assertiveness and sometimes unaggressive behaviour.
- Categories 3 and 4 resemble a habit of less involvement or complete uninvolved attitude.
- Categories 1 and 4 represent a shared attitude of unaggressive behaviour.

Figure 3.4.2 shows the attitude distribution of the benchmark group.

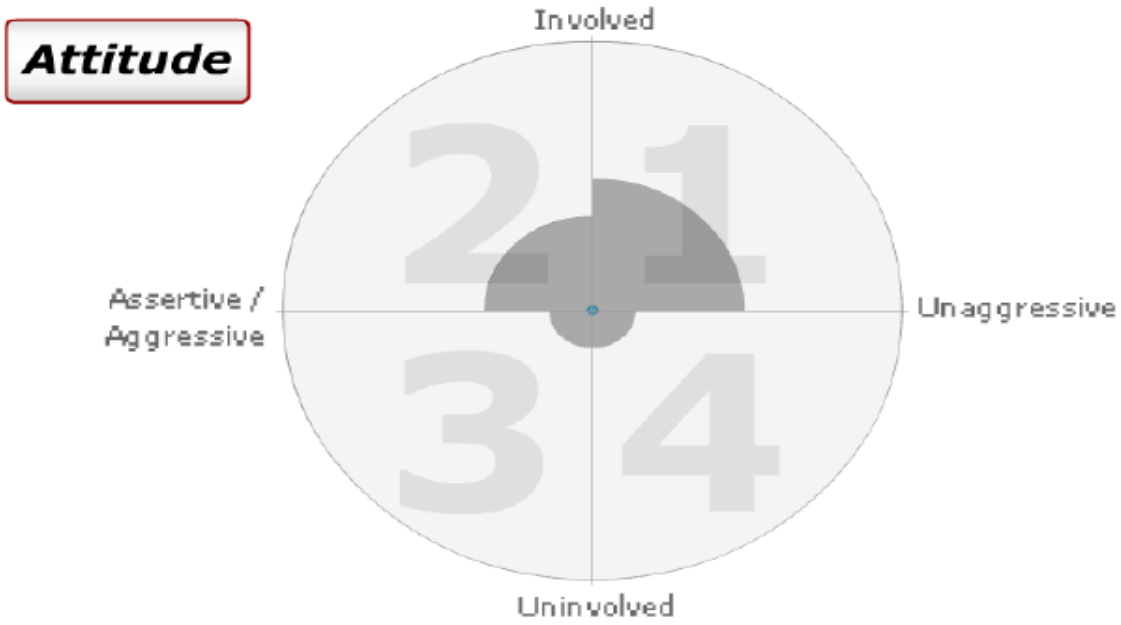

Figure 3.4.2: Attitude distribution of the benchmark group.

As shown in Figure 3.4.2, the benchmark group shows a strong attitude of involved, unaggressive behaviour. The benchmark group showed positive involvement in their work environment. They found it easy to get involved and it formed part of their natural behaviour. The group thus showed positivity when working with people and exhibit optimism.

This type of attitude represents strong principles that the benchmark group saw as the “right and wrong” way of performing tasks. The results indicate that the benchmark group has a drive towards a better world by means of active participation. This type of attitude is concerned with the important aspects of an activity and these individuals usually lack an attention to detail when it comes to less important matters.

The attitude is associated with altruism since the group proved to be unconditional in their actions and willing to make the necessary sacrifices to achieve a greater goal. Importantly, the benchmark group may be seen as materialistic, but emphasising the

value of all life. The way they perform work is not to serve others, but to drive a certain principle.

With regards to conflict handling, the benchmark group resolved conflict in a mature way without feeling compelled to shout and get aggressive. This type of attitude does not seek revenge or personal gain.

The second largest amount of participants within the benchmark group formed part of the category 2 type of attitude. This group of individuals are assertive and might sometimes be aggressive in their involvement. They will stand for what they believe in and how they prefer executing tasks. Personal gain is extremely important to people with this type of attitude since it benefits them in their own interests.

A category 2 attitude is not necessarily a bad attitude. These individuals prove to be successful in business, independence and positions of power. When involved in a dispute, they will often win it.

Unfortunately, this type of attitude results in placing other people (such as co-workers) under extreme pressure since they are motivated to get things done. Their attitude towards opinions is based on facts and comprehensive follow up procedures. It was most likely this group that resulted in the low score for propensity to change of the benchmark group. These individuals want things their way and will go out of their way to get what they want.

Category 2 individuals are in it for the win. They are obsessed with being in control and rely on facts, answers and solutions. Their attitude makes them dedicated, hardworking people that thrive under pressure.

3.4.3 Conceptual Fitness and Task Efficiency

A detailed description of the aim of the conceptual questions and task efficiency was given under section 2.7. This section will focus on the results in terms of the average conceptual fitness and average task efficiency of the benchmark group.

The benchmark group completed the survey in an average time of 50 minutes and 33 seconds. The survey has no time limit, but the time taken by the benchmark group to complete the survey was well within the recommended one hour time frame. (See section 2.7 on average survey completion times) It generally takes an

average of 30-45 minutes to complete the survey. The additional time taken by the benchmark group was attributed to a lack in computer literacy and “back clicks” in the questionnaire.

The 10 conceptual questions (problem-based questions with correct and incorrect answers) in the questionnaire usually take the longest to answer. This was also the case with regards to the benchmark group. The group spent an average of 16 minutes and 38 seconds to answer the conceptual questions. The results showed that most of the individuals in the benchmark group possessed the habit of applying their minds to find the correct answer to an abstract problem. The results showed that the benchmark group had an average conceptual fitness of 5/10.

The task efficiency of the group was relatively low. The benchmark group obtained an average task efficiency of 38%. This result indicated that although the benchmark group managed to usually perform tasks correctly, they were often inefficient and had poor time management skills when it comes to tasks that involve reading and answering questions on a computer system. The Shadowmatch task efficiency measurement is a tool that tests how well the individual takes ownership of a task and how efficiently he completes it; the task in this case having been to complete the worksheet. Efficiency is thus an area that may require intervention in the benchmark group.

3.4.4 Recommended Personal Development Programmes (PDP’s)

Based on the results of the benchmark group, the Shadowmatch system recommended the following personal development programmes for shift bosses that were not part of the benchmark group (ranked in terms of number of recommendations from high to low):

1. Handling frustration.
2. Routine.
3. Problem solving.
4. Propensity to hand off.
5. Individual inclination.
6. Team inclination.

Again, the set of PDP's that were recommended by the system fits the results obtained from the gold mine and the cultural study like a glove. It further emphasises the habits and behavioural patterns that were identified that could lead to sub-standard practises in the working environment with adverse effects on safety.

3.4.5 Comparison between Benchmark Group and Study Group Results

For the purpose of comparative reasons, it was decided to provide some overall statistics with regards to the study group that was compared to the benchmark group. The purpose of the comparison was to establish any differences and correlations between the habits and behaviours exhibited by the two groups.

It was decided to compare the "worst" and "best" performers in terms of the Shadowmatch study to the data obtained from the benchmark group in order to determine any similarities or differences.

First, the results of the best and worst performer were compared to the results of the benchmark group. The full profile and time graph of these individuals can be viewed in Appendix C.

The best performer's scores with regards to the critical habits showed a high correlation with the scores of the benchmark group. The comparison of the scores is shown in Table 3.4.5a.

Table 3.4.5a: Comparison between critical habit scores of benchmark group and the best and worst performing individuals.

Habit	Benchmark	Best Performer	Worst Performer
Team inclination	63	61	46
Conflict handling	59	67	38
Discipline	58	65	39
Resilience	57	57	32
Altruism	57	64	43

The worst performer scored significantly lower in all the critical habits of the benchmark group. This individual had a high likelihood of being extremely problematic in the working environment due to his/her habits.

The best performer showed to significantly stronger habits than the benchmark group in conflict handling, discipline and altruism. For this specific individual, it could be said that these 3 habits are ultimately the drivers behind his success. The worst performer, scored higher than the benchmark group in only two habits, namely propensity to hand-off and individual inclination. However, it is necessary to discuss the possible reasons for these two higher scores. The habit of propensity to hand-off is almost self-explanatory. This individual's critical habits showed very low scores. It may be speculated that he/she would be the type of person who is not involved at all, has no confidence in what he does, showed no altruism and preferred to give the task at hand to someone else to complete.

Other habits in which the best performer scored higher than the benchmark group include (see Appendix C):

- Responsiveness.
- Innovation.
- People positive.

The best performer scored 7/10 for the conceptual questions. This showed that the individual under consideration had a higher average conceptual fitness than the benchmark group who scored 5/10. The high conceptual fitness might be indicative of the strong habits such as responsiveness, innovation and altruism. This person is highly likely to embrace change, a new environment and new technologies.

The worst performer on the other hand, scored a low 2/10 for the conceptual questions. This individual's conceptual fitness is too low for the type of work that he was required to perform and could result in habits such as frustration and immature conflict handling due to the nature of the work.

The task efficiency of the best performer was 43%, which was slightly higher than the 38% of the benchmark group. This individual was the most successful candidate in terms of completing the Shadowmatch worksheet. The worst performer had a task efficiency of 24% that showed that he/she was mostly incompetent in performing tasks efficiently.

The total time spent on the worksheet by the best performer 46 minutes and 9 seconds compared to the 50 minutes and 33 seconds of the benchmark group. The

worst performer took 64 minutes and 23 seconds to complete the Shadowmatch worksheet. This was an indication that he/she clearly struggled with the questions.

An interesting point in the results of the best performer is the attitude of this individual. Although there is a strong correlation with the benchmark group in category 1 and 2 attitudes, the individual showed a significantly stronger category 4 attitude than the benchmark group. As opposed to the best performer, the worst performer showed strong category 2 and 3 attitudes and a low category 1attitude.

The worst performer would be likely to not get involved in any task, but openly voice his/her frustrations. These types of individuals are pessimistic, confrontational and choose not to participate in a solution to a problem. Simply put, the worst performer is not suited for being a shift boss based on the results of the Shadowmatch benchmark group as well as the study group.

Category 4 represents an attitude of caution. This individual found it easy to walk away from conflict situations without voicing his/her feelings. The recommended personal development programme (PDP) for the individual was self-confidence. This is a critical habit needed by shift bosses since they are in a position of leadership.

The recommended PDP for the worst performer was problem solving. As described earlier, the fact that this individual has none of the critical habits of the benchmark group, he/she would be likely to see all aspects of his job as a major challenge.

The time graphs of the best and worst performers revealed a number of interesting results with regards to the performance and habits of the concerned individuals. The time graphs can be viewed in Appendix C.

The best performer answered 3 of the 10 conceptual questions wrong. This individual had one back click (going back to a question that has been answered and changing the answer) and the question of which the answer was changed was then correct. The worst performer had a total number of 6 back clicks. This shows that he/she was extremely uncertain about the answer that was selected. A total number of 3 changes were made to the conceptual question answers, which were all wrong. After answering 3 questions, the individual paused the questionnaire and then went back to the third question to change it. The individual exhibited low self-confidence and no structure in answering the questions.

The best performing individual spent an average of 103.86 seconds per question on the conceptual questions that were answered correctly. This showed that the individual took time to figure out the correct answer to the question. As opposed to this, the worst performing individual spent an average of 55 seconds per question on the conceptual questions. This showed that the answers to these questions were clearly not thought through.

Table 3.4.5b: Averages of benchmark group and study group indicators.

	Study Group	**Benchmark Group**
Overall Match	78	86
Critical Match	81	87
Conceptual Fitness	4	5
Efficiency	35	38

Table 3.4.5b shows the comparison between the averages of the benchmark group and the study group in terms of overall matches within the group, critical matches to the benchmark group, average conceptual fitness and average efficiency.

There is no significant difference in the average conceptual fitness and efficiency. The difference lies in the critical match between the benchmark group and study group as well as the overall match between the groups.

A number of different PDP's was recommended for the study group. The PDP's are recommended based on the habits that were determined as critical habits of the benchmark group. The recommended PDP addresses the habit that needs development.

The results are shown in Figure 3.4.5a.

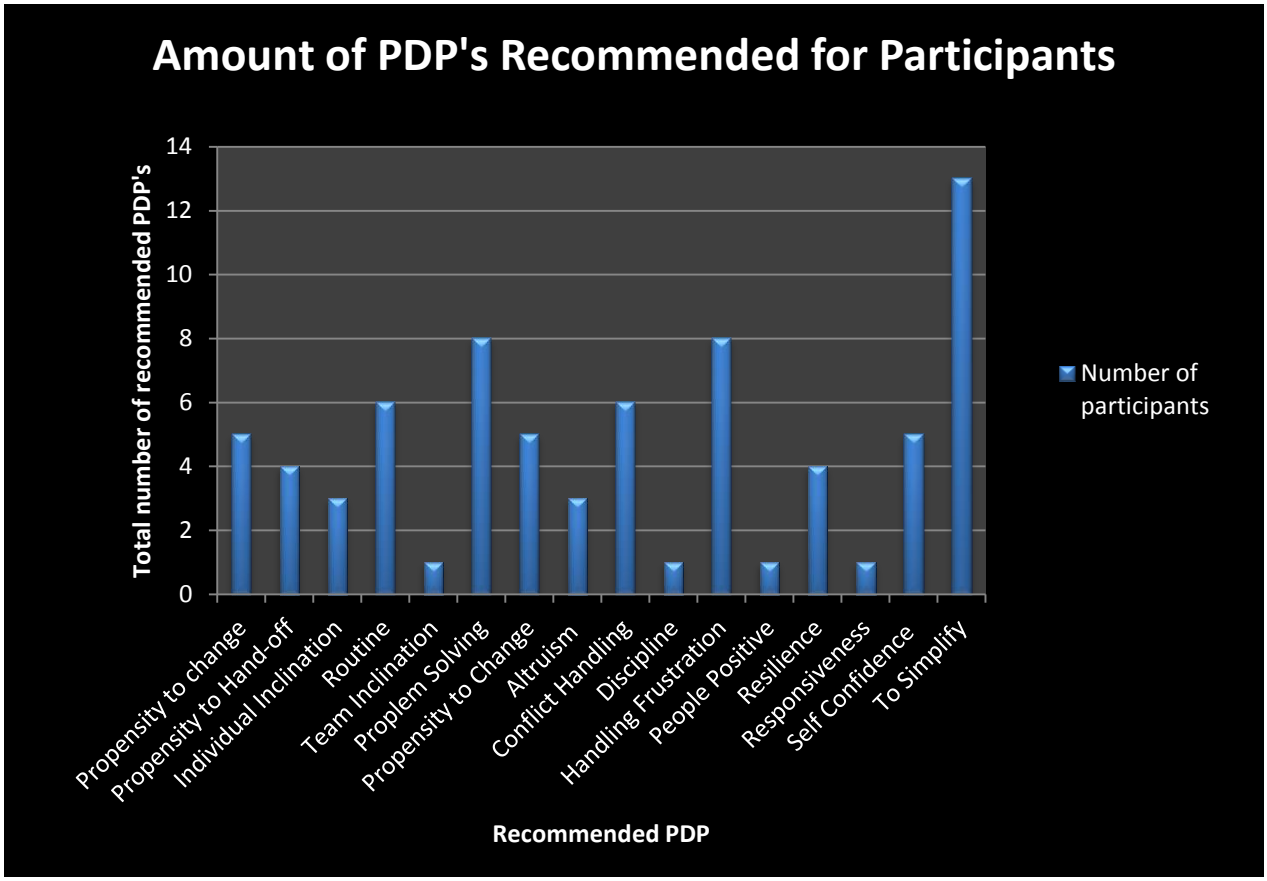

Figure 3.4.5a: Number of different PDP's recommended for the study group.

Figure 3.4.5a shows the different PDP's that were recommended to the study group as well as the number of each recommended PDP. It is clear from the figure that the habit of being able to simplify problems is a major concern. This habit is closely related to the habit of problem solving which was recommended for 8 individuals. Frustration handling is the third habit that requires intervention. The underground working environment is full of challenges and definitely requires a radical habit of frustration handling.

3.5 The Effects of Sub-Standard Practices on Safety

It is a known fact that sub-standard practices in the mining environment results in adverse effects on safety. Sub-standard practises are not always the cause of accidents or fatalities, but there exists cases where sub-standard acts have either directly or indirectly led to an incident.

Sub-standard practises compromise the effectiveness of any safety measures, devices or procedures that have been put in place. It creates a weak spot in the system that is bound to fail due to the slightest amount of interference. Standards and safety are very closely related and standards are necessary not only to maintain the safety of underground employees, but also to improve current safety practises.

The information below represents some of the safety statistics at the gold mine and was compiled from data obtained from the gold mine Safety Department.

From 17 February 2009 to 22 December 2014 a total of 2042 accidents occurred on the gold mine. A total of 26 of these accidents led to fatalities. Upon analysis, it was found that the accident occurrence frequency rate at the gold mine was approximately 0.94 accidents per day.

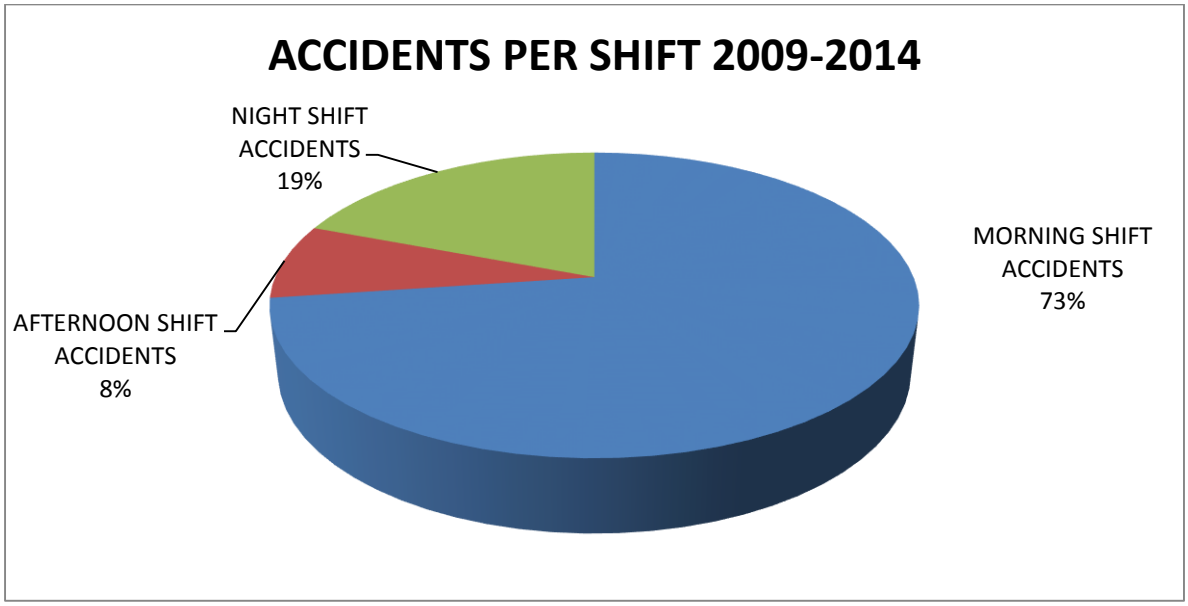

Figure 3.5a: Gold mine accident distribution by shift.

Figure 3.5a shows that the majority of accidents at the gold mine occurred during the morning shift. The average time of occurrence of morning shift accidents was 11:58:17 am.

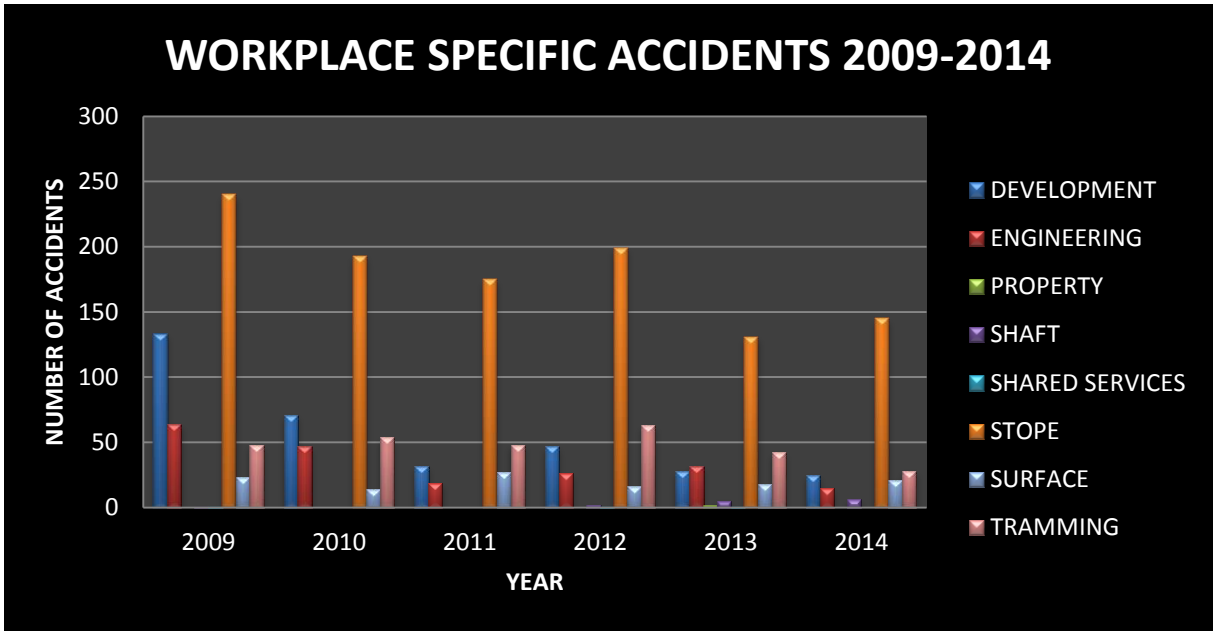

Figure 3.5b: Accidents by workplace at the gold mine 2009-2014.

Figure 3.5b shows that the greatest amount of accidents at the gold mine occurred in the stopes. The second highest number of accidents occurred in development and the third highest number of accidents occurred in tramming.

Not surprisingly, these are also the departments underground that have shown the greatest amount of sub-standard practises. It is estimated that approximately 40-50% of all accidents underground occur as the inevitable result of a sub-standard or number of sub-standard acts.

As the Swiss Cheese Model (see section 2.6.3) of accident causation suggests, a number of safety measures have to fail simultaneously in order for the incident to occur. Sub-standard practises and their effects on safety show the same trend. Let us consider an example of a fall of ground in a stope.

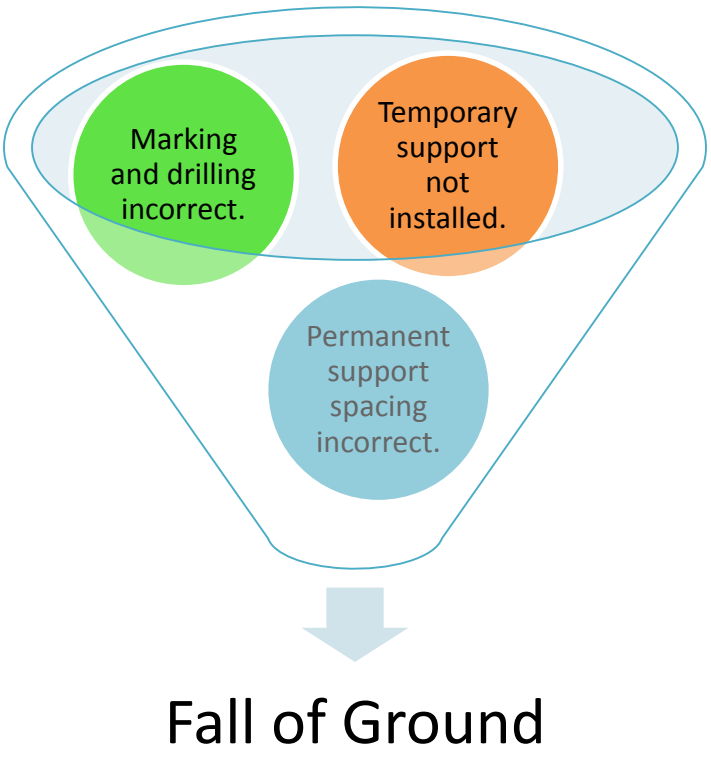

Figure 3.5c: Accident causation due to sub-standard practises.

As Figure 3.5c suggests, the fall of ground ultimately occurs as a result of sub-standard practises that followed on each other.

Sub-standard practises may also result in the failure of inherent safety of equipment. For instance, a winch has the inherent safety measure not to cause a spark that will ignite methane. However, if the winch is installed incorrectly with the power source exposed to the atmosphere, it might lead to a methane explosion.

Essentially, any type of sub-standard practise decreases safety. Sub-standard practises can lead to a number of different outcomes with regards to safety:

- Injury or loss of life of the person committing the sub-standard act. Example: person walking between the rails.
- Injury or loss of life of other employees. Example: not testing for methane before starting to drill the face.

- Damage to equipment. Example: rails not installed to standard can cause loco and hoppers to derail.

Employees that admitted they were guilty of performing sub-standard acts also admitted that a bad example was being set by them for new employees. Since younger employees often look up to older employees, they follow their lead and fall in the trap of contributing to sub-standard practises.

Sub-standard practises do not only affect personal safety or the safety of a team in a specific location. It compromises the entire safety system implemented because it causes room for failure. It creates a safety culture that promotes sub-standard acts if left untreated.

In the underground environment, sub-standard acts impact negatively on health over the long term. Failing to comply with health and environmental standards can lead to health issues such as silicosis and noise induced hearing loss. As a result, higher safety levies have to be paid by the mine due to a poor safety record.

The safety reputation of the mine takes a blow when sub-standard practises are identified as the cause of accidents and fatalities, which is in turn not good for the reputation of the company.

It is clear that the effects of sub-standard practises go further than just a negative impact on safety.

3.6 Identified Root Causes of Sub-Standard Practices

The author's hypothesis that sub-standard practises could largely be attributed to multiple causes on different organisational levels was proven in the previous sections. To answer the question that management is perplexed about, which is why employees still engage in sub-standard acts, proved not to be an easy task.

The results of this study are highly comparable with the study conducted by the CSIR (see section 2.4) to determine root-causes of accidents. The root causes of sub-standard practises discussed below was based on the literature review and the investigation done at the gold mine.

Root causes very seldom occur in singularity. Whether the cause was mental, physical or occurred as an act of revenge, a number of events can usually be identified that ultimately led to the sub-standard act being executed. It is important to understand that root causes of sub-standard practises cannot be seen as coincidental events. A decision was made to perform the act and is therefore a function of fully functional thought processes.

Each one of the root causes of sub-standard practises in the gold mining industry of South Africa requires individual study due to the complexity thereof. A summary of the most important root causes of sub-standard practises that were identified during this study is listed below.

1. A lack of understanding of standards on a theoretical as well as practical level, mostly found amongst underground personnel who perform work in the stopes.
2. Insufficient on the job training within the specific working environment due to the misconception that training centre training and standards are enough to prove competency for underground skilled labour.
3. A lack of trust and teamwork. These factors are inseparable in the mining environment but are clearly an issue amongst employees of different ages and cultural backgrounds. Equality due to age and years' experience is the major contributor to the feeling of inequality.
4. No motivation amongst employees, supervisors and management. All that the bottom employees are longing for is recognition from supervisors and managers where it is due. Motivation is not necessarily expected in the form of money, but rather in terms of corporate citizenship.
5. External factors for employees require counselling and moral support, not only from a specialist but also colleagues. These factors include debt, stress, dealing with loss of life and anxiety.
6. Insufficient risk management programmes and incompetency with regards to current risk management principles. These include procedures such as risk identification, risk evaluation, risk assessment and risk control. Employees across all levels of the organisation seemed to be lacking knowledge on risk principles.

7. Supervision and a lack of supervisory skills. Supervision is not performed actively and regularly, but rather in an occasional fashion. This type of supervision proved to not only create problems amongst employees, but also encouraged the execution of sub-standard practises.
8. Seeking attention by means of rebellious behaviour. Employees showed an inclination towards deliberately performing sub-standard acts in an attempt to feel that they belong and are worthy to the company.
9. Discipline proved to be lacking amongst most employees. The authority established by the company, seemed to have limited effect on employees behaviour. A mine overseer was treated the same as a fellow RDO, without giving attention to orders from a higher authority.
10. Fatigue. As simple as it may sound, fatigue has a long chain of related behavioural effects that influence employees' inclination to perform sub-standard acts. One such an effect is unproductivity and reduced mental energy.
11. An unclear vision of the company and its objectives. Employees did not understand that they were the most valuable to the mining industry. They see innovation and new technology as potential threats to their jobs and then perform sub-standard acts to sabotage equipment and processes.
12. A lack of involvement from management. Employees took matters into their own hands when they felt that enough time has passed for them to receive answers on questions posed to management. Management seemed to not be actively involved with the maintenance of current - and implementation of new standards.
13. Working conditions. Employees accepted the fact that mining is a harsh environment, but there were certain factors that were out of their control with regards to the working environment. One such an example is ventilation. Some working places were extremely hot and after numerous complaints, nothing was done to address the issue. Sub-standard acts are then committed to compensate for the working conditions.
14. Mental fitness was probably one of the most unexpected causes of sub-standard practises. The type of work and conditions underground require a certain mindset in order to positively complete one's daily tasks. This type of mindset was shown only by a very small minority.

15. Toleration of sub-standard practises. Because sub-standard practises usually did not directly affect an employee or supervisor, it was generally tolerated. Supervisors seemed to be aware of it, but had not done much to address the issue.
16. Shortcomings in the managerial style in the gold mining sector. Managerial styles are an important factor to consider with regards to the behaviour of employees. Aggressive management often results in employees exhibiting the same type of behaviour.
17. Habits. The Shadowmatch study revealed that a certain set of habits were critical in order to be successful as a shift boss. The majority of the study group were lacking these habits.
18. Attitude. A certain attitude is required for a certain working environment. The Shadowmatch survey revealed that some individuals had an attitude that was not well suited for the environment.
19. Behaviour. Behaviour is a consequence of habits. If a person possessed the wrong set of habits for the specific job, he/she was likely to be a concern in the working environment.

The root causes described above are not the only causes of sub-standard practises in the gold mining industry, but these are the causes that showed to have caused the major problems with regards to behaviour and safety and require immediate attention.

3.7 Possible Solutions to Sub-Standard Practices and Their Effects

The importance of this entire study is to realise that the current situation can be changed, if the correct procedures and solutions are implemented as soon as possible. It is not impossible to change the culture at hand, but it will also not happen overnight.

There is no single solution to address all sub-standard practices in the mining environment simultaneously. Each solution suggested below has its application to a specific situation and would require trials in the mining environment in order to assess the effectiveness of the solution.

1. Revision of standards, standard procedures as well as their practicability on all levels of the organisation. There exists interaction on different organisational levels and standards need to cater for these interactions.
2. Revision of risk management principles implemented by the organisation. The best solution to a sub-standard act, accident or loss of life is to prevent it from occurring in the first place by implementing a detailed risk management program that covers all aspects on the managerial level through to the operational level of the organisation.
3. Improved training methods that do not only involve a better on the job training experience, but also focuses more on employees' understanding of concepts in order to provide a competent employee from training centers.
4. Team building exercises and team skills workshops in order to address the problem of trust within teams. Teams require coaching in order to gain the skills required to function as a unit in the working environment.
5. Assessing employees' brain dominances, preferences and characteristics in order to improve the composition of teams. Certain thinking patterns and behavioural trends suit some better than others.
6. Improved employee counselling services. Possibly the employment of clinical psychologists that specialise in certain traits of behaviour that were found amongst the culture in the gold mining industry. Individuals with problems can then discuss personal problems with counsellors and receive support from support groups.
7. Introduce initiatives that promote and reward the implementation of standards. For example a system that takes into account standards for the calculation of bonuses and that penalizes sub-standard practices.
8. A reassessment of the management style throughout the organization in order to determine differences in successful and unsuccessful management.
9. A leadership program in which all employees must participate with the focus on conflict resolution, human relationships, communication and sustainable behaviour.
10. Better communication channels between bottom level employees and management in order to gather trustworthy information and avoid dishonest behaviour underground.

11. Incorporating the Shadowmatch tool as a determinant for the suitability of applicants for a specific job.
12. To use the Shadowmatch tool as an instrument to determine which habits, attitudes and behaviours are required for specific working environments, team structures and jobs. Then, using the recommended PDP's to develop the required habits and skills.

The list for possible solutions can continue for pages, but the aim should be to address the culture with the end goal in mind to ultimately change the culture by means of developing the required habits for success one step at a time to the point where standard procedures are once again the norm.

CHAPTER 4: CONCLUSION

4. CONCLUSION

Sub-standard practices and their adverse effects on safety remains a challenge in the South African gold mining industry. Although a number of efforts have been made to determine the root causes of sub-standard practices, the results were inconclusive or addressed the same technical issues that have long been present in the mining industry.

The origin of sub-standard practices in the underground working environment was found to be in the habits, attitude and behaviour of employees. However, it is important to realise that habits and attitude are not fixed characteristics such as personality. Habits and attitude can be changed and developed with the correct instruments.

The studies described in this document (the study performed at a gold mine in the Free State, the cultural survey conducted at West Wits and the Shadowmatch survey) all highlighted correlating causes of sub-standard practices which had its roots in the habits and behaviour of employees. A lack of a certain set of radical habits (such as team inclination, conflict handling, leadership, altruism, discipline and resilience) for a specific working environment and a specific job title (in this case underground production employees with the focus having been on shift bosses) could possibly be the number one reason for the occurrence of sub-standard practices.

Aspects such as a lack of education, improper on the job training, and shortcomings in the managerial style were found to further increase the occurrence of sub-standard practices that in turn resulted in the adverse effects on the safety culture at the gold mine.

It was determined that the problem was larger than a specific section at one mine or a specific shaft and that it was most likely an industry-wide issue that needed to be addressed. The best solution to the problem would be to determine whether the habits and attitude of an individual are suited for a specific job position and working environment before employing the person. This renders the need for remedial action after a sub-standard act has been performed.

However, there is no single solution that would render the current problem obsolete. In order to address the different aspects of the problem, a number of solutions such as a Shadowmatch survey, improved training, basic education, revision of risk control programs etc. were suggested.

Finally, the gold mining environment in South Africa poses some of the most extreme challenges with regards to working conditions. Looking forward, it would be impossible to improve on the current situation if the necessary habits such as propensity to change, simplification of problems, self-motivation and team inclination are not addressed.

"*We are what we repeatedly do. Excellence, then, is not an act but a habit*" – Aristotle

CHAPTER 5: RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER STUDY

5.1 RECOMMENDATIONS

The following recommendations are proposed in order to gain more detailed insight into the problem and suggested solutions:

1. Basic education should be incorporated into the training programs of the existing labour force as well as new recruits.
2. An on the job training program should be implemented and form an integral part of competency training after candidates have passed out from the training center.
3. It is recommended that the management style should be reassessed in order to improve areas of shortcomings, especially from a soft skills perspective.
4. A leadership program should be adopted by the company that provides employees in leadership positions (such as shift bosses) with the necessary skills to develop the habit of leadership in order to be successful and efficient in their jobs.
5. The Shadowmatch instrument is highly recommended as a means of determining habits and attitudes of new recruits in order to establish whether they possess a certain set of radical habits that are required for a specific job position.
6. The current study should be trialed on different teams and levels within the organization and the results should be compared to the findings of this study to establish a framework of which aspects require intervention to reduce the occurrence of sub-standard practices and the adverse effects on safety.

5.2 SUGGESTIONS FOR FURTHER STUDY

The following points are suggested for further study:

- Utilize the existing study as a foundation for conducting an in depth study on the occurrence of sub-standard practices and the adverse effects on safety in the organization.
- Conduct a similar study at different mining houses that mine other commodities such as platinum, coal and diamonds and compare the results to the study done at the gold mine.

- Perform a company-wide and ultimately an industry wide Shadowmatch survey to build a database of habits and attitudes required in different sectors of the mining industry.
- Perform a similar study to this study with the focus on sub-standard practices in the surface working environment and compare the results.
- Use the Shadowmatch database of employees in the mining industry to ultimately develop a development program for the required habits, attitudes and behaviour in different job titles in the mining industry.
- A feasibility study that examines the feasibility of employing Shadowmatch in the mining industry as a habit analysis and development tool.

APPENDIX A

An example of the questionnaire employed for collecting data during the investigation.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Questionnaire For Final Year Research Project

An Investigation Into Sub-Standard Underground Practises At a Free State Gold Mine

Gerard Kleyn

B. Eng (Mining) Undergraduate

Introduction:

The purpose of this questionnaire is to collect the relevant information regarding sub-standard practises that are currently being practised underground at the Gold Mine. The information provided will be used for the purposes of my final year research project in the Department of Mining Engineering at the University of Pretoria. This information will also be used to address the problem at hand in order to formulate a possible solution strategy.

Please answer the questions that follow honestly. This is an anonymous questionnaire.

OCCUPATION:

DATE:

AGE:

YEARS IN MINING INDUSTRY:

SHAFT: (PLEASE TICK APPLICABLE BLOCK)

1# **2#** **3#** **4#**

SHIFT: (PLEASE TICK)

MORNING **AFTERNOON** **NIGHT**

Questions:

1. ARE YOU AWARE OF ANY SUB-STANDARD WORK BEING PERFORMED IN YOUR WORKING PLACE OR UNDER YOUR SUPERVISION?

YES **NO**

2. IF YES, BRIEFLY DESCRIBE THE TYPE OF SUB-STANDARD WORK THAT YOU HAVE ENCOUNTERED, E.G WRONG PROCEDURES FOLLOWED, WINCHES NOT TO STANDARD ETC.

_____
_____
_____
_____
_____
_____

3. HAVE YOU BEEN TRAINED IN SUCH A WAY AS TO UNDERSTAND WHY CERTAIN STANDARDS ARE REQUIRED AND NEED TO BE UPHELD?

YES ☐ **NO** ☐

4. DO YOU UNDERSTAND THE CONSEQUENCES OF SUB-STANDARD WORK?

YES ☐ **NO** ☐

5. IF YOU ANSWERED YES IN QUESTION 4, HAVE YOU DONE, OR ARE YOU STILL SOMETIMES PREPARED TO DO SUB-STANDARD WORK?

YES ☐ **NO** ☐

6. HOW OFTEN DO YOU ENCOUNTER SUB-STANDARD PRACTISES IN THE UNDERGROUND WORK ENVIRONMENT? (PLEASE TICK APPLICABLE BLOCK)

DAILY ☐ **WEEKLY** ☐ **MONTHLY** ☐ **YEARLY** ☐

7. HAVE YOU EVER PERFORMED SUB-STANDARD WORK YOURSELF (7.1) OR INSTRUCTED SOMEONE TO PERFORM SUB STANDARD WORK (7.2)?

7.1 **YES** ☐ **NO** ☐

7.2 **YES** ☐ **NO** ☐

8. IF YOU TICKED YES IN ANY OF THE TWO TICKBOXES ABOVE, PLEASE PROVIDE A REASON.

7.1_____

_____

_____

_____

7.2_____

_____

_____

_____

9. WHAT DO *YOU* THINK, ARE THE REASONS BEHIND SUB-STANDARD WORK?

_____

_____

_____

_____

_____

_____

_____

_____

10. ON A SCALE OF 1 TO 5, WHERE 1 IS COMPLETELY SUB-STANDARD, 2 IS MOSTLY SUB-STANDARD, 3 IS SOMETIMES SUB-STANDARD, 4 IS MOSTLY UP TO STANDARD AND 5 IS ALWAYS UP TO STANDARD, WHAT RATING WOULD YOU GIVE YOURSELF?

1 ☐ **2** ☐ **3** ☐ **4** ☐ **5** ☐

11. WOULD YOU FEEL CONFIDENT TO LET AN INSPECTOR OF THE DMR INTO YOUR CURRENT WORKING PLACE?

YES ☐ **NO** ☐

12. BRIEFLY STATE *YOUR* OPINION ON WHY SUB-STANDARD WORK HAS BECOME PART OF THE WORKING CULTURE AT THE MINE.

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_____

_____

_____

_____

_____

13. WHAT REMEDIAL ACTIONS DO *YOU* THINK NEED TO BE TAKEN IN ORDER TO ADDRESS THIS SITUATION?

_____
_____
_____
_____
_____

14. HOW WOULD *YOU*, PERSONALLY BE ENCOURAGED NOT TO PERFORM SUB-STANDARD WORK?

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_____
_____
_____
_____

15. WHAT DO *YOU* THINK IS THE ORIGIN OF SUB-STANDARD WORK?

_____
_____

COMMENTS

_____
_____
_____

SUGGESTIONS

_____
_____
_____

Thank you for taking the time to complete this questionnaire. Your honesty is appreciated and your input valued.

APPENDIX B

Statistics of the 2012 Cultural Survey

Table B1: Results from cultural survey at West Wits (Part A) (Gold Fields , 2012).

KDC	E-Surveys KDC East	KDC East Overall	Shaft 1	Shaft 3	Shaft 4	Shaft 7	Shaft 8	Training Centre East	E-Surveys KDC West	KDC West Overall	D1 Masakhane	D2 Pitseng	D4 Ya Rona	D5 Hlanganani	D6-8 Khomanani	D7 Rethibile	D10 Thabelang	Training Centre West
Respondents	295	3848	805	581	1087	548	449	378	316	4097	657	187	762	1025	709	201	80	476
Gender																		
Female	89	208	81	63	54	96	37	26	231	246	26	9	91	62	14	7	7	24
Male	201	3250	676	502	794	434	401	352	85	3728	631	150	671	912	525	189	71	438
Unspecified	5	12	48	16	239	18	11	0	0	123	0	28	0	51	170	5	2	14
Age category																		
20-29 (Generation Y)	38	423	105	65	130	71	47	64	47	696	125	26	213	226	156	30	15	81
30-39 (Generation X)	84	1116	354	105	315	137	121	110	98	1065	204	62	198	338	199	58	23	176
40-49 (Generation X)	95	808	185	148	250	208	137	121	105	901	197	45	229	246	178	56	22	119
50-59 (Baby Boomers)	67	385	105	135	109	77	101	68	50	451	85	19	76	113	92	30	14	67
60-69 (Baby boomers)	7	154	24	17	33	5	15	3	3	164	13	11	0	31	21	4	0	0
Unspecified	4	962	32	111	250	49	28	12	13	819	33	24	46	72	63	22	6	33
Years' experience																		
<1yr	13	308	48	21	130	16	62	23	12	656	13	9	46	51	28	12	2	29
1.5 - 3	30	423	105	54	120	44	87	26	21	1024	85	28	168	174	71	16	10	71
3.5-5	51	539	169	75	152	66	102	72	44	860	105	34	152	164	79	28	13	67
5.5-10	50	654	193	157	228	121	79	91	83	410	145	26	130	215	92	32	15	119
10.5-15	23	770	72	63	98	55	47	26	45	164	92	26	46	123	43	20	4	24
15.5-20	35	231	121	74	65	96	26	34	40	451	79	26	99	92	92	28	6	79
20.5-25	31	269	40	36	76	87	8	34	35	205	53	15	46	62	50	18	7	52
25.5-30	32	192	34	21	65	37	13	53	23	123	59	9	53	72	43	14	8	11
>30.5	30	115	17	17	54	21	2	19	13	41	24	9	1	51	24	12	2	3
Unspecified	0	301	5	63	98	5	23	0	0	164	2	4	22	20	188	20	13	22

Table B2: Results from cultural survey at West Wits (Part B) (Gold Fields , 2012).

KDC	E-Surveys KDC East	KDC East Overall	Shaft 1	Shaft 3	Shaft 4	Shaft 7	Shaft 8	Training Centre East	E-Surveys KDC West	KDC West Overall	D1 Masakhane	D2 Pitseng	D4 Ya Rona	D5 Hlanganani	D6-8 Khomanani	D7 Rethibile	D10 Thabelang	Training Centre West
Respondents	295	3848	805	581	1087	548	449	378	316	4097	657	187	762	1025	709	201	80	476
Language																		
English	138	423	89	96	109	71	85	57	71	287	79	19	30	103	21	12	2	33
Afrikaans	109	115	56	34	8	16	11	15	102	41	13	4	8	21	7	4	1	5
Izulu	11	808	177	122	217	159	123	76	63	819	204	45	91	226	177	36	17	109
Ixhosa	10	924	209	141	261	121	103	95	37	860	151	45	191	308	113	42	24	138
Southern sotho	13	1039	129	102	152	132	63	76	19	1147	145	36	206	215	135	56	11	90
Northern sotho	4	406	137	84	98	16	41	26	10	737	26	13	15	82	35	14	6	48
Other	10	80	8	2	242	33	23	34	14	205	39	26	221	72	220	36	19	52
Ethnic Group																		
White	163	346	24	17	11	0	9	11	149	246	13	2	15	21	4	0	0	14
Black	117	2859	741	523	880	510	426	344	129	3196	598	161	732	943	532	179	75	419
Coloured	3	30	6	8	4	0	5	8	5	164	7	3	15	21	1	6	2	14
Indian	3	47	1	4	1	3	2	3	7	123	3	0	0	4	0	0	0	5
Asian	0	21	0	0	0	0	0	2	1	41	0	0	0	0	0	0	0	0
Prefer not to share	9	545	34	29	190	35	7	9	25	328	36	22	0	37	172	16	3	24
Grading																		
A	4	1077	306	201	272	225	217	129	4	1229	13	83	396	256	163	38	15	205
B	40	1193	330	198	544	219	157	140	39	1393	604	84	229	574	284	121	42	171
C	164	867	113	53	65	44	42	57	197	778	0	13	30	92	50	14	6	5
D	78	327	16	13	11	22	12	4	68	164	0	4	19	10	14	0	0	1
E	9	69	16	11	3	11	7	1	8	123	0	2	15	8	6	0	1	3
F	0	8	8	6	8	22	6	3	0	41	0	1	0	10	17	1	1	14
Unspecified	0	307	16	99	185	6	8	45	0	369	39	0	72	74	176	27	14	77

APPENDIX C

Shadowmatch Results and Individual Profiles

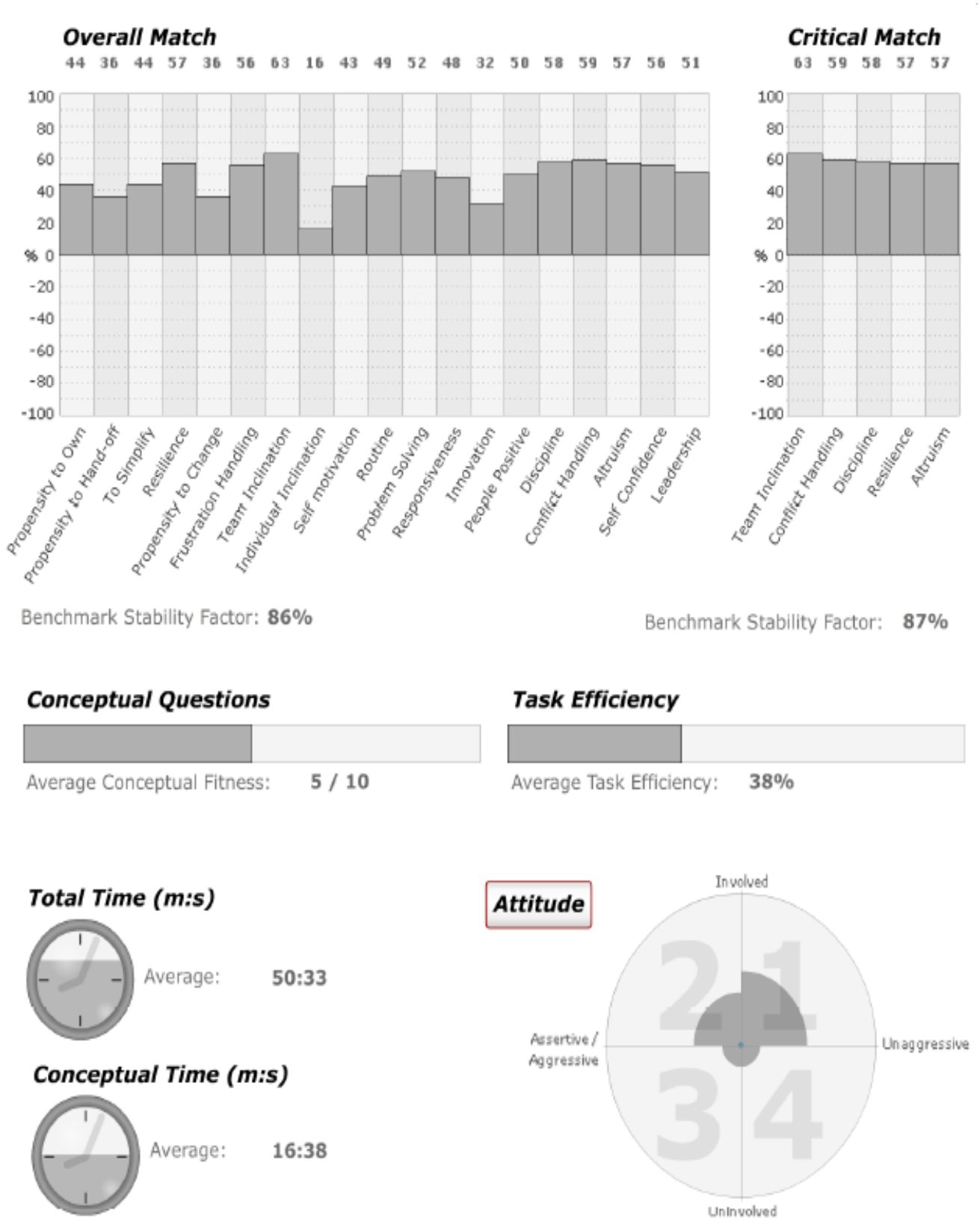


Figure C1: Full Shadowmatch profile of benchmark group.

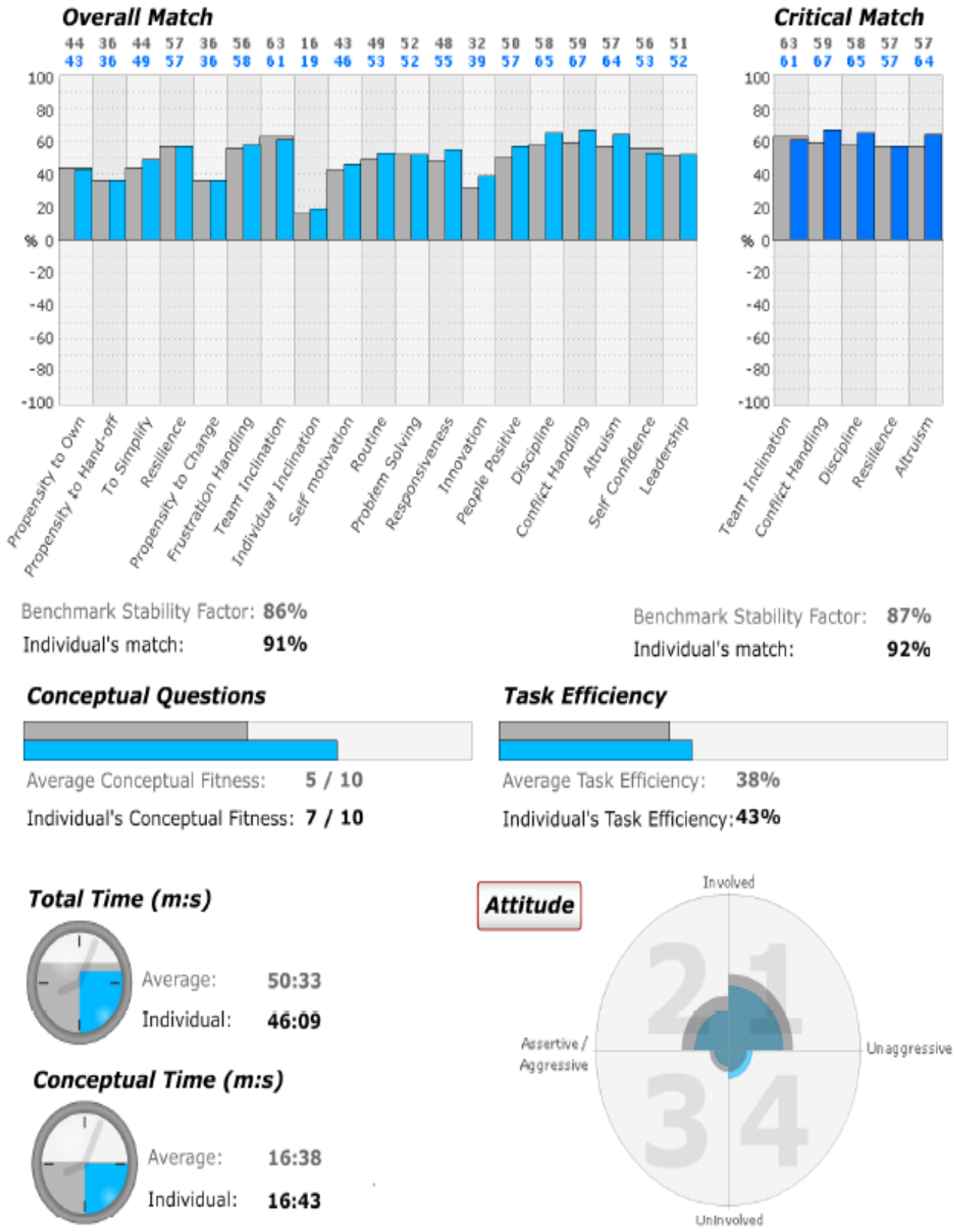


Figure C2: Full Shadowmatch profile of "best" performer (Individual's scores indicated in blue).

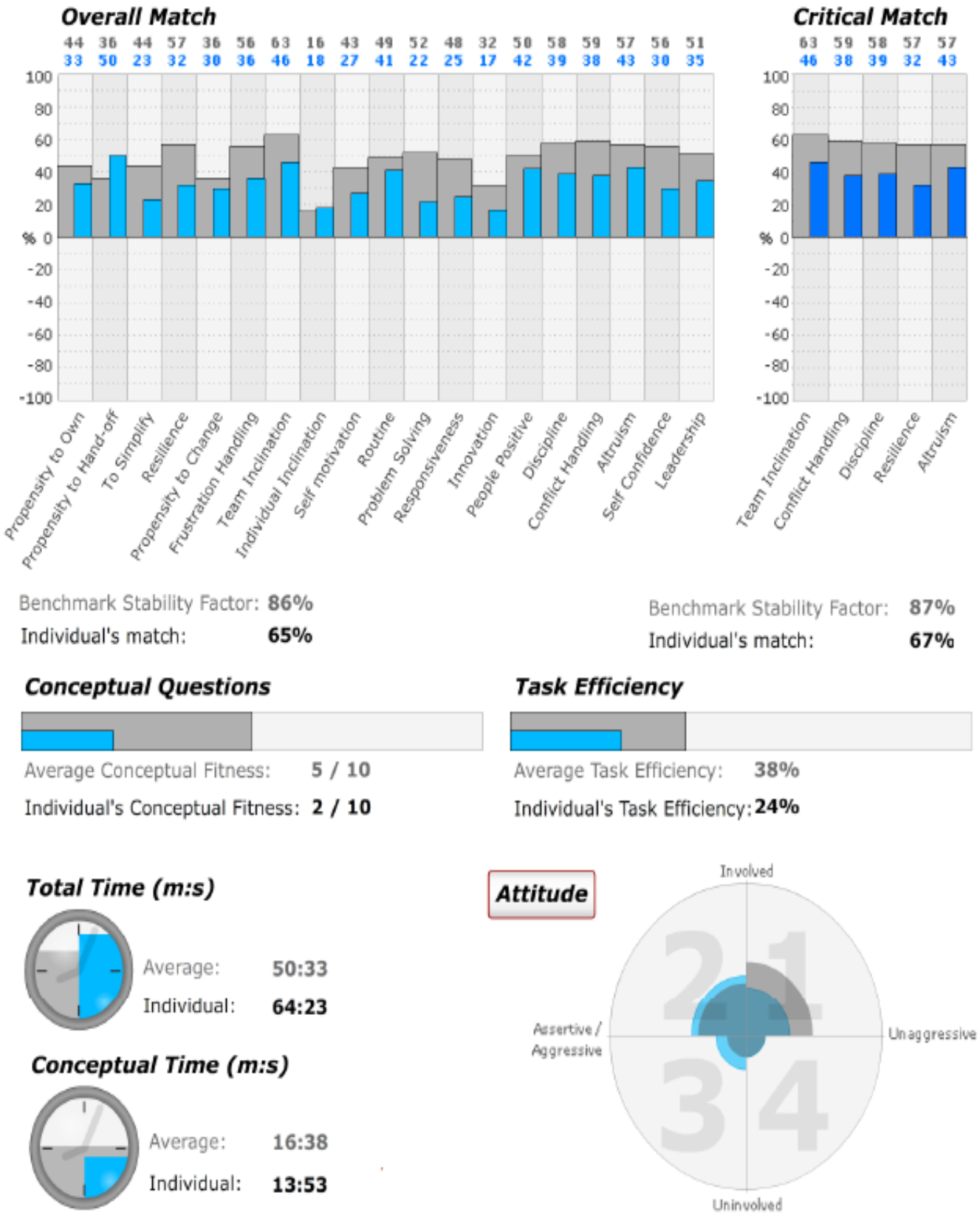
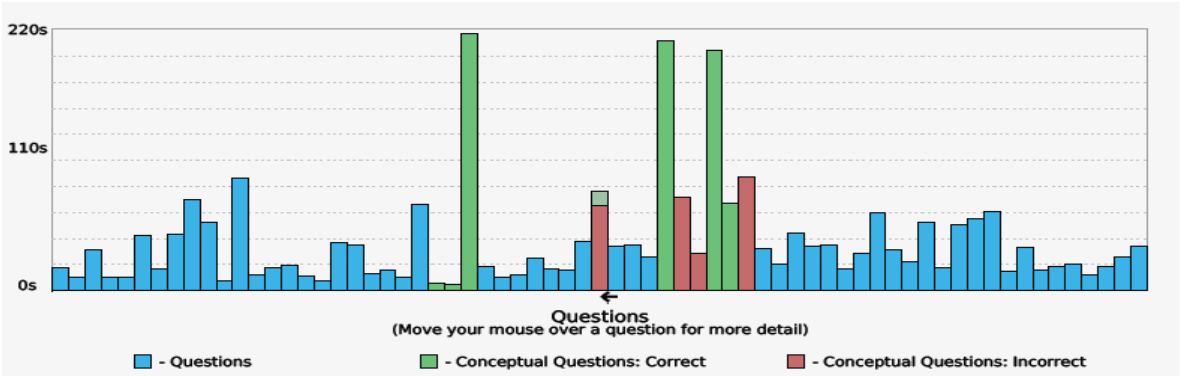


Figure C3: Full Shadowmatch profile of "worst" performer (Individual's scores indicated in blue).



Summary:

Total time (m:s): 00:46:09

Conceptual time (m:s): 00:16:43

Individual's task efficiency: 43%

Individual's conceptual fitness: 7 / 10

Avg time spent on conceptual questions (correct): 103.86s

Avg time spent on conceptual questions (incorrect): 92s

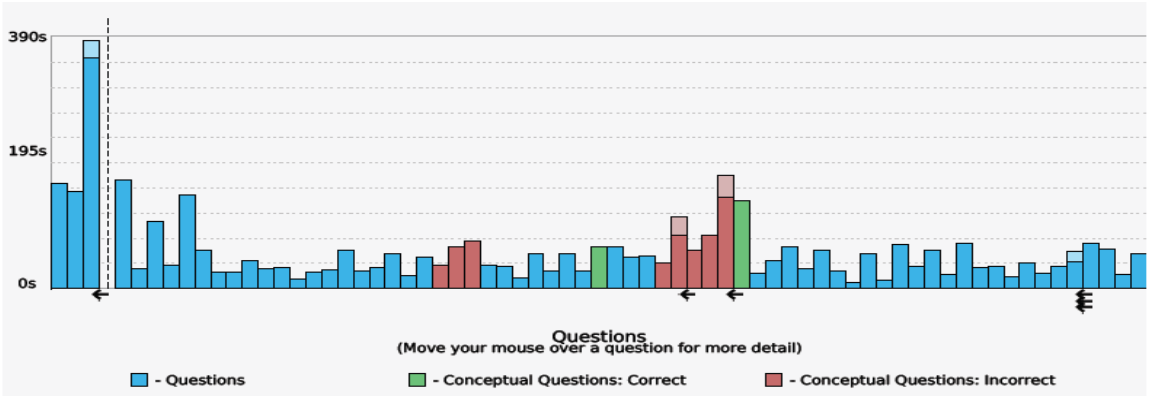
Total number of backclicks: 1

Total number of changes: 1

Number of pauses: 0

Number of reminders sent: 0

Figure C4: Time graph of best performer.



Summary:

Total time (m:s): 01:04:23

Conceptual time (m:s): 00:13:53

Individual's task efficiency: 24%

Individual's conceptual fitness: 2 / 10

Avg time spent on conceptual questions (correct): 55s

Avg time spent on conceptual questions (incorrect): 90.38s

Total number of backclicks: 6

Total number of changes: 3

Number of pauses: 1

Number of reminders sent: 0

Figure C5: Time graph of worst performer.

Introduction

Shadowmatch identifies the habits of people that are successful in performing a specific task in a specific working environment and provides the ability to compare the habits of individuals to the habits of the successful people. This functionality provides users of the system with a benchmark / shadow of habits necessary to succeed in doing the same job under the same conditions as those that were selected to create the benchmark (group of top performers).

Critical Habits

In this department the following were identified as critical habits and need to be present in the behavior of the candidate in order to ensure success in this job:

Habit	Description
Conflict Handling:	Conflict manifests in a situation where people have opposing interests that might unfold with destructive consequences to each other. A strong habit of dealing with conflict in a positive way towards a solution, with no or minimal negative consequences for either party is required.
Discipline:	The habit of working under extreme levels of discipline, in a highly disciplined working environment where adherence to structure, rules and regulations and time- frames are imperative.
Altruism:	Strong behavior to help others without expecting something in return needs to be displayed.
Team Inclination:	A preference towards working as part of a team, functions positively in a team framework of activities and prefers to work with active team support.
Resilience:	The habit of overcoming challenges despite difficulties experienced. Stick with the task and finish it, even if serious set- backs have to be faced. The person needs to complete the task and have the habit of doing whatever is necessary to finish.
Conceptual Application:	This job does not require a strong application of an individual's conceptual abilities.
Task Efficiency:	Take note: Extremely efficient people might find this job to be very frustrating.
Attitude:	Involved and unaggressive/ kind. When pushed to the point of radical behavior to overcome challenges, an attitude of assertive involvement is necessary.

The following habits should preferably not be prominent:

Individual Inclination

The following attitude should NOT be displayed doing this job in this environment:

Unaggressive/ kind and uninvolved behavior.

Figure C6: Recruitment specification for shift bosses recommended by the Shadowmatch system.

Shadowmatch Habits Defined

Propensity to own versus Propensity to hand-off: These two habits indicate whether the individual takes ownership to solve a problem and handles a challenge him/herself, or whether he/she prefers an outside agent to solve problems, handle difficulties or even execute tasks. It refers to the place where the individual places the control and/or task execution, with him/herself or outside of him/herself. In some jobs a habit of handing-off a task is necessary, in some jobs it's not. The same applies to keeping the task as a self-execution responsibility. From the data gathered by Shadowmatch it is clear that for some unique tasks a balance between the two is necessary.

To Simplify: refers to the habit of breaking complex scenarios down to linear challenges that can easily be resolved. It can be seen as the habit of taking the easy route towards solving complex challenges. The purpose of this habit normally ties up with efficiency whereby an individual has developed the ability to easily find the simple way to resolve challenges / problems. The habit of simplification can develop in tandem with the habit of problem solving. When both these habits are well formed the individual might develop extremely strong behaviours towards effectively solving problems by applying extremely simple ways towards a solution.

Resilience: Some people give up easily when faced with a challenge and some apply themselves relentlessly to solve problems and overcome challenges. The Shadowmatch worksheet calculates the habit of the person in overcoming challenges despite the difficulties experienced. It also calculates whether the individual tends to give up or whether he/she completes a task despite difficulties and toughness of the journey. Be aware of the fact that if the individual answers the questions in a specific way, it might indicate a negative level of resilience. When this happens, the indication is that the specific person tends to disembark from a task not because he/she experienced the task to be tough but because he/she anticipates it to be tough without even trying. If this is a habit (giving up without even trying) the individual will also tend to develop a habit of low self-confidence.

Propensity to Change: Some people find it very difficult to adapt to change and to get comfortable with new methods, new ways of doing things, a new environment and new technology. On the other hand there are people who advocate change, they always venture towards new frontiers. These people are very comfortable with anything new, be it a new job, new ways of doing things, new technology and so on. Shadowmatch determines how positive (comfortable) the individual behaves towards change and adopts anything new, different and even strange. If this is marked as a habit, (more than 50 points) it indicates the behavioural pattern of pushing for change, early embracing the new and even invites those around them to participate in a process of changing the world where they work and live.

Propensity to Handle Frustration: This Shadowmatch calculator indicates an individual's habit towards applying positive behaviour when dealing with frustrating circumstances. Frustration occurs when the individual is obstructed from reaching his/her goal. It is the experience that stems from a situation when obstacles block one from reaching a goal. A high graph indicates a strong habit 26 of handling a frustrating situation. The behaviour types that Shadowmatch measures are those acts whereby the individual deals with the obstructing source/interference in such a way that his/her actions towards successful results, stay on track.

Team / Individual Inclination: The system calculates, according to the answers given, whether the individual prefers working as part of a team or whether he/ she prefer working as an individual. When these two calculations are very close to each other, it indicates that the individual is equally comfortable working in a team or as an individual.

Self-Motivation: Some people have the habit of energising themselves whilst others are dependent on external energisers to stay positive, driven and active. Shadowmatch calculates the individual's habit towards the capacity of the individual to behave with high levels of energy despite the absence of external motivating agents. Self-Motivation is the behaviour of continuous positive action towards a desired outcome in the absence of external energisers.

Routine: The routine graph is an indicator of an individual's habit towards structure and repetition, sometimes even mundane activities. It determines whether the individual has a habit of behaving in harmony with an environment of repetition and patterns of the same behaviour. A high graph indicates a high propensity towards a positive blend between the individual and an environment where structure and routine results in a reality whereby every day is pretty much the same as the previous.

Problem Solving: This is the habit of engaging with challenges on a conceptual, social and practical level and successfully managing these difficulties/challenges towards resolving them. People with a strong embedded habit of problem solving easily become intrigued by challenges and riddles to be resolved. In fact, if anybody scores more than 70 points on problem solving, they will find it extremely difficult not to engage with a challenge to be resolved. When an individual scores less than 30 points he / she will find it easy to bypass or even ignore a problem that needs some effort to be resolved.

Responsiveness: This indicates the individual's reaction speed, in other words the habit of acting immediately if and when necessary. A low graph will merely indicate that an individual doesn't have the habit of acting immediately, whilst a high graph indicates the habit of acting immediately. As with all Shadowmatch indicators, there is no good or bad in this calculation. In some jobs people don't need to act quickly, they need to wait and think very thoroughly. In some jobs people must act quickly. This indicates the individual's inclination. A high score indicates a strong habit of responsiveness.

Innovation: This is the habit of finding new ways and identifying better processes and methods to improve on current methods of working. It also indicates the habit of working out-of-the-box and creating new realities. Shadowmatch defines innovation as the behaviour of an individual doing things that are new, design new practical functionalities that improve on the way things are done and even create new realities. Someone with great ideas is not regarded as innovative. Shadowmatch regards them as dreamers – something Shadowmatch prefers not to map or pretend to understand.

People Positive Behaviour: This calculates whether the individual has the habit of working with people in a positive way and building positive relationships. It also tracks the way a person influences people towards a positive and meaningful experience of life. The system follows answers that will indicate a natural people oriented person, somebody not easily frustrated by others.

Discipline: The habit of working under extreme levels of discipline, in a highly disciplined working environment where adherence to structure, rules and regulations and time-frames are imperative. People with a high (above 70) score on this habit will even create structures of discipline for others to adhere to. Individuals with an extremely low score do not easily conform to structure, discipline and strict order.

Conceptual Capabilities: The conceptual questions measure an individual's application of his/her abstract ability. In other words: To what level has the individual developed the habit to apply his/her mind in working through an abstract problem towards finding the correct solution? This doesn't indicate if a person is conceptually strong or weak, it indicates whether the person continuously applies his/her mind towards solving a problem with an expected successful result.

Conflict Handling: Conflict manifests in a situation where people have opposing interests that might unfold with destructive consequences to each other. This reading on the Shadowmatch graph indicates the habit of dealing with conflict in a positive way towards and outcome with no or minimal negative consequences for either party. Avoiding conflict is not regarded by this worksheet as a positive way to deal with it.

Altruism: This reflects a person's willingness to help others without expecting something back. People that have a strong altruistic habit are relatively free from the 'What's in it for me' approach to helping others. These people do well in service driven jobs. Shadowmatch has gathered evidence to the effect that a high score on altruistic behaviour doesn't always implicate a high score on people positive behaviour.

Self Confidence: Shadowmatch calculates behaviour that indicates the person's

ability to act with conviction and stay with a decision that he/she has made. In short, self-confidence is the habit of acting with a high level of trust in your own abilities, qualities and judgment, knowing who you are and what you can and can't do. A high score indicates that an individual has a habit of acting in a secure and confident manner.

Task Efficiency: When someone completes the Shadowmatch worksheet, it represents an end to end task during which every individual tends to present a level of efficiency. These efficiencies are being presented as recurring patterns or habits. This is a combination of how they manage their time, how efficient they are in doing the job end to end and how successfully they are in getting the job done correctly. The Task Efficiency graph calculates the relative efficiency with which the individual has completed the task of working through the Shadowmatch Worksheet. It combines total time, conceptual results and time used for the conceptual questions into a single percentage of relative efficiency. The full meaning of this calculation is a cold factual calculation of how the individual has taken ownership of a task successfully and effectively. That task being to complete the Shadowmatch Worksheet.

Leadership: Shadowmatch defines leadership as the ability to integrate resilience, discipline, a team oriented approach, the propensity to act immediately and self-confidence with an attitude of positive involvement. All these behavioural strengths are harnessed to lead a group of people towards a successful outcome.

Attitude: This is the way people approach life and work through their actions. It must not be seen as body language. Attitude in the framework of the Shadowmatch worksheet results indicate those actions with which someone approaches the world around them. Shadowmatch distinguishes 4 attitude categories: Category 1 is a positive, non-aggressively involved person. Category 2 is a more aggressive but positively involved person. Category 3 is also aggressive but not always positive and not always involved. Category 4 is a person who is not involved, not aggressive but also not destructive. Nobody is ever seen as a category one, two, three or four only; we are all a combination of the four with dominance in one or more of the categories. A full understanding of the different attitude categories is very important.

Shadowmatch displays attitude in a separate graph. A broader description of this is necessary.