To investigate the safety and health performance and culture in the Australian Coal Mining Industry

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TO INVESTIGATE THE SAFETY AND HEALTH PERFORMANCE AND CULTURE IN THE AUSTRALIAN COAL MINING INDUSTRY

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The number of fatalities, serious bodily injuries and high potential injuries is unsatisfactory according to community standards; people are still being killed and seriously injured on mine sites due to human behaviour factors, such as not complying with rules, procedures and management failings. This research aims to conduct an analysis of the Australian Mining Industry safety performance and make comparisons with international mining operations, examine the mine safety environment and determine the effects that culture, risk management, prosecution policies, fly in fly out, fatigue and mental health are having on safety improvement. In this regard, as a major part of this research, a field survey has been conducted in the Qld and NSW coal mining industry. A total of 37 mines participated in a manual and electronic surveys and responses were received from over 1200 questionnaires. A statistical comparison of the two surveys has been conducted using the Wilcoxon Signed Rank Test. This research has found that fatigue and awareness issues as well as travel times to work are having a major impact on safety at work, which is particularly evident when employees are working 12 hour shifts. The survey results show that there is a lack of experienced personnel in the industry and that the effective management of contractors continue to cause concern. This research has demonstrated that the current approach to prosecution is counter-productive, as it inhibits thorough safety investigation and creates a defensive rather than a no blame culture. It also prevents the sharing of safety information and heeding the lessons learned. It has been found that there is a lack of training in safety management systems, management influence effects the outcomes of risk assessments, accident investigation would be better without legal people's involvement and an official inquiry would produce better outcomes if there was no fear of prosecution. This research has demonstrated that safety performance in the Australian Mining Industry has not improved and may even be deteriorating and that in order to improve safety performance the mining industry needs to adopt the recommendations which have been made regarding culture, prosecution policies, training, risk assessments, shift lengths and fly in fly out operations.

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ABSTRACT

The number of fatalities, serious bodily injuries and high potential injuries is unsatisfactory according to community standards; people are still being killed and seriously injured on mine sites due to human behaviour factors, such as not complying with rules, procedures and management failings. This research aims to conduct an analysis of the Australian Mining Industry safety performance and make comparisons with international mining operations, examine the mine safety environment and determine the effects that culture, risk management, prosecution policies, fly in fly out, fatigue and mental health are having on safety improvement.

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This research has demonstrated that the safety performance in the Australian Mining Industry has not improved and may even be deteriorating and that in order to improve safety performance the mining industry needs to adopt the recommendations which have been made regarding culture, prosecution policies, training, risk assessments, shift lengths and fly in fly out operations.

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LIST OF PUBLICATIONS

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R .J. Parkin, D. Laurence, The Next Steps Towards “Zero Harm”. Paper presented at the NSW Mining Industry Conference in Terrigal 2010.

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A GLOSSARY OF TERMS AND ACHRONYMS

Definitions

As Low As Reasonably Possible – ALARP

Australian Workplace Agreements - AWA

Consolidated Rutile Limited - CSR

Construction Forestry Mining and Energy Union - CFMEU

Corporate Mining Industry - CMI

Disabling Injury – DI

A work related injury or disease resulting in a worker being unable to fully perform their regular job. (Either light duties or alternative duties are performed)

Duration Rate – (DR)

The average time lost for every lost time injury. This is a measure of the severity of the injuries occurring. This rate is calculated using the following formula:

$$\frac{\text{(total number of days lost)}}{\text{(Number of lost time injuries)}}$$

Fatal Injury – (F)

An injury that results in death.

Fatal Injury Frequency Rate – (FIFR)

The number of fatal injuries per one million hours worked.

Frequency Rate – (FR)

The number of occupational fatalities or injuries expressed as a rate per million hours worked. This rate is calculated using the following formula:

$$\frac{\text{(number of occupational fatalities or injuries)} \times \text{(1,000,000)}}{\text{(number of hours worked)}}$$

Health Safety Environment and Community - HSEC

High Potential Injuries - HPI

A high potential injury at a coalmine is an event, or series of events, that causes or has the potential to cause a significant adverse effect on safety or health of a person.

Incidence Rate – (IR)

The number of fatalities or injuries per 1000 employees.
This rate is calculated using the following formula:

$$\frac{\text{(number of occupational fatalities or injuries)} \times (1000)}{\text{(number of employees)}}$$

Incident Cause Analysis Method – (ICAM)

It enables identification of health and safety or environmental deficiencies and assists investigation teams to find out what went wrong and what needs to be done to prevent a recurrence.

Job Safety Analysis - JSA

Lost Time Injury – (LTI)

An injury that results in a minimum of one full shift's absence (AS1885.1 – 1990).

Lost Time Injury Frequency Rate – (LTIFR)

The number of lost time injuries per one million hours worked.

Medical Treatment Case – (MTC)

A medical treatment case is an injury requiring treatment by a doctor, nurse or a person required to give first aid.

Notifiable Injuries – (NI)

Injuries that have to be notified to the Inspectorate

Occupational Health and Safety Management Systems - OHSMS

Safety and Health Management Systems – SHMS

Safety Management Plan – SMP

Safe Working Plan - SWP

Site Senior Executive – SSE

The site senior executive is the most senior officer employed by the coal mine operator for the coal mine who is located near the mine and has full responsibility for the mine.

Severity Rate – (SR)

The average number of days lost per one million hours worked.

$$\frac{(\text{number of days lost}) \times (1{,}000{,}000)}{(\text{number of hours worked})}$$

APPENDICES

1. Letter to CEOs
2. Letter to survey respondents
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4. Letter of support from CEOs
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INTRODUCTION

This research into the safety of the Australian Mining Industry is important because the numbers of fatalities, serious injuries and potential injuries are unsatisfactory according to community standards. Although significant advances have been made throughout the mining industry, that improvement appears to have plateaued and may be deteriorating. Fatigue and awareness issues are having a major impact on safety at work, which is particularly evident when employees are working 12-hour shifts. The rapid expansion of the mining industry has required the growing use of contractors, hence creating a more inexperienced workforce. This expansion has created problems associated with the fly-in and fly-out and drive-in and drive-out workforce and the accompanied accidents especially with the drive-in drive-out employees. This is due to the fact that most of the expansion in the industry is in remote locations and permanent residency is not available so single camps are the normal practice. The current approach to prosecution is counter-productive, as it inhibits thorough investigation and creates a defensive rather than a proactive safety culture. This approach has resulted in the unwillingness by companies to examine the root causes of accidents and incidents for fear of being prosecuted. Safety improvement is at the cross roads and according to Parkin (2009) who stated *"that In order for the industry to address the problem the following issues must be addressed with some urgency:*

- *Prosecution Policies*
- *The growing use of contractors*
- *Lack of trust*
- *Hours of work and fatigue issues*
- *Lack of consultation*
- *Lack of experienced qualified people and*
- *Safety culture"*

A preliminary analysis reveals that as well as the abovementioned issues, the fly in and fly out (FIFO), drive in and drive out (DIDO) operations and the social implications which include the impact that mental health is having on FIFO employees also needs to be to be investigated. In addition the lack of appropriate training, heavy vehicle interactions, falls from height and different approaches to fitness for work are contributing to the detriment of safety improvement.

Aims and Objectives of the Research Programme

The specific aims that will be addressed in this research are as follows:

- To analyse the safety paradigm and determine if the safety performance is improving in the Australian mining industry by conducting a rigorous qualitative and quantitative analysis of the safety performance data. This data will include fatalities, lost time injuries, high potential injuries, significant injuries, disabling injuries, notifiable injuries and medical treatment cases
- An international safety performance comparison will be undertaken which will compare Australia with the United States of America, United Kingdom, South Africa and Canada of coal and metalliferous mining operations
- To compare the safety performance in the Australian mining industry with other Australian industries.
- To examine the mine safety environment and determine the effects that mining industry culture, risk management processes, safety management systems and the effects of fatigue are having on safety improvement
- To investigate why companies appear to be hiding behind legal privilege regarding the facts involving fatalities, serious injuries and high potential injuries
- To investigate the impact that FIFO and DIDO operations are having on safety performance

An industry survey will be conducted as a major part of the research programme which is the vehicle that will help research the above mentioned points.

The Significance of this Research Programme

People are still being killed and seriously injured on mine sites due to human behaviour factors, including not complying with rules, procedures and management failings. The findings of the industry survey which was conducted as a major part of this research programme provided the industry with some answers to questions which have been outlined in the aims and objectives in the survey. The results of this research will help the mining industry to improve its safety performance and the gap in knowledge in these areas.

Research Hypothesis

This research will test the hypothesis that the safety performance in the Australian mining industry has not improved despite all the rhetoric in the industry and is based on evidence which will be presented in this thesis. An investigation will be conducted into the safety performance in the Australian mining industry and compare this with relevant International mining industries, examine the mining safety environment which includes risk assessments, safety management plans, fatigue, awareness issues and why companies are being forced to hide behind legal privilege .

CHAPTER 1

INTRODUCTION – MINING LEGISLATION, ACCIDENTS AND INCIDENTS IN THE MINING INDUSTRY

1.1 Historical Background To Legislative Development

The coal mining legislation in Australia is based primarily on legislation developed in the United Kingdom and so the history of legislation in the two countries is intimately connected. The history of occupational safety legislation in the United Kingdom is to a great extent, though not exclusively, the history of legislative control over manufacturing industry (Langdon 1999).

The Industrial Revolution brought with it the use of powered machinery and created working conditions of a type previously unknown. In the latter part of the eighteenth century the development of water powered machinery led to the establishment of textile mills in country districts and to a significant demand for labour, which was filled largely by the importation of pauper children. It was the appalling conditions in which some of these children worked, that led in 1802 to the first Factories Act.

Although The United Kingdom was the first of the leading countries of the world to become highly industrialised, it was France who in the early 19^{th} century first established the principle of government inspection of mines (Taylor 1986). The mining legislation of today came about following the events which occurred in the first half of 19^{th} century and in 1833 the first government inspectors in industry were appointed. The early mining methods gradually developed in scope and sophistication over time and by 1830 the application of basic mining engineering principles had enabled mining to proceed to depths of close to 200 meters. The availability of the steam engine for winding and dewatering purposes allowed mines to extend even deeper into more gassy and geologically complex seams which brought a new range of safety and ventilation problems. Gas and coal dust explosions, leading to huge loss of life, became more frequent and costly. They were commonly caused by the naked flames used by miners for illumination purposes.

At the same time of the increase in the number of explosions in coal mines the deplorable working conditions were being progressively being revealed. In 1812, 92 persons were killed in an explosion at the Felling mine in South Tyneside; this disturbed the local society sufficiently to form the now historic Sunderland Committee to enquire into mining accidents

and to find means of preventing them. These catastrophic events highlighted the need for safe illumination underground and in 1815; Humphry Davey devised the flame safety lamp where the flame was surrounded by iron gauze. The gauze would not allow a flame to pass through, but was able to admit methane, which could burn harmlessly inside the lamp. This flame safety lamp quickly gained acceptance in gassy mines.

However, explosions continued to occur and in 1839 an explosion at the St Hilda mine which is located in South Shields in which 52 persons died, led to the formation of the South Shields Committee, which , like the Sunderland Committee, was set up to investigate the causes and means for the prevention of accidents. The committee was composed of non-mining people and its report stressed several important issues, which included the prohibition of single shafts and a system of inspection. It was not until after the Hartley Colliery disaster in 1862 where 204 men and boys died because of their inability to exit the mine when the single entry collapsed, that single entries were made unlawful.

These committees played an important part in the process of formulating the early coal mining legislation in the United Kingdom. A Royal Commission was established in 1840 to enquire into the employment of young children and women in mines. The report was issued in 1842 and was described as the most depressing Royal Commission Report ever written (Taylor 1986). A Government Bill seeking to prevent the employment of women and children underground was presented to Parliament but it met violent opposition in the House of Lords. However the bill was passed and the employment of women and boys under 10 was prohibited. Provision was also made for the introduction of government appointed inspectors of mines at the same time. The most prominent legislation to follow was the Coal Mines Act 1911. This in turn was superseded by the Mines and Quarries Act 1954, together with the attendant regulations. The next important legislation was the passing of the Health and Safety at Work Act in 1974 which brought some eight million persons within safety and health legislation for the first time ever which also included employers.

By the late 1960s it became clear that the system for regulating health, safety and welfare in employment was not all it should be.

"Every year something like 1000 people were killed at work; half a million suffered injuries of varying degrees of severity; and 23 million working days were lost on account of industrial injury and disease" (Langdon 1999).

It was against this background that the Robens Committee was appointed in May 1970. Lord Robens had been Chairman of British coal from 1961 to 1971. The 1974 Robens Report was responsible for introduction of the Health and Safety at Work Act which controversially promoted self-regulation by employers. In 1994 the British Government introduced the Coal Industry Bill into Parliament with the intention of privatising British Coal.

1.2 Major Impacts of Disasters on Legislation

British coal mining has a long history of disasters that have caused considerable suffering to mining communities. These disasters have shaped the course of legislation which has improved the safety in the coal mining industry. The most important ones regarding safety improvement in the mining industry have been investigated by (Galloway1969).

1.2.1 Felling Colliery

In 1812, 92 miners were killed at the Felling colliery in South Tyneside. The mine was equipped with two shafts about 600 feet deep. The disaster was caused by an ignition of methane, which then propagated into a coal dust explosion. At the time, adequate lighting was hazardous, since open flames could easily ignite any combustible gases that were present.

As previously discussed, this disaster stimulated Humphry Davey to devise the first oil flame safety lamp which improved safety underground significantly. However there were other *sources of ignition, such as sparks from metal tools and upon their development electrical equipment and explosives used for blasting*.

1.2.2 Hartley Colliery

In 1862 a disaster occurred at Hartley colliery in Northumberland killing 204 men and boys. This disaster was caused by the fracture of a steam engine beam, which was used to dewater the mine. The beam suddenly broke, and one end fell into the shaft of the mine. The mine was being worked with a single shaft in which entombed 204 men and boys.

This disaster led to changes in legislation requiring all mines to be worked with a minimum of two entries separated by not less than 15 meters of natural ground. This would provide a second means of egress and facilitate mine ventilation.

1.2.3 Creswell Colliery

A disaster occurred in Creswell, North Derbyshire in 1950 when a fire killed 80 miners. Eighty miners were trapped inbye of a fire which was out of control, which led to the decision to seal the mine. It was concluded that friction between a damaged belt and rollers had built up and started the fire.

After this disaster the coal mining legislation was changed such that all rubber conveyor belts were replaced with fire resistance belt.

1.2.4 Easington Colliery

In 1951 an explosion at Easington colliery in Durham killed 83 miners which included two rescue workers. The workings extended several kilometres under the North Sea where retreat longwall mining was practiced. The explosion was caused by sparks from a machine cutter picks igniting a methane air mixture which then propagated into a coal dust explosion.

This resulted in new legislation relating to the provision of stone dust barriers in conveyor roadways, ventilation in retreat mining and goaf support.

1.2.5 Markham Colliery

The Markham colliery disaster occurred near Chesterfield, Derbyshire in 1973 killing eighteen miners and seriously injuring eleven. This accident was caused by a brake rod failure due to a fatigue crack whilst the cage was descending to the bottom of shaft killing eighteen men.

In order to avoid a recurrence of this accident legislation was changed such that all winding gear had to be crack detected at periodic intervals.

These disasters were instrumental in bringing about major changes in the progression of the UK mine safety legislation. They ranged from;

- The invention of the flame safety lamp
- The requirement for two separate means of egress at all mines
- The provision of stone dust barriers
- The provision of fire resistant belt underground
- Goaf support
- Improved ventilation and
- Routine crack detection of winding gear.

1.3 Coal Mining Industry Fatalities in the UK

One way to illustrate the benefits that the introduction of legislation has achieved is to examine the number of fatalities over a reasonably long time period in the UK coal mining industry. It can be observed from Table 1.1 that in 1930 some 943,000 people were employed in coal mines and the number of fatalities was 1,013, which means that a miner had a 1 in 931 chance of being killed within that year. In 2009, 79 years later about 5000 people were employed and the number of fatalities was 1. This means that a miner had a I in 5000 chance of being killed within that year. This means that the safety performance in coal mines has improved substantially and that the introduction of legislation has played a significant role in improving safety and health of people working in coal mines. Over the same time period the introduction of technology has also played its part in safety improvement. Information sourced from (Taylor 1986) and the following web site which was accessed on the 8/8/2012 - http://www.hse.gov.uk/mining/index.htm.

Table 1.1 Coal Mining Fatalities in the UK between 1930 and 2009

Year	No. Employed	Fatalities	Risk
1930	943,000	1,013	1 in 931
1946	716,000	543	1 in 1319
1970	304,400	91	1 in 3341
1986	138,500	28	1 in 4946
2009	5000	1	1 in 5000

The development of legislation in the UK mining industry has played an important part of the evolution of safety improvement in the mining industry worldwide. It is therefore highly appropriate when evaluating the mine safety performance in Australia. Legislation in the Australian mining industry will be discussed in chapter 2 of this thesis.

1.4 Australian Mining Industry Safety Performance

The Australian mining industry safety performance is measured in terms of the fatality injury frequency rate (FIFR) and the lost time injury frequency rate (LTIFR). These base line lagging indicators are used throughout the mining industry to measure safety performance. The (FIFR) is the number of fatal injuries recorded per one million hours worked and the (LTIFR) is the number of lost time injuries recorded per million hours worked. A lost time injury is recorded when a person is prevented from attending his place of work on the following shift. The information has been sourced from the last Minerals Council of Australia Annual Reports (1997-98 – 2008-09) which has used data collected from the States/Territory Mines Inspectorate. This data provides a very comprehensive record of the safety performance in the minerals industry. It is an unfortunate fact that the year 2008-09 is the last year that the Minerals Council of Australia produced the Annual Safety and Health Report. This was the only safety report that compared all the safety data across the minerals industry in Australia and it was used extensively for bench marking purposes across the mineral industry.

It can be observed in Figure 1.1 that in 2008-09 eighteen fatalities were recorded by the Australian minerals industry. This is fourteen more than the four fatalities recorded in 2007-08. Over the last twelve years Figure 1.1 the minerals industry has recorded 151 fatalities, at an average of over twelve deaths per year. This means that the eighteen fatalities recorded in 2008-09 is higher than the twelve year average of just over 12. According to the Minerals Council of Australia the number of fatalities over the last ten years has varied widely from year to year ranging from a low of 4 in 2007-08 to a high of 19 in 1999-2000 which indicates that there is limited evidence of a sustained improvement over the decade. This emphasises the need for minerals companies and governments to maintain an ongoing focus of fatality prevention and in that regard the Minerals Council of Australia set up a Fatality Taskforce.

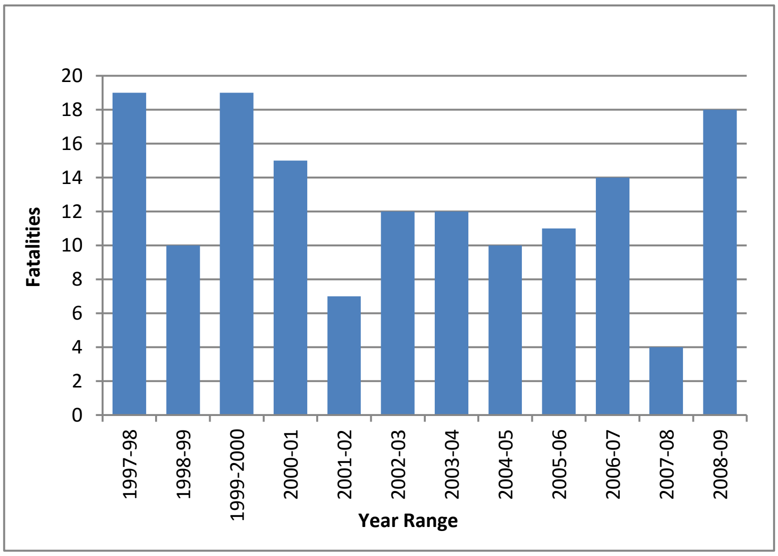


Figure 1.1 Australian Minerals Industry Fatalities 1997-98 to 2008-09

During 2008-09 the highest number of fatalities per sector, eight, was recorded in the open cut metalliferous sector Figure 1.2. The underground metalliferous and coal sectors recorded three fatalities. The open cut coal sector recorded two fatalities and extractive industries and exploration recorded one fatality.

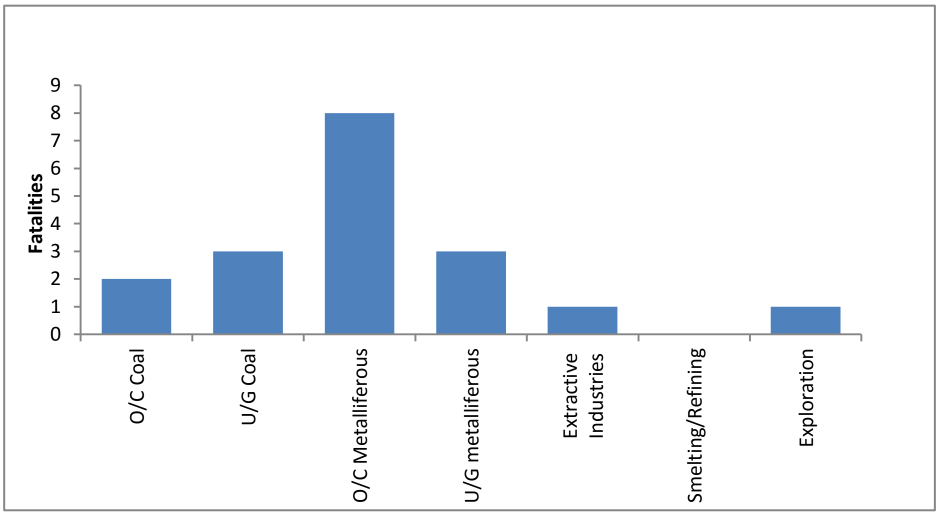


Figure 1.2 Fatal Injuries by Sector 2008-2009

The risk of fatalities is measured by the Fatal Injury Frequency Rate (FIFR).
It can be observed in Figure 1.3 that Exploration recorded the highest FIFR of 0.14 followed by U/G Coal on 0.11. O/C Metalliferous and Extractive Industries recorded 0.06 with U/G Metalliferous recording 0.05 and O/C Coal was the best performer on 0.03

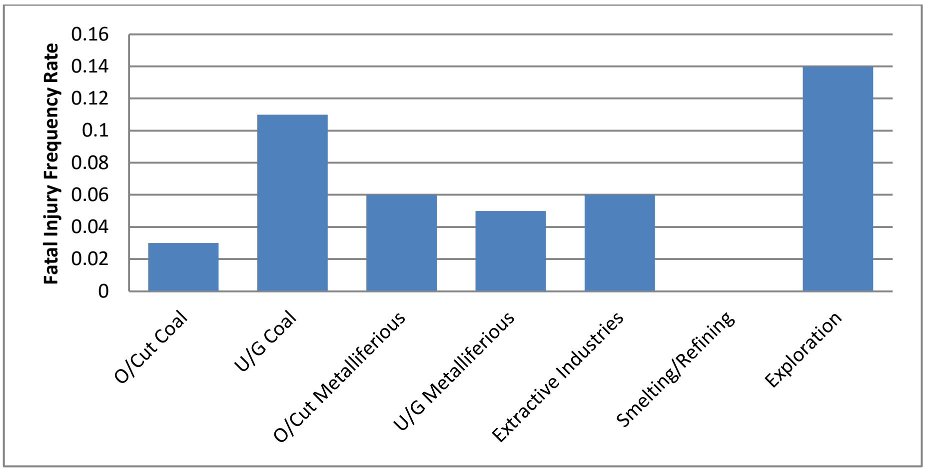


Figure 1.3 Fatal Injury Frequency Rate by Sector 2008-2009

Typically, a high proportion of total fatalities are recorded by the most active mining States – Western Australia and Queensland. This trend has essentially continued in 2008-09 –

Table 1.2, with Western Australia recording seven fatalities, Queensland recording four fatalities and New South Wales recording 3 fatalities. South Australia recorded three fatalities and Victoria recorded one fatality. Of the three large mining states Qld had the best FIFR of 0.04 followed by WA on 0.05 and NSW on 0.06.

The eighteen fatalities were caused by the following:

- Eight were caused by vehicle interaction
- Four were involved falling from height (including one vehicle related)
- Four were caused by crushing
- Two were maintenance related and
- One was due to being hit by a falling object.

Table 1.2 Number of Fatalities and FIFR by State from 1998-99 to 2008-09

Fatalities and FIFR by State from 1998-99 to 2008-09

	1988-99	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2008/09 FIFR
WA	3	6	5	3	5	4	2	5	4	2	7	0.05
QLD	2	2	2	2	3	1	4	3	4	1	4	0.04
NSW	4	11	4	2	1	4	1	0	2	0	3	0.06
VIC	0	0	1	0	1	0	0	1	2	0	1	0.08
TAS	1	0	3	0	2	0	0	1	0	0	0	0.00
SA	0	0	0	0	0	3	2	1	0	1	3	0.31
NT	0	0	0	0	0	0	1	0	2	0	0	0.00
Total	**10**	**19**	**15**	**7**	**12**	**12**	**10**	**11**	**14**	**4**	**18**	**0.05**

The Australian FIFR in 2008-09 was 0.05 per million hours worked Figure 1.4. Although a FIFR of 0.05 is below the ten-year average of 0.06, rates have fluctuated widely from year to year and a consistent downward trend has not emerged according to the Mineral Council of Australia Annual Reports (1997-98 – 2008-09).

The FIFR of 0.05 is the highest recorded over the last five years.

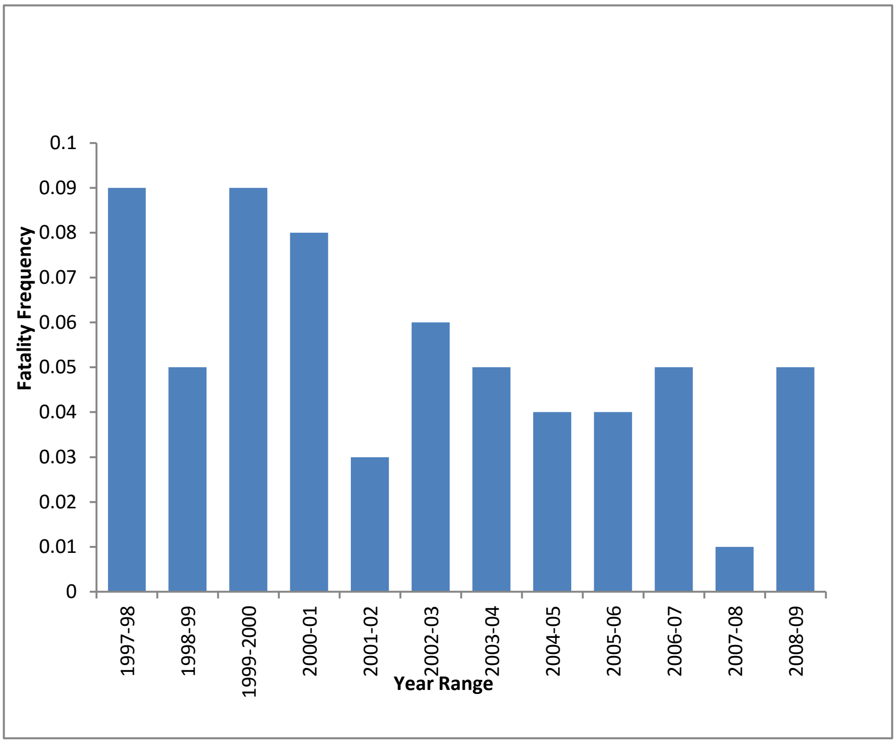


Figure 1.4 Fatal Injury Frequency Rate Australian Minerals Industry 1998-99 to 2008-09

In 2008 a senior staff member of a safety organisation (anonymity requested) stated to the author that some fatalities on mine sites are not recorded in some States because construction on site did not constitute a fatality in terms of reporting at that operation. This statement may suggest that some states are under reporting important information and as such statistics do not reflect the true facts. If or when "The National Mine Safety Framework " is fully established this should rectify the problems associated with under reporting. This framework will be discussed later on in the thesis.

Over the past decade Lost Time Injuries (LTIs) have decreased consistently from year to year until 2005-06 where there was a slight increase Figure 1.5. Over the decade the number of lost time injuries has reduced by 31% from 2294 to 1575.

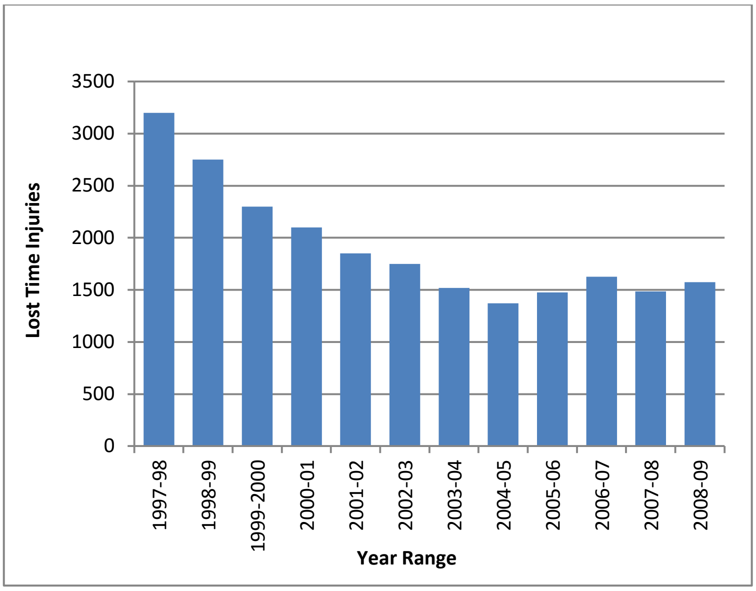
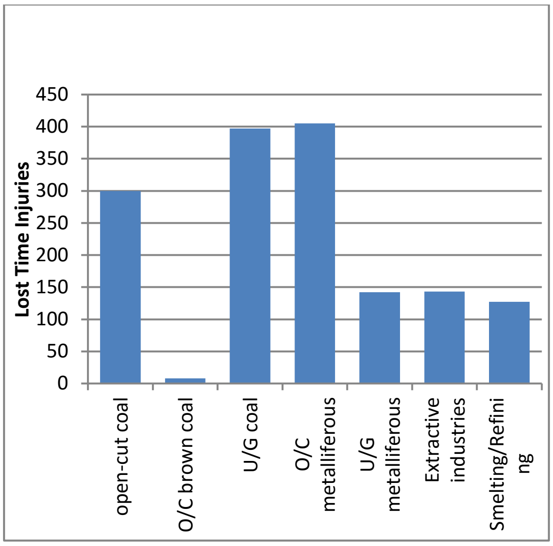


Figure 1.5 Lost Time Injuries Australian Minerals Industry 1997-98 to 2008-09

In 2008-09 the highest number of lost time injuries of 405 was recorded in the open cut metalliferous sector followed by the underground coal sector of 397 with open cut coal recording 300 LTIs. Underground metalliferous and extractive industries recorded 142 and 143 respectively. Smelting and refineries recorded 127 with open cut brown coal recording 8 Figure 1.6. In Figure 1.7 it can be observed that U/G coal recorded the highest LTIFR of 14 followed by extraction industries on 9. O/C coal recorded 7, O/C metalliferous and smelting and refining recorded 3 and U/G metalliferous and O/C brown coal recorded a LTIFR of 2.

It is interesting to note that U/G metalliferous and O/C brown coal were the best performers with a LTIFR of 2.



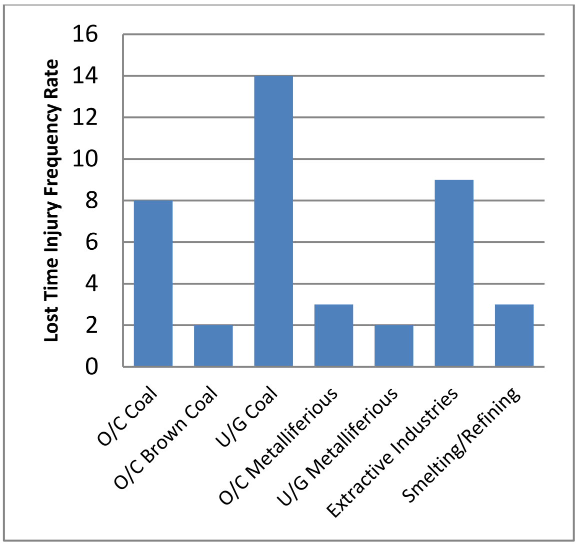


Figure 1.6 Lost Time Injuries by Sector 2008-09. **Figure 1.7 LTIFR by Sector**

The Lost Time Injury Frequency Rate is a measure of the risk of LTIs. During the past decade the LTIFR has decreased consistently from year to year Figure 1.8, though in recent years it appears to have plateaued according to the Mineral Council of Australia. In order to illustrate the dangers of relying on the falling of the LTIFR it is appropriate to examine the following three examples which show a falling LTIFR preceded by a major organisational accident. The management in all three cases were convinced on the basis of their LTIFR record that they were operating safely. According to Reason (2005) “the road to disaster is paved with ailing or low LTIFR” he then made the following observations;

1. Westray mining disaster – Canada 1992
   26 miners died.
   The Company had just received an award for reducing its LTIFR
2. Moura mining disaster – Queensland 1994
   11 men died.
   The Company had halved its LTIFR in the four years preceding the accident

3. Longford gas plant explosion - Victoria 1998

   Two died 8 injured.

   Safety effort had been directed at reducing the LTIFR.

   Major hazards of unrepaired equipment not recognised.

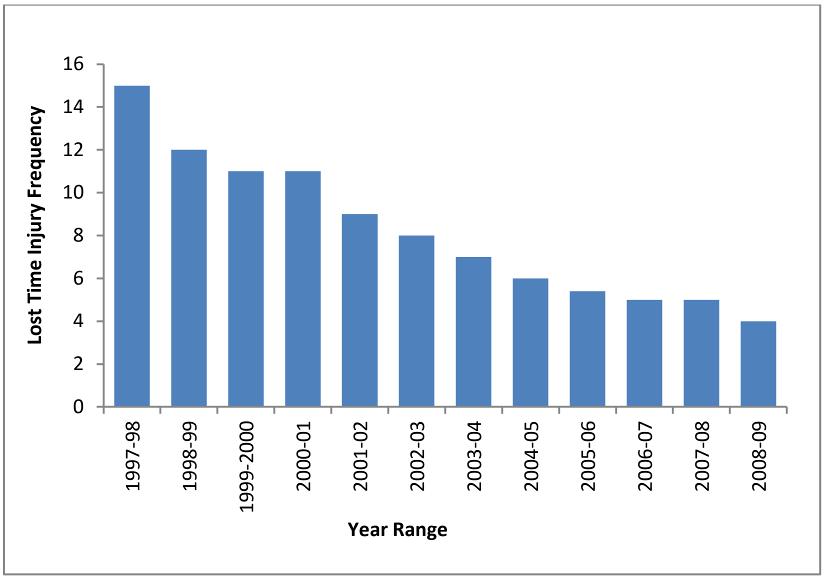


Figure 1.8 Lost Time Injury Frequency Rate Australian Minerals Industry 1997-98 to 2008-09

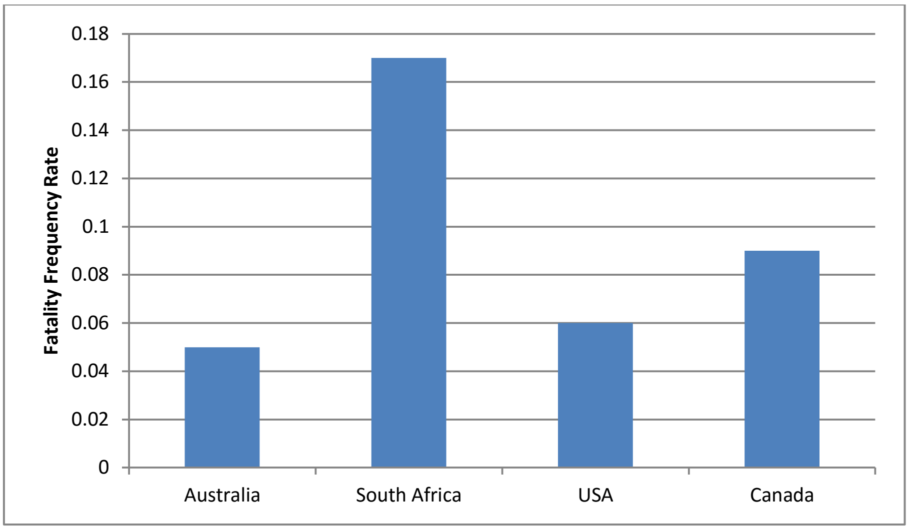
The lessons from these three examples demonstrate that when the LTIFR is decreasing it does not necessarily mean that safety is improving because the potential for a disaster or serious injury is ever present, especially when considering the rapid increase of employment numbers over the last few years. This statement is further somewhat substantiated when one considers the consistent decline in the LTIFR in the Australian Minerals Industry from 1997-98 to 2008-09 Figure 1.8. However the 18 fatalities recorded in 2008-09 is the highest number recorded in 9 years Figure 1.1. The FIFR varies from year to year and the FIFR of 0.05 is the highest recorded over the last five years, which would suggest that there is no correlation or connection between the FIFR and the LTIFR.

The year 08-09 was the last year that the Minerals Council of Australia produced the Safety and Health report for the Australian Minerals Industry which resulted in industry not being able to use this valuable data for bench marking purposes.

1.5 Comparisons of Safety Performance in the International Mining Industry

A comparison will be made of the Australian Fatality and Lost Time Injury Frequency Rates with those of the United States of America, South Africa and the Province of Ontario in Canada. The information has been obtained from the Minerals Council of Australia (MCA) Annual Report. When reporting international statistics, there are limited data readily available for direct comparisons and benchmarking. The injury data is often presented using different criteria, depending on each country's legislative reporting requirements. Nonetheless, the analysis below should provide a reasonable indication of the relative qualitative safety performance of the countries concerned.

It can be observed from Figure 1.9 that the Australian Mining Industry FIFR compares very favourably with the USA, Canada and South Africa.
Australia recorded a FIFR of 0.05, followed by the USA on 0.06, Canada on 0.09 and South Africa on 0.17. It is not surprising that South Africa recorded the highest FIFR when you take into consideration that its industry is dominated by its underground gold operations, which are the deepest hot humid mines in the world. Some of these mines are approaching four kilometres deep with the associated hazards of rock outbursts and ventilation issues. The mines are much more labour intensive, as well as the cultural and political environments being very different to those in Australia, which contributes to the increase in the high FIFR when compared to Australia.



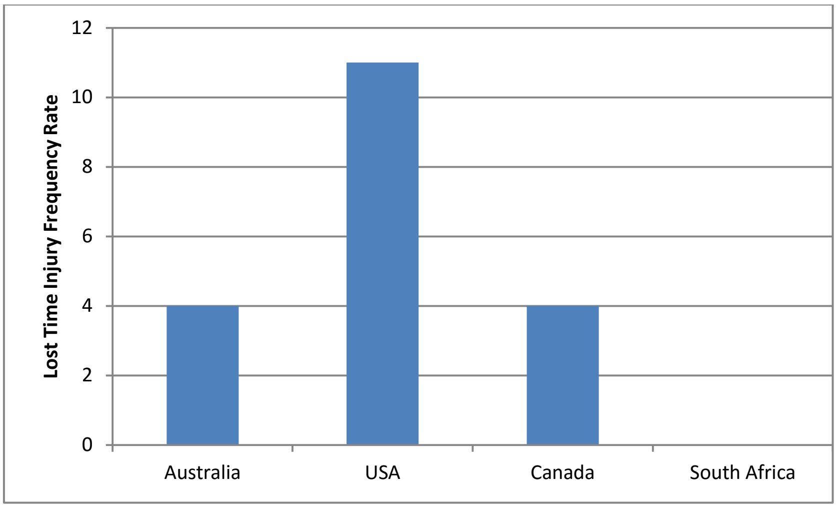
*Note the results for Canada are for the year 2007

Figure 1.9 International Fatal Injury Frequency Rate 2008-09

The South African mining industry recorded a FIFR of 0.17 and suffered 167 fatalities in 2009, 24 less than the previous year and its best result to date. The number of fatalities has declined steadily over recent years, with this year's figure of 167 being well below the average annual number of fatalities for the decade of 235. By comparison Australia experienced 18 fatalities this year with a FIFR of 0.05, six more than its average annual number of fatalities for the decade of 12.

The United States mining industry reported 29 fatalities in 2009. An all-mining FIFR of 0.06 was reported which is lower than last year's recorded rate of 0.09.
Ontario experienced three fatalities in the calendar year 2007. In 2007, Ontario had a FIFR of 0.09 across its mining sector, down slightly from 0.01 last year.
*Ontario does not have coal mines.

The International Lost Time Injury Frequency (LTIFR) for Australia, the United States of America and Canada is illustrated in Figure 1.10. It can be observed that Canada has a LTIFR of 4 followed by Australia on a LTIFR of 4 and the United States of America recording an equivalent of a LTIFR of 11 (Estimated). Information for South Africa is unavailable for comparison.



*Note information for South Africa is unavailable

Figure 1.10 International Lost Time Injury Frequency Rate for All Mines 2008-09

1.6 Significant Incident Reports from Western Australia, Queensland and New South Wales 2005 – 2011

Although the next chapter will analyse the safety performance in more detail in the three large mining states in Australia namely Queensland New South Wales and Western Australia it is first of all appropriate to examine some of the most significant incident reports which have been derived from the listed web pages of each government mines inspectorate in Western Australia, Queensland and New South Wales from 2005-2011. Fatalities and Serious incidents were recorded based on the latest recorded fatalities and serious injuries in each state at the time of reporting. The contribution of human factors to incidents and serious accidents is illustrated in Table 1.3. The fact that human behaviour is still a major component in many of the accidents and incidents in the mining industry today was made by Laurence (2003) *"A body of evidence exists suggesting that many accidents are caused by mineworkers failing to follow procedures or rules".*

According to Billingham (2007) when doing a summary of the Chief Inspectors report he stated; *"The Inspectorate in Queensland is devoting resources to human factors research, which was a key aspect of each of the four fatalities over the past year. A recognised authority in this field from the United States of America has been engaged to assist the inspectorate to identify interventions that can be put in place to better handle the interaction between workers and the equipment and vehicles they use in mining environments".*

Human behaviour will be discussed in much greater detail in chapter 3. Table 1.3 illustrates the fatal and significant incident reports over a six year period where human behaviour and other factors can be identified. The incidents have been caused by the following issues;

- Not complying with rules and procedures
- Lack of awareness of rules and procedures
- Inadequate training
- Fatigue
- Lack of supervision
- Poor communication
- Lack of clear instructions and
- Lack of appreciation of the consequences of individual and team actions.

The incident causes can be categorised into the following areas

1. Fall from heights
2. The release of stored energy
3. Vehicle interaction
4. Contact with high voltage and
5. Carrying out maintenance.

Table 1.3 Significant Incident Reports Derived from Western Australia, Queensland, and New South Wales between 2005 - 2011 (Sourced from Departmental Web Sites)

1.Western Australia	**Incident Cause**
FATALITY AFTER FALL FROM CANTERILEVERED SCAFFOLD PLATFORM	An employee was killed when the cantilevered platform he was dismantling collapsed into the water at a ship loading facility. **Recommendations included the fact that this incident should send a warning to all who use or manage scaffold activities to follow well established safety rules and ensure people working or adjacent to water wear an approved flotation devices where there is potential to fall into the water. Also a documented risk assessment to be completed.**
FATAL ACCIDENT SUSPENSION COMPONENT EJECTED UNDER HIGH PRESSURE DURING MAINTENANACE	An employee sustained fatal injuries after being struck by a suspension component that was ejected under high pressure during a routine maintenance operation. The likely cause of the accident was the release of stored energy in an uncontrolled manner. **Safe operating procedures were inadequate. Managers and employers must establish and maintain safe work practices. Maintenance personnel must be trained and competent to carry out the task.**
FATALITY AFTER FALL FROM HEIGHT IN A PROCESS VESSEL	An employee sustained fatal injuries when he fell into the lower chamber of a process vessel and then at least 25 metres to the ground. The causes to this accident are that no barrier or guide rails were being used, a fall from height hazard had not being identified and fall arrest equipment was not being used. **Safety rules were not being followed and safe work procedures were totally inadequate.**
FATAL ACCIDENT AFTER A FALL FROM HEIGHT IN AN ORE PASS	An employee sustained fatal injuries when he fell 25 metres through a grizzly installed over an ore pass at an underground mine. The employee was not wearing any fall arrest protection attached to a suitable anchor point while attempting to cover the ore pass. **Safety rules were not being followed and safe work procedures were totally inadequate.**
FATAL ACCIDENT OCCURRED WHEN AN OPERATOR WAS STRUCK BY A MOVING TRAIN	A railway operator was involved in maintenance on a mainline track and was struck while between a track maintenance machine and a passing empty ore train. The deceased was working his first night shift of a fly-in fly-out roster and would probably been awake for nineteen hours before the accident**. According to the inspectorate contributory factors include Design, Systems and Human factors. Appropriate safe work procedures need to be developed and implemented and a review of fatigue management policies.**
FATAL ACCIDENT OCCURRED WHEN A TRADESPERSON FELL THROUGH A GRID MESH FLOOR	A tradesperson sustained fatal injuries when he fell 10 metres through an unsecured grid mesh floor. The cause was identified as the hazard of the unsecured sections had not been identified, barricaded or controlled**. Recommendation included grid mesh floors should be installed in accordance with safe work procedures based on risk assessment and manufactures recommendations. Safety rules were not being followed.**
A FATAL ACCIDENT OCCURRED WHEN AN OPERATOR WAS STRUCK WITH A ROCK DURING A SUPPORT CYCLE	During the support cycle of an high heading development an operator was moving forward to place a bolt on the boom of a jumbo when a large rock fell striking him to the ground. It was found that the operator was operating in unsupported ground. **Recommendations reiterated that all employees in these developments must stay under supported ground at all times. Safe work procedures were inadequate.**

2. Queensland	**Incident Cause**
OPAL MINER DIES FROM ENGULFMENT	A miner was removing mullock used to backfill a shaft, by hand. The weight of mullock backfilling the shaft collapsed and flowed into the workings and engulfed the miner. **Recommendations made by the Inspectorate included, proper support of the roof and sides, awareness of backfilled shafts and backfill any excavations that have been abandoned. Safe work procedures were inadequate.**
FATALITY INVOLVING A WATER TRUCK	A quarry worker received fatal injuries when the water truck he was driving left a designated roadway and went over an embankment. The worker lost control of the truck prior to it leaving the road. **Recommendations by the inspectorate included audits being undertaken by sites to ensure adequate travel way design, traffic management procedures are in place and that all equipment must be suitably maintained.**
DRILLERS FEET CRUSHED IN DRILL FOOT CLAMPS	A driller had his feet crushed when drill rig foot clamps unexpectedly closed**. Safe operating procedures were inadequate and there was an absence of a risk assessment for safe operation of the drill.**
FALLING BOREHOLE PUMP CAUSES UNCONTROLLED MOVEMENT OF CABLES AND CABLE REELS	As each rod was rotated at the collar to untwist the cables, the rod string was uncoupling at a corroded joint in the borehole**. Safe operating procedures were inadequate and again there was an absence of a risk assessment process for the operation of the life cycle of a bore hole pump installation.**
FATALITY WHEN A MINER WAS STRUCK BY ROCK DEFLECTING OUT OF STOPE	A loader operator sustained fatal injuries when struck by a rock, which deflected out of an open stope. Safe work procedures were not being followed**. Recommendations included developing a risk assessment for the review of operating procedures and standard work instructions for working near open excavations.**
SEVERE BURNS RECEIVED FROM 11KV ARC FLASH EXPLOSION	A contract electrician was severely burnt by an 11 KV arc flash explosion when recommissioning high voltage electrical equipment. **Safety rules and safe operating procedures were not being followed. Recommendations included Site Senior Executives to review contractor management and ensure that they are appropriately supervised. Risk assessments and safe work procedures to be in place before work commences.**
SERIOUS INJURY – HYDRAULIC TORQUE WRENCH	During the assembly of an excavator a fitter was struck on the head by a hydraulic torque wrench whilst it was under pressure. The torque wrench was not secured to prevent uncontrolled movement. **Safe work procedures were not being followed. Manufactures safety instructions and procedures were not available to the fitters at the time. Recommendations included a comprehensive Job Safety Analysis to be conducted prior to commencing work and personnel to be trained in equipment used**.
SEVERE BURNS RECEIVED FROM DEWATERING PUMP	While inspecting a pump an operator was sprayed with superheated water when he sustained first degree burns to his left arm and stomach**. Safe operating procedures were not being followed. Recommendations included undertaking a risk assessment to identify hazards and associated controls with pumping systems.**

3. NEW SOUTH WALES	INCIDENT CAUSE
MINER FATALLY INJURED WHEN OPERATING A MOBILE BOLTER	A miner was fatally injured when the drill head of a bolter while being retracted caught a drill steel which was placed under tension, the drill steel released striking the miner. **Inspectorate found that the cause of the incident was a failure to identify risks from poor plant design and housekeeping and lack of appropriate guarding. Safe operating procedures were inadequate.**
MINER FATALLY INJURED DURING MAINTENANCE	While replacing the shear shaft of a shearer loader at an underground mine a coupling breaks off striking the deceased on the head. **The inspectorate found that the safe work procedures were totally inadequate. The shearer isolation had been removed before maintenance work had been completed and human factors in not following procedures and risks not identified in regard to energised plant.**
FATAL INJURIES TO A SUB CONTRACTER	A subcontractor sustained fatal injuries when he was struck by recoiling polyethylene pipe. The pipe was being pulled from a horizontal borehole with chains attached to an excavator which became overloaded to the point of failure. **The Inspectorate found deficient work practices had contributed to the accident and using equipment which was not fit for purpose. Recommendations were made to ensure safe work practices and competency training on excavators.**
FATALITY INVOLVING A TRUCK DRIVER	A contractor worker received fatal injuries whilst he was driving his truck under the reject delivery bin when the chute door opened prematurely, dumping rejects onto the cabin of his truck**. The Inspectorate issued several prohibition notices and instructed the mine operator to review the effectiveness of operator protection systems. A risk assessment was to be carried out ensuring safe operating procedures for the operation of reject disposal system.**
SERIOUS INJURY DUE TO A FALL FROM HEIGHT	A maintenance worker sustains serious injuries from a fall from height when he fell through a handrail of a raised walkway whilst cleaning screens at an underground mine. The primary cause was when the maintenance worker fell against the handrail which failed under load**. Inspectorate findings include the quality of risk assessments at the mine, no safe procedure for people working alone. (It was three hours after the incident before rescue arrived) The safe work procedures were totally inadequate.**
ELECTRIC SHOCK AND BURNS INVOLVING 3.3KV	A coal preparation plant technician received an electric shock and burns when he touched a live 3.3KV electrical circuit. **The Inspectorate found the primary cause of the incident was the failure to identify potential risk to live electrical installations. Isolation procedures were inadequate, high voltage rules were not being used and no formal training had been provided to employees at the preparation plant. Safe work rules were not being followed and the safe work procedures were inadequate.**
SERIOUS INJURY WITH A BACKHOE EXCAVATOR	A mine worker sustained serious head injuries when he was struck by a log which was extracted from a log pile of felled bush timber by a backhoe excavator bucket. The cause of the incident was that the operator was in the operating zone of the backhoe whilst the machine was applying energy to lever out the log**. The Inspectorate found that the documented safe work procedures and safety rules were not being followed.**

1.7 Discussion

When one considers the fatalities and serious injuries which are still occurring in the Australian mining industry, the aims and objectives outlined in the introduction of this thesis are very appropriate. It substantiates the hypothesis that safety performance in the Australian mining industry has not improved despite all the rhetoric in the industry. An historical background to legislative development in the United Kingdom and the impact of disasters on legislation has been discussed in some detail. It has been demonstrated how these disasters were instrumental in bring about changes in safety attitudes and the progression of mine safety legislation in the UK mining industry where in 1930 a miner had a 1 in 931 chance of being killed in that year compared to a miner in 2009 having a 1 in 5000 chance of being killed in that year.

This demonstrates that the introduction of legislation and technology have played a significant role in improving safety and health in the mining industry. When evaluating the Australian mine safety performance it has been shown that the LTIFR has reduced from year to year however the 18 fatalities recorded in2008-09 is the highest number recorded in 9 years. The Australian Minerals industry recorded a FIFR of 0.05 in 2008-2009 which is below the 10 year average of 0.06. The FIFR has fluctuated widely from year to year with no consistent trend being evident. The FIFR of 0.05 is the highest recorded over the last five years. The Australian Minerals industry lost time injury frequency rate over last 10 years has decreased consistently from year to year from a LTIFR of 15 to 4. This result would suggest that there is no correlation between the FIFR and LTIFR and it substantiates the hypothesis that safety performance in the Australian mining industry has not improved despite all the rhetoric in the industry.

It has been demonstrated that the Australian safety performance compares very favourably with the USA, Canada (Ontario) and South Africa. Australia recorded a FIFR of 0.05, followed by the USA on 0.06, Canada on 0.09 and South Africa on 0.17. It is not surprising that South Africa recorded the highest FIFR when you take into consideration that its industry is dominated by its underground gold operations, which are the deepest hot humid mines in the world. The International Lost Time Injury Frequency Rate was observed to be 4 for

Canada and with the United States of America recording an equivalent of a LTIFR of 11 (Estimated). The information for South Africa was unavailable for comparison.

The analysis relating to the to the significant incidents reports derived from Western Australia, Queensland and New South Wales reports over a six year period demonstrates that people are still being killed and seriously injured on mine sites and that the causes are due to human behaviour such as not complying with rules, lack of awareness of rules and procedures, inadequate training, fatigue, lack of supervision and poor communication. These incidents were categorised into the following areas, falling from heights, release of stored energy, vehicle interaction, contact with high voltage and carrying out maintenance.

The next chapter will discuss Australian historical legislation in mines and its impact on safety performance. The safety performance of the mining industry will be compared with Australian industry. Also the safety performance of the three largest mining states in Australia, namely Western Australia, Queensland and New South Wales will be investigated. The discussion will also include the impact of Fly-in Fly-out (FIFO) /Drive-in Drive-out (DIDO) work practices and mental health issues are having on the mining industry.

CHAPTER 2

LEGISLATION AND SAFETY PERFORMANCE REVIEW IN NEW SOUTH WALES, QUEENSLAND AND WESTERN AUSTRALIA

2.1 Legislation and Safety Performance Review in New South Wales, Queensland and Western Australia

In the first chapter of this thesis it has been demonstrated how the evolution of legislation and the impact of disasters have had on the improvement of safety performance in the UK mining industry. A general review of mine safety performance in the Australian Mining Industry has been undertaken and International comparisons have been made.

A review will be made of the historical legislation in New South Wales and Queensland since it is necessary to understand the impact that legislation and the setting of rules have had on the safety performance in the mining industry. Later on in this thesis the impact of the Robens Report will also be discussed. It is also appropriate to investigate the safety performance of the mining industry compared with other Australian industry. Also this thesis will further investigate the safety performance in the big mining states in Australia namely New South Wales, Queensland and Western Australia. The latest mining disasters in New Zealand, United States of America and Australia will be analysed along with the Gretley inrush inquiry in order to learn the lessons to try and prevent similar accidents occurring in the future. This chapter will also investigate the implications of FIFO and DIDO work practices and the impacts of mental health on mine workers.

2.2 Historical Overview of New South Wales Mining Legislation

The development of legislation in the United Kingdom after catastrophic disasters which have been described in detail in Chapter One formed the basis for mine legislation in New South Wales. This legislation was prescriptive in nature, where the duty holder is told precisely what actions to take. NSW was considered a more mature mining state in the early 1900’s and closely followed UK legislation. According to (Reason 1997) “Prescriptive legislation" can be described as the exact steps to be adopted by individuals and organisations in order to comply, leaving little or no discretion for deviation. The first Act specifically involving coal mines and their registration and inspection in New South Wales was enacted in 1854. Other developments in the history of coal mining legislation include (McLaughin 1995):

- 1854: Mine plans and a requirement for the appointment of an examiner were introduced.
- 1862: In order to improve the level of safety in mines an Act was passed in response from pressure from miners and the general public.
- 1875: The New South Wales department of mines was established.
- 1876: Minor amendments were made to the Act such as appointing government coal mine inspectors to enforce the provisions of the Coal Mines Regulation Act (CMRA), and reports were filed from that time onwards.
- 1890: Four Inspectors were appointed to report on safety to the Examiner of Coal Mines.
- 1896: Major amendments were made to the legislation and a new bill was enacted after the explosion at Bulli colliery in which 81 miners lost their lives. This significant change in legislation placed the responsibility for mine safety on the colliery manager. It also provided for certificates of competency and examinations for mining statutory officials.
- 1897: The first Chief Inspector of Coal Mines was appointed to administer the CMRA and manage the operations of mines inspectors.
- 1912: A revision of the Act consisting of a consolidation of amendments that had been made since 1896 was completed.
- 1926: In response to the Mt. Mulligan disaster in 1921 in which 76 miners were killed and the 1923 Bellbird disaster in which 21 miners lost their lives the 1912 Act underwent a major revision. This involved additional regulations for ventilation, explosives, coal dust and the duties and powers of inspectors.
- 1941: Following the Royal Commission on Safety and Health the 1912 Act underwent further revision, which up graded the rules for explosives, shot-firing, ventilation and

the prohibition of naked lights in all mines. Electric safety lamps were introduced and owners were to supply personal protective equipment.

- 1966: The Act was amended following the 1965 Goran Inquiry into the Bulli disaster of that year.
- 1979: Following the 1979 Goran Inquiry into the West Wallsend No: 2 explosion the Act was amended.
- 1980: Further amendments followed the 1979 Appin explosion in which 14 miners were killed.
- 1982: A major revision occurred when drafting of a new Coal Mines Regulation Act (CMRA) took place after the Robens Report on Safety and Health at Work was published in 1972. This report influenced the NSW government to adopt a new approach to industrial safety and health. This Act required the implementation of rules and schemes, which had to be approved by an inspector of mines.
- 1999: A revision of the Regulations made under the CMRA (1982). The provisions included the development and implementation of management systems to cover some issues previously prescribed by regulations. The concept of safety management plans based on risk assessment approach was also adopted.
- 2000: This 2000 Occupational Health and Safety Act applies to all mines in New South Wales and is performance based.
- 2002: The New South Wales Coal Mine Health and Safety Act and the associated regulations go some way towards a duty of care approach at the same time specifying management arrangements and duties.

When investigating the history of NSW legislation it can be observed that many of the amendments to legislation have resulted from inquiries which were established after a disaster. The most recent disasters, their causes and their impact on legislation will be discussed later in this chapter.

The 1982 CMRA and the 2000 Occupational Health and Safety Act applies to all coal mines in New South Wales. If there is a conflict between the Occupational Health and Safety Act (OHSA) and the CMRA the OHSA will prevail. The Occupational Health and Safety Act is performance based and the Coal Mine Regulation Act is prescriptive but does contain some performance standards. The CMRA places the primary responsibility for health and safety on the mine owner and the mine manager, the OHSA places the primary responsibility on the employer.

2.3 The New South Wales Regulatory Framework in Coal Mines

In the Australian mining industry each State or Territory is regulated by specific legislation which applies to that jurisdiction. In 2012, there is still no common mining legislation, however, Commonwealth State and Territory governments are in the process of harmonising their work health and safety regulatory regimes. This subject will be discussed later in this chapter.

The regulatory frame work in New South Wales coal mines consists of Acts of Parliament, regulations that are made under the Act, Conditions of Exemptions or Approvals, Managers Rules and Schemes, Australian and International standards and codes of practice. In 1999 the Coal Mining (General, Underground and Open Cut) Regulations (NSW government 1999) established the concepts of duty of care and risk management into coal mining legislation. The revised Occupational Health and Safety Act 2000 (NSW Government, 2000) was passed. This replaced the 1983 Act and reinforced the duty of care and risk management responsibilities for coal mining employers. This was updated to the NSW Work Health and Safety Act and Regulation (NSW Government, 2011). The Coal Mine Health and Safety Act 2002 further strengthened the requirements for duty of care and risk management.

The NSW regulatory framework has recently updated the coal, metalliferous and quarrying safety legislation to a nationally consistent act and regulation, the Work Health and Safety (Mines) Act 2013 and Regulation 2014. It makes provisions for all mining in NSW and maintains the health and safety standards of the previous legislation. This legislation commenced on 1 February 2015. The enforcement principles adopted by the Department are to: • protect the safety and health of the mining workforce and those who may be affected by mining in a firm, fair and reasonable way consistent with community attitudes • co-ordinate development, review and promulgation of acceptable standards • examine that compliance with acceptable standards for the management of health and safety is accepted and the primary responsibility lies with mine operators.

2.4 Historical Overview of Coal Mine Legislation in Queensland

The historical development of legislation in Queensland closely follows the legislation which was developed in the United Kingdom and subsequently adopted by New South Wales. From 1859 until 1862 the Colonial Secretary's Office administered the mining industry. Regulations for non-competitive sale of crown lands containing coal were introduced in 1865. Until 1887 coal land was administered under the provisions of the crown lands act. The New South Wales Registration and Inspection Act 1854 was nominally in force in Queensland, and is interesting to note that the New South Wales examiner never visited the Queensland coal mines. ('Queensland State Archives : Brief Guide 13 Mining Records').

- In 1865 regulations for non-competitive sale of crown lands containing coal were introduced. The first coal mining area developed under these regulations was at Burrum River.
- In 1881 The Mines Regulation Act was introduced which provided for the supervision of coal mines and established an active Inspectorate of Mines.
- In 1886 the Employers Liability Act extended the provision of workers compensation to miners.
- In 1898 and 1968 major modifications to mining law were made when there was a shift in emphasis from the smaller miner to mining companies.
- 1925: The Coal Mine Act 1925 was enacted to consolidate and amend laws with respect to prospecting and mining for coal and the regulation of coal mines.
- 1930: The Mining Amendment Act was introduced which allowed Authorities to Prospect on Private Lands.
- The Coal Mining Safety and Health Act 1999 was enacted in response to the Moura No 2 underground coal mine disaster of the 9th August 1994 which resulted in the death of 11 miners. The government of the day committed themselves to the full implementation of the inquiry's recommendations, which was established to determine the nature and cause of the tragedy. This disaster will be discussed in some detail later on in this chapter.
- The Coal Mining Safety and Health Regulation 2001 were introduced which is necessary to translate the principles contained in the Act into practice.

The Queensland mining industry has always been subjected to a separate Occupational Health and Safety (OHS) regulatory regime, which has been enforced by an independent mines inspectorate. The Act is the principle legislation setting out the responsibility to control risks at an “acceptable level” through the measures that are put in place at each mine site. The regulations sets the performance requirements for risk control and also contains prescriptive detailed requirements for procedures, critical processes, equipment and persons, where these are necessary.

The Queensland's Mineral Resources Act 1989 is currently being reviewed to ensure that it meets the demands and challenges of the modern local mining industry. The Act is the principal piece of legislation regulating mineral exploration, extraction and processing. It recognises that the modern mining environment has a broader focus than in the past, acknowledging the rights and interests of those affected by the industry as well as economic development imperatives.

2.5 The Robens Report

The “Robens Report” had far reaching effects beyond the United Kingdom on modern occupational health and safety legislation in a number of countries in the western world, including Australia. The committee of Inquiry into the Safety and Health at Work was set up under the chairmanship of Lord Robens in 1970 to review the provision made for the safety and health of persons in the course of their employment and to consider whether any changes are needed in the scope or nature of the relevant enactments, or the nature and extent of voluntary actions and to make any recommended changes that may be required (Robens 1972). The committee’s report, which was presented to Parliament in July 1972, became widely known as the “Robens Report”. It was the first comprehensive study of occupational health and safety attempted in the United Kingdom.

According to (Smith 1997) the report found that not only was there too much law, but much of the existing law is intrinsically unsatisfactory. The legislation is badly structured, and the attempt to cover contingency after contingency has resulted in a degree of elaboration, detail and complexity that would test even the most determined reader. It is written in a language and style that renders it unintelligible to those whose actions it is intended to influence. Line managers, supervisors and shop floor operatives are not legal experts. Even the inspectorate personnel had experienced difficulty in picking their way through it all.

In essence the report concluded that Safety and Health Legislation in the UK needed a radical overhaul and that:

1. There was too much law
2. The law should be simplified
3. The balance between “prescriptive” and “goal setting” legislation needed to shift towards the latter
4. The framework law should be supported by specific Regulations, Codes of Practice and Guidance where necessary and appropriate. Voluntary Standards would form the next tier in this scheme and
5. The Inspectorate should be reformed.

One of the main conclusions from the committee was that *“The primary responsibility for doing something about present levels of health, occupational accidents and disease lies with those who create the risks and those who work with them…Our present system encourages rather too much reliance on state regulation, and rather too little on personal responsibility and voluntary, self-generating effort. This imbalance must be redressed”.*

One of the most significant benefits of the Robens Report was the creation of safety representatives and safety committees. It has been postulated by many safety professionals in the mining industry that safety representatives and safety committees are very effective in improving safety and health performance. What makes them effective according to Walters and Frick (2000) in their extensive review of such evidence note that features promoting effectiveness include:

- Opportunities to investigate and communicate with other workers
- Channels for dialogue with management on existing problems and planned changes and

- Adequate training information

Worker representatives when supported by trade unions directly or indirectly, are more likely to be able to engage meaningfully and autonomously in the dialogue with employers, which is so essential to self-regulation. It is an important requirement that workers and or their representatives, to be directly involved in the participation and consultation of safety matters. Research in Britain reviewed in (Walters 1996) indicated that the effectiveness of these safety matters in improving OHS is supported by:

- Worker organisation at the workplace that prioritises OHS and integrates it into other aspects of representation on industrial relations
- Management commitment both to better health and safety performance and participative arrangements coupled with the centrality of the provision for preventive OHS in strategies for ensuring the quality and efficiency of production
- Legislative provisions for worker representation actively supported by regulatory inspectorates
- Well-trained and informed representatives
- Support for workers' representation from trade unions outside workplaces, especially in the provision of information and training and
- Consultation between worker health and safety representatives and the constituencies they represent.

2.6 Australian Approach To Workplace Arrangements

Each Australian state has adopted the provisions of the 19th century British Health and Safety Legislation which include the Factories Act, and later the Coal Mines Act 1911. By 1970 each of the six states had an Occupational Health and Safety (OHS) statute which implemented the British model of OHS regulation (National Research Centre For OHS regulation2007).

State inspectorates with very broad powers, which essentially relied on negotiated compliance, used informal enforcement methods. This was usually in the form of persuasion, advice and education. If this approach was not successful the last resort was to use the criminal law for prosecution. The inspectors were able to command respect particularly within the coal mining industry, because they usually had similar qualifications and experience as the operating managers. The OHS inspectorates were able to enforce the legislation relatively easily because the advantage of the traditional approach was that the people operating the legislation knew exactly what was expected of them.

The traditional approach relied on a significant number of detailed technical rules, which very often were difficult to understand and the problems keeping the legislation up to date were considerable. In order to resolve problems that occurred at regular intervals, standards had to be developed on an ad hoc basis. The rigidity of the standards did not encourage employers to be innovative or to investigate more cost effective solutions. They also ignored the view that most hazards arise from the way work is carried out. There was little or no involvement in OHS from employees and unions because the traditional approach created a dependence on state regulation.

In Australia different states have adopted different approaches to workplace arrangements required for health and safety. However in relation of setting standards in all Australian states, the occupational health and safety legislation has adopted the three tiered recommendations of the Robens Report:

- Broad, overarching general duties
- Detailed provisions in the regulations and
- Codes of practice

They have all adopted a similar approach as (Johnstone 1999) has written:

'A major development in Occupational Health and Safety (OHS) regulation in Australia since the 1970s has been the move away from detailed, technical specification or prescriptive standards, to a combination of general duties, supplemented by performance standards, process-based standards and documentation requirements in regulations and codes of practice made under the OHS statutes. The general duty provisions have all been introduced to ensure that the principal parties involved in all work processes are subject to a range of

interlocking and overlapping duties requiring them to do all that is reasonably practicable to ensure that work is carried out in a way that is safe and without risks to health'.

2.7 The National Mine Safety Framework

Occupational Health and Safety (OHS) is a key issue for all Australian employers, workers and the community. A good OHS practice not only provides a safer working environment but improves worker morale and productivity. By pursuing good OHS practices businesses face fewer workplace injuries and benefit from higher employee retention rates and enhanced corporate image. This reduces the costs associated with production delays, recruiting new staff and replacing equipment, and avoids the resulting uncertainty and workload pressure placed on co-workers. Businesses that strive to improve their OHS performance create safer workplaces. This benefits not only employers and employees but also their families, their communities and the Australian economy (The National OHS Strategy 2002-2012). Priorities identified by National Strategy to achieve short and long term OHS improvements are to:

- Reduce the impact of risks at work
- Improve the capacity of business operators and workers to manage OHS effectively
- Prevent occupational disease more effectively
- Eliminate hazards at the design stage and
- Strengthen the capacity of governments to influence OHS outcomes.

The lack of uniformity in Australian legislation has been a concern for some time within the mining industry. In this regard in 2005 the Ministerial Council established a tripartite group, with representatives from industry, the workforce and State, Territory and Australian governments to guide the development and implementation of a national framework for mine safety. The National Mine Safety Framework (NMSF) was developed to deliver greater consistency in mine safety and health regulations across Australia. Most industry stakeholders agree that a consistent law across all States and Territories would be a benefit to the health and safety of all mineworkers. The following statement substantiates this proposition, which emanated from the Moura disaster of 1994.

The Moura Inquiry (Windridge et al 1996) stated:

"The Kianga Inquiry of 1975 recommended that the Queensland and New South Wales coal mining legislation should be standardised. Progress in this direction over the subsequent twenty years appears to have been glacial. Learning and applying different legislation intended to manage the same hazards must be seen as unnecessarily wasteful of the time and effort of key industry personnel.

It is, moreover, a hazard source of itself with State and Federal Mutual Recognition Acts of 1992 now overruling any requirement for a statutory official appointed from New South Wales to demonstrate knowledge of the Queensland coal mine legislation, and vice versa. There is a need for common legislation, finally, to be progressed into existence and at Federal level if that is what it takes".

The author was one of four advisors to the Warden of the Moura Inquiry.

The National Mine Safety Framework is an initiative of the Australian Ministerial Council on Minerals and Petroleum Resources and was initially developed by the Chief Inspectors of Mines, which was a sub-committee of the Ministerial Council. In the States and Northern Territory of Australia the Chief Inspectors are the most senior technical officers with Regulatory responsibility for mining operations.

Seven strategies have been developed for the framework:

- A consistent nationwide legislative framework
- A strategic approach to mine safety and health research and development
- Competency support
- Compliance support
- A consistently applied enforcement protocol
- Effective data collection and management analysis and
- Consistent approaches to consultation.

2.7.1 Current Legislative Situation

According to the NMSF the current legislative situation in Australia is that the NMSF recognises that there are different legislative arrangements for mine safety in the different jurisdictions:

- In Regulations under a general OHS Act
  (Victoria, South Australia, Tasmania and Northern Territory)
- In separate mine safety Acts and Regulations
  (Western Australia and Queensland)
- In separate mine safety Act and Regulations subordinate to a general OHS Act
  (New South Wales)

2.8 Harmonising Work Health and Safety Regulatory Regimes

Commonwealth, state and territory governments are in the process of harmonising their work health and safety (WHS) regulatory regimes. A model Work Health and Safety Bill has been developed which the majority of jurisdictions (including NSW and Queensland) are already implementing. A nationally consistent work health and safety regulatory regime for the Australian mining industry is also being developed, involving ‘core’ provisions common to all jurisdictions, and ‘non-core’ provisions that will be applicable to the mining states. According to Gunningham (2012) some doubt remains as to whether or to what extent mining specific provisions will be adopted by some jurisdictions and the decision of the incoming Queensland government in May 2012 to withdraw its support from the mine safety harmonisation initiative has added uncertainty. However codes of practice may be one area where de facto harmonisation remains possible.

The model WHS Bill involves three tiers:

1. A set of general duties of care (to do what is ‘reasonably practicable’ to ensure safety and health)
2. More detailed standards laid down in regulations and

3. Codes of practice which set out one way of achieving and demonstrating compliance with relevant provisions of the Act and regulations, but are not mandatory.

The codes of practice will provide practical and detailed guidance to duty holders, without being overly prescriptive. However it is not clear if the codes of practice will actually work as intended. According to Gunningham (2012) *stakeholders in the coal mining industry have expressed concerns regarding such matters as how codes are developed and reviewed, and their tendency to be overly prescriptive and their potential misuse by the inspectorate in terms of enforcement.*

Another example of the difficulties encountered when harmonising WHS regimes can be observed in the Queensland Government's proposal for a nationally consistent legislative framework (Queensland Government 2012).

The three options which are being considered to implement new mine legislation in Queensland are:

Option 1. Retain the current Coal Mining Safety and Health Act 1999 and Mining and Quarrying Safety and Health Act 1999 for coal and metalliferous sectors plus the provisions that improve safety and consistency.

Option 2. Have one single Act for coal and metalliferous sectors plus any NMSF provisions that improve safety and consistency.

Option 3. Develop mine safety legislation primarily based on the Model Act plus any NMSF provisions that improve safety and consistency.

The Queensland government's position is option 1 which retains the current legislation with the NMSF provisions while the Queensland Resource Council's position is for option 3, which would retain the current Coal Mining and Quarries Safety and Health Acts 1999 plus the NMSF provisions. The General Secretary of the Construction Forestry Mining and Energy Union (CFMEU) Andrew Vickers has a completely different view (Vickers 2012);

Under the guise of national harmonisation laws we have mining bosses, politicians and government bureaucrats pushing an impossible deadline for consideration of significant changes that will affect every single mineworker in Australia.

Mining bosses through their peak bodies like the Minerals Council, are pushing for greater deregulation, they want to push through a process that needs proper time to consider the complex details contained in in various reports and recommendations on occupational health and safety. They hope that by rushing through the process they will create a smokescreen to conceal their real purpose of deregulating and undermining the existing mine safety laws.

2.9 A Mining Industry Comparison of the Fatalities and Frequency Rates when compared with Australian Industry.

Despite the introduction of the Occupational Safety and Health Acts and the current harmonisation process in Australia, the number of fatalities and serious injuries in Australian Industry remains unacceptable. Figure 2.1 shows that Australian work related fatalities range from 267 in 2003-04 to 286 in 2008-09. (Information sourced from Workcover Australia 2008-09 for Figures 2.1, 2.2, 2.3 and 2.4).

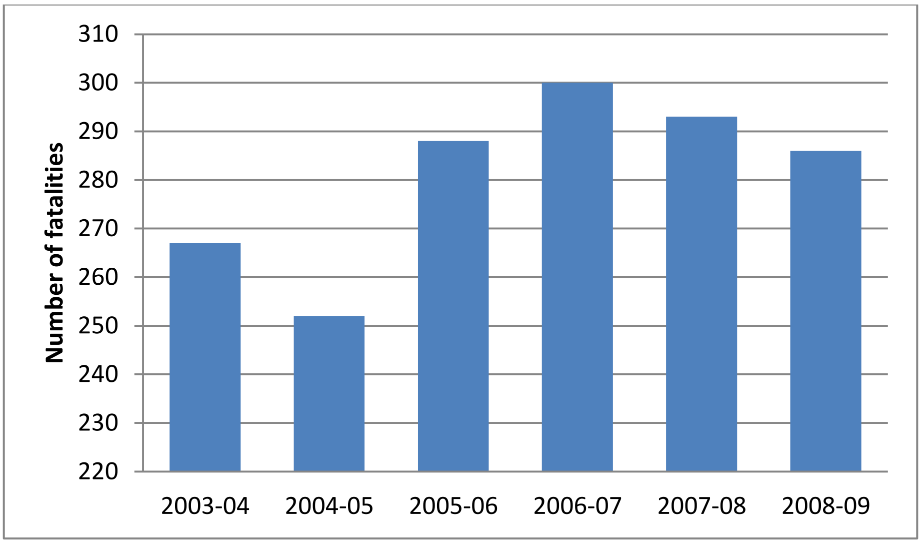


Figure 2.1 Australian Industry Work-Related Fatalities from 2003-2004 to 2008-09

It may be observed from Fig 2.2 that in 2008-09 the eighteen fatalities recorded in the mining industry compares very favourably with the 73 in Agriculture/Forestry, 66 in Transport/Postal, 45 in Construction and 26 in the Manufacturing industries.

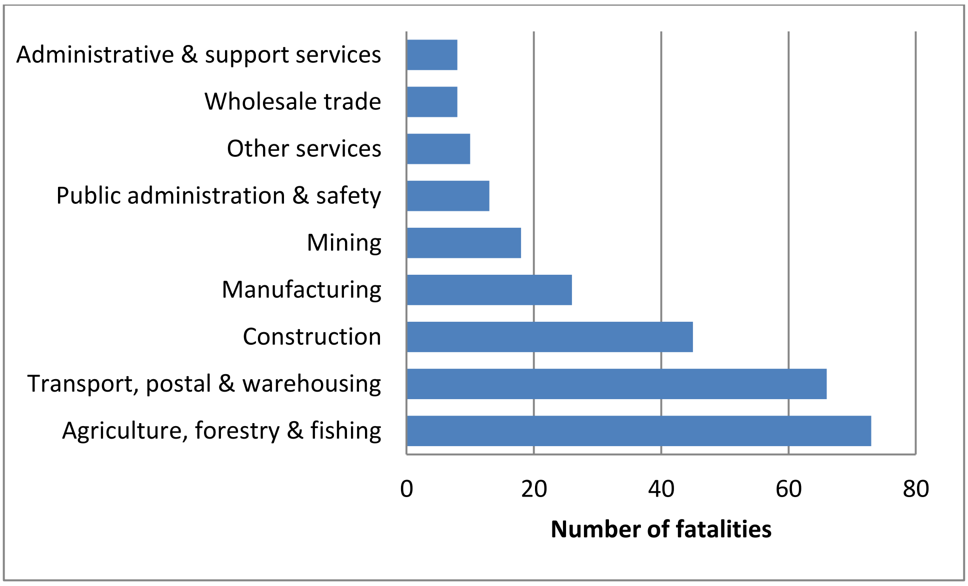


Figure 2.2 Australian Industry Working Related Fatalities 2008-09

Figure 2.3 shows that in 2008-09 45% of all fatalities were due to ‘vehicle incidents’ which were followed by 16 % of all fatalities being due to ‘being hit by moving objects’ and 12% of all fatalities were due to 'falls from height'. Over the past three years the most common causes of fatalities in the mining industry were:

- Vehicle accidents and
- Falls from height.

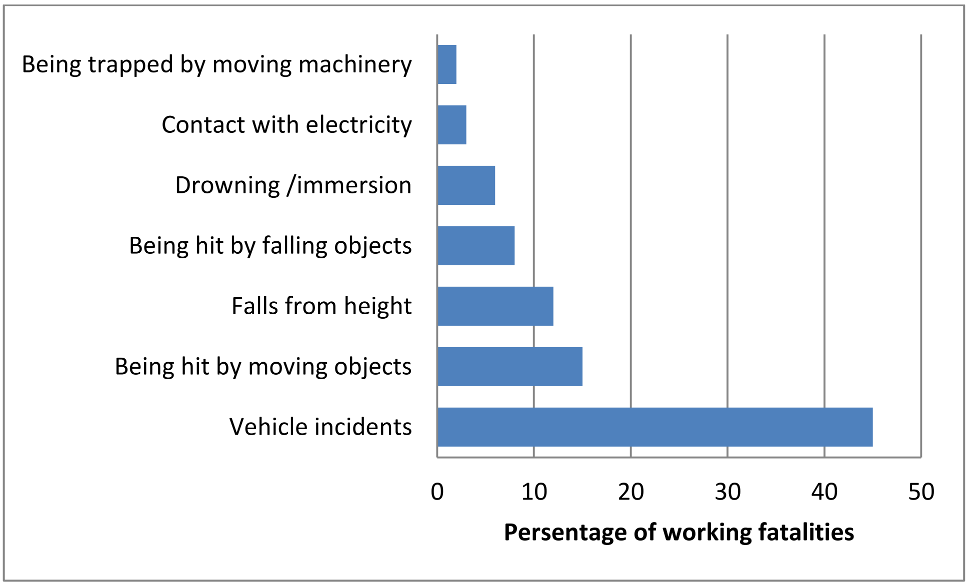


Figure 2.3 Australian Working Fatalities by Mechanism of Incident 2008-09

It can be observed from Figure 2.4 which shows the Australian frequency rate by Industry for 2008-09. The graph illustrates the fact that the Electricity & Water Supply industry recorded a frequency rate of 2.7, followed by Communications & Services on 3.5. The Mining industry recorded the third best frequency rate of 6, followed by Wholesale Trade on 7.7, Health and Community Services on 10, Construction on 10.3, Manufacturing on 11.3, Transport & Storage on 12.4 and Agriculture/Forestry & Fishing on 12.6. It can be concluded that mining industry when compared with the other labour intensive industries like Agriculture/Forestry & Fishing, compares very favourably.

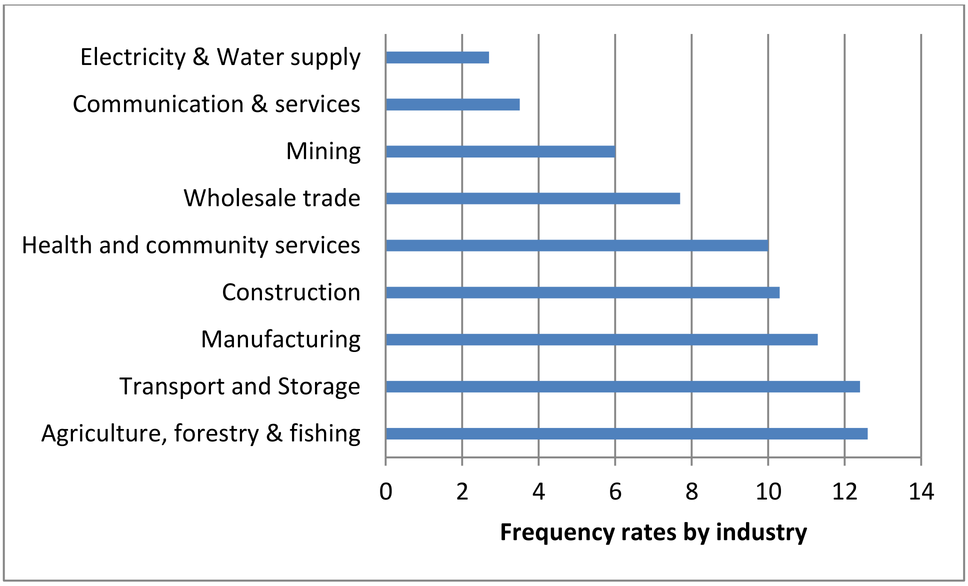


Figure 2.4 Australian Frequency Rate by Industry 2008-09

2.10 A Safety Performance Review of Queensland, New South Wales and Western Australia.

In order to further investigate safety performance in Queensland, New South Wales and Western Australia this thesis will analyse the Fatal Injury Frequency Rate, Lost Time Injury Frequency Rate, High Potential Incidents, Medical Treatment Cases, Disabling Injuries, Permanent Incapacities, Notifiable Injuries and Serious bodily injuries in order to establish safety performance trends.

2.10.1 Mine Safety Performance in Queensland Mines

It can be observed from Table 2.1 that during the six year period from 2005-06 to 2010-11 the Lost Time Injury Frequency Rate (LTIFR) is trending downwards except for 2009-10 where there was a slight increase. Over the same time period it can be observed that the number of fatalities show no improvement since the 3 fatalities recorded in 2010-11 is higher than the six year average of 2.7 with a FIFR of 0.3.

Table 2.1 Queensland Mines Lost Time Injury Frequency Rate and Number of Fatalities and FIFR from 2005-06 to 2010-11

Year	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Coal - surface	3.2	3.3	3.7	2.7	2.8	2.7
Coal - underground	12.8	13.0	8.2	7.9	6.1	3.7
Metalliferous - surface	3.2	3.0	3.0	3.1	2.9	2.3
Metalliferous – U/G	4.2	3.9	3.9	2.1	2.8	2.6
Quarries	11.0	9.6	11.3	5.6	9.7	9.0
All operations	**4.7**	**4.6**	**4.3**	**3.4**	**3.5**	**2.8**
No of Fatalities	**3**	**4**	**1**	**4**	**1**	**3**
FIFR	**0.04**	**0.05**	**0.01**	**0.05**	**0.01**	**0.03**

2.10.2 High Potential Incidents in Queensland Mines

A 'high potential incident" (HPI) at mine in Queensland is an event, or series of events, that causes or has the potential to cause a significant adverse effect on safety or health of a person. According to Queensland Mines and Quarries Safety and Health Report 2010-11 the identification of HPIs enables industry to implement proactive strategies for managing the identified risks before anyone is injured. The reporting of HPIs at mines and quarries is mandatory by legislation in Queensland and the results of these incidents can often prove costly, both in human and commercial terms. According to information sourced from the Coal Mining Safety and Health Regulation 2001 Schedule 1 and 2, Serious accidents and HPI's include the following:

- A fire
- An electric shock to a person
- An ignition of gas
- An inrush
- Spontaneous combustion
- Damage or failure of equipment used
- A ventilation failure

- An unplanned movement
- A failure of explosion protected equipment
- A coal or rock outburst
- A major failure of strata control
- A failure of electrical equipment if failure causes a hazard and
- An unplanned ignition or explosion of a blasting agent.

The most common incidents were from fires, found in engine bays, turbo's and brakes, which were often associated with bursting hydraulic hoses. Loss of control and unplanned movements were the next most common incidents followed by electrical and vehicle incidents. Many of the incidents involving mobile equipment were accidents that were due to collisions. However the accurate reporting of HPI's is still a cause for concern, according to the Queensland Mines and Quarries Safety Performance Report 2009-10: *some Site Senior Executives continue to inaccurately record and report high potential incidents. If these incidents are disregarded then the root causes are not being thoroughly identified and a continuing latent hazard exists.*

The all mines high potential incidents from 2005-06 to 2010-11 can be observed in Figure 2.5, where the number of recorded high potential injuries has increased significantly from 864 in 2005-06 to 1979 in 2010-11 which is a 129% increase.

The inspectorate has expressed concern for some time that not all high-potential incidents were being reported. If incidents are not being reported, then latent hazards are not being addressed industrywide and that is of significant concern. With mature safety systems the number of incidents will decrease, but given that many of the systems in the mining industry are not mature, it is expected that this type of incident will remain high for some time.

The ramifications of these incidents are often costly, both in human and commercial terms. It is therefore important that these data are gathered and not lost. The publication of this collective data benefits industry by raising awareness of repeat incidents at mines so that corrective action can be taken. An effective incident-reporting system is also indicative of a mature industry that treats the safety of its workers seriously.

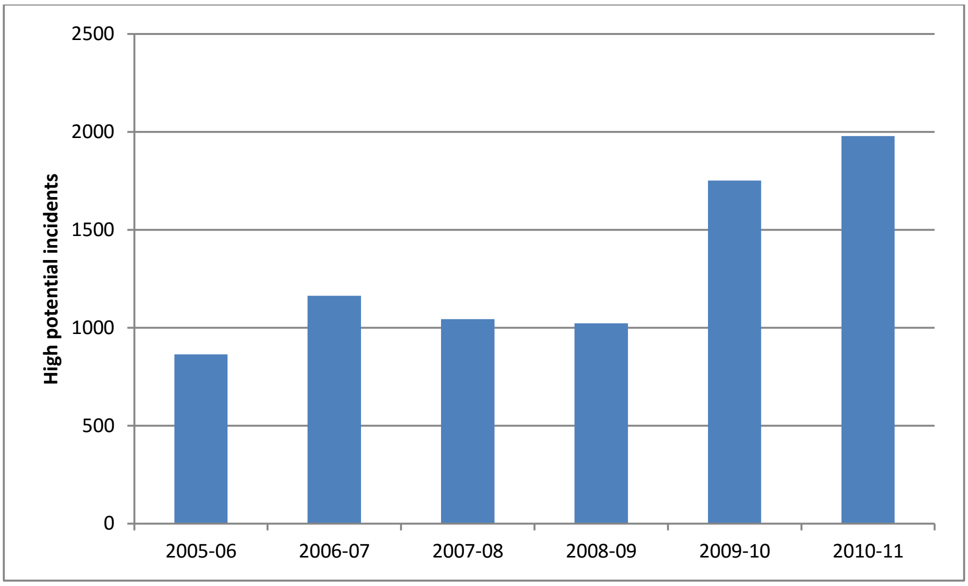


Figure 2.5 Queensland All Mines High Potential Injuries from 2005-06 to 2010-11. Sourced from the Queensland Mines and Quarries Safety and Health Reports.

It has been shown in Table 2.1 that the LTIFR has generally plateaued except for the last year being reviewed 2010-11 which has shown a slight decrease. Also the fatalities being recorded are showing no consistent trend in fact, the 3 recorded in 2010-11 are higher than the six year average of 2.7. The 129% increase in high potential injuries being recorded could suggest that the safety performance in the mining industry is not improving and therefore the potential for accidents and incidents based on this information is unacceptable to all industry stakeholders.

2.10.3 Medical Treatment and Disabling Injury Cases in Queensland Mines from 2005-06 to 2010-11

In 2003-04 the Queensland Department of Mines and Energy started to obtain medical treatment case information and disabling injury statistics Table 2.2. A Medical Treatment Case is an injury requiring treatment by a doctor, nurse or a person qualified to give first aid. A Disabling injury is a work related injury or disease resulting in a worker being unable to fully perform their regular work. (Either light duties or alternative duties are performed). It may be observed in Table 2.2 that the total medical treatment cases of 811 in 2010-11 is lower than the 6 year average of 866 and the total disabling injuries recorded in 2010-11 of 505 is higher than the 6 year average of 475. The frequency rate for both medical treatment cases and disabling injuries shows a very slight improvement from 2005-06 to 2010-11.

Table 2.2 Medical Treatment and Disabling Cases in Queensland Mines from 2005-06 to 2010-11

Medical Treatment	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Coal -surface	384	577	618	446	264	368
Coal – U/G	374	558	548	478	139	272
Metalliferous	N/A	N/A	N/A	N/A	N/A	141
Total	758	1135	1166	924	403	811
Total Employees	31,900	31,700	32,700	38,200	37,600	45,400
Frequency %	2.4	3.6	3.5	2.4	1.1	1.8
Disabling Injury						
Coal	405	441	309	329	329	423
Metalliferous	105	131	113	88	98	82
Total	510	572	422	417	427	505
Total Employees	31,900	31,700	32,700	38,200	37,600	45,400
Frequency %	1.6	1.8	1.3	1.1	1.1	1.1

2.10.4 Number of Permanent Incapacities and Employee's in Queensland Mines from 2005-06 to 20010-11

A permanent incapacity is a work related injury or disease that leads to one of the following outcomes:

- The complete loss or permanent loss of any part of the body
- Any permanent impairment of any part of the body, regardless of any pre-existing disability of that part
- Any permanent impairment of physical or mental functioning, regardless of any pre-existing impaired physical or mental functioning
- A permanent transfer to any job and
- Termination of employment.

The number of permanent incapacities from 2005-06 to 2007-08 will not be considered since it would appear that there is a problem with the reporting of the statistics, however from 2008-09 to 2010-11 the number of permanent incapacities has increased by 18 which is a 53% increase. The employment numbers over the same time period have increased by 7,200 which is a 19% increase which would suggest that there is no correlation between the permanent incapacities and employee numbers. According to the Chief Inspectors report in the 2010-11 Queensland Mines and Quarries Safety Performance Report which stated that *"we believe the increase in the number of permanent incapacities is due to better data collection by the department and improved reporting by industry".*

Table 2.3 Number of Permanent Incapacities and Employees in Queensland Mines from 2005-06 to 2010-11

	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Coal	2	3	5	31	41	50
Metalliferous	1	2	1	3	5	2
Total	3	5	6	34	46	52
Total Employees						
Coal	21,400	20,500	23,500	26,600	26,800	32,500
Metalliferous	10,500	11,200	9,200	11,600	10,800	12,900
Total	31,900	31,700	32,700	38,200	37,600	45,400

On the subject of reporting, over the last few years there has been considerable discussion regarding the limitations of traditional reporting of health and safety data which emphasises the more negative and lag time injuries such as lost time injuries. Concern has been raised about the accuracy and validity of reported data. An example of misreporting is lost time injuries being reported as disabling or medical treatment injuries. Also injuries leading to permanent disability are believed to be under reported which may in part be related to some cases not ending up as workers compensation claims. With these issues in mind a review of the Queensland Mines and Quarries Annual Safety and Health Report was commissioned. The findings of this report were published in October 2007 (Parker & Cliff 2007). A summary of these findings are:

- More than 50% of injuries that resulted in workers not being able to carry out their normal work on the next shift are not allocated in any detail. This is due to the reporting being limited to Lost Time Injury (LTI) and not including a Disabling Injury (DI) or a Return to Work I (RWI).
- There is limited analysis of the severity or duration of injuries or illnesses.
- The collection of permanent disability injuries and illnesses is not adequate. There were some instances reported where workers with permanent disabilities received redundancy or retrenchment payment rather than workers compensation.
- A number of permanent disability cases were reported as DI or Medical Treatment Injury (MTI) and as such not reported as a LTI.
- It was found that some industry personnel who fill out Department of Mineral and Energy (DME) forms are inadequately trained in understanding the definitions and terms used. The current method of reporting individual mine performance may encourage the under reporting of incidents.
- There is a perception in the industry that mines will be penalised by the DME for reporting too many incidents.
- The current practice of presenting awards to mines who have no LTIs may encourage underreporting of incidents.
- The focus on LTIs by the industry and the small number reported may also encourage underreporting.
- It was found that some contractors and sub-contractors were not reporting all accidents and incidents that they were involved in, due to safety targets being a condition of their contract. The safety performance of contractors is measured by reported injuries and high potential injuries and since contract payments are linked to safety performance, there is an incentive not to report injuries to the operator.
- The use of the tool ‘Incident Cause Analysis Method’ (ICAM) is of dubious value due to the input format of the forms, the limited training of data entry personnel in ICAM and the use by a number of companies of alternate incident investigation techniques that are not readily transportable into ICAM format.
- A concern within stakeholders is that sub-contractors and self-employed persons were not adequately monitored.

- The incomplete capture of safety data for employees not employed by the operator of the mine. A concern has been expressed over a lack of reporting of injuries for some sub-contractors and self-employed persons.
- Some persons on fixed term contracts who are injured at the time of the contract ending do not get contracts renewed, but are not counted as losing employment due to injury.

The summary of the findings of this report have demonstrated that underreporting in the mining industry is an issue which needs to be addressed. It can be observed in Table 2.3 that a spike in permanent incapacities in 2008-09 is coincident with the review carried out by Tony Parker and David Cliff. According to Andrew Vickers the District President of the Construction Forestry Mining and Energy Union made the following statement in 2006;

"the injury figures are wrong and distorted. People hurt at work were going back to light duties….management contracts were linked to performance indicators such as injury rates….there was evidence that injury rates were standing still at best but could be worse"

Another example of reporting problems in the Queensland Mining Industry according to the Ombudsmen's Report (2008) on Regulation of Mine Safety in Queensland;

"Hundreds of serious injuries are not being reported in Queensland's booming mining industry, a top level State Government review confirms ….The State Government has completed nine [unannounced mine safety audits] this year but their failure to systematically check figures provided by mining companies is criticised in the review".

The main reason for the investigation by the Ombudsman was criticism in recent years in academic forums and in the media about Queensland mine safety. This investigation considers if the Queensland Mines Inspectorate (QMI) is adequately performing its role. The investigation found that the QMI was not recording much of its informal compliance activity at mines. The report made 44 recommendations, in order to ensure that the QMI's compliance activity is supported by a robust administrative foundation. A summary of the key recommendations on compliance include:

- Implement better record keeping practices to ensure that vital safety information is not lost and that a more comprehensive picture is presented of the QMI's compliance activity
- Be given access to a broader range of compliance options
- Take greater responsibility for the investigation of incidents at mines that result or could have resulted in serious injury and
- Ensure greater consistency in the compliance actions that are undertaken by inspectors.

2.10.5 Queensland Mines Worker's Compensation Data from 06-07 to 2010-11

Workers compensation is currently paid for exposure to a number of health risks which include silica, coal dust, asbestosis, noise induced hearing loss, musculoskeletal disorders, diesel fumes, dermatitis, ergonomic back and fatigue disorders, and skin diseases. The common mining related exposure to coal and silica dust appears to be generally well controlled. According to Driscoll (2007)

"the traditional mining-related exposures of concern – silica, coal and to a lesser extent, asbestos are generally well controlled, and the resulting traditional respiratory diseases most associated with mining are almost certainly becoming far less common…. Using national compensation data for all miners in Australia, for eight years from July 2007, there was on average 2,544 claims each year by mining industry workers. Eighty three per cent of these claims were for injury. Of the remaining claims, only 10% were for disease of the nervous system and sense organs (primarily noise induced hearing loss), 2% for disease of the musculoskeletal system and 2% for disease of the digestive system".

It can be observed from Table 2.4 that the number of compensation claims in the Queensland mining industry in 2009-10 was 1347 at a total cost of $11 million. The most common being trauma to muscles and tendons, followed by trauma to joints and ligaments, contusion and bruising, lacerations or open wound and hearing loss.

Table 2.4 Queensland Mines Workers Compensation Data from 2006-07 to 2010-11

	2006-07	2007-08	2008-09	2009-10	2010-11
Coal					
Claims	802	996	1008	832	936
Cost/$million	5.6	6.6	5.7	5.1	8.3
Metalliferous					
Claims	436	603	581	453	411
Cost/$million	2.4	4.5	3.1	2.2	2.7

2.11. New South Wales Mining Safety Performance

The New South Wales Department of Primary Industries use some different quantifiable safety parameters than those used in Queensland and WA. Therefore, in order to make a fair comparison, between Queensland and WA safety performance data, statistics for Serious Bodily Injury (SBI) and Notifiable Injuries will be used. The information has been sourced from the NSW Department of Primary Industries Annual Reports from 2005-06 to 2010-11.

2.11.1 Fatalities, Lost Time Injury Frequency Rate, Serious Bodily Injuries and Notifiable Incidents in the NSW Mining Industry

The Fatalities, LTIFR, Serious Bodily Injuries and Notifiable Incidents in the NSW mining industry from 2005-06 to 1010-11 can be observed in Table 2.5, which shows that the 3 fatalities recorded in 2010-11 are higher than the 6 year average of 1.8, however the FIFR has shown an improvement from 0.04 to 0.025. Over the same time period the LTIFR has reduced from 12.4 in 2005-06 to 5.5 in 20010-11 and the SBI are also indicating a downward trend. The NSW Department of Primary Industries Annual Report stated that notifiable incidents in all mines increased from 1510 in 2006-07 to 3018 in 2010-11 which is practically a 100% increase in five years. These reportable incidents may include those described for serious bodily injuries and an event, or series of events that can cause a significant adverse effect on the safety or health of a person, which is described in item 55 and 56 of the Coal Mine Health and Safety Regulation 2006.

The New South Wales Minerals Council Safety Performance Report (2012) stated that "*while significant gains in occupational health and safety performance have been achieved, further improvements are required to meet community and industry expectations. Zero harm is not about reaching a goal, it's a journey that a company, its people and the industry are committed to*".
Despite the encouraging trend in SBI and the LTIFR in the mining industry employees, continue to sustain serious injuries at work. The number of Notifiable Incidents and the number of fatalities continues to cause concern and certainly does not meet community and industry expectations.

Table 2.5 Fatalities, Lost Time Injury Frequency Rate and Serious Bodily Injuries in NSW mines from 20005-06 to 2010-11

All Mines	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Fatalities	0	2	0	3	3	3
FIFR	0.04	0.043	0.036	0.028	0.022	0.025
LTIFR	12.4	13.2	7.3	7.6	6.9	5.5
SBI	53	59	33	43	40	37
Notifiable Injuries	567	1510	2448	2788	3009	3018

A Serious Bodily Injury is an injury to a person that causes the injured person's death, or loss of a distinct part or organ of the injured person's body, or the injured person to be absent from the person's voluntary or paid employment for more than four working days.
According to the Coal Mines (General Regulation) 1999 – Clause 85 a serious bodily injury can be described as follows:

- A fracture of the skull, jaw, spine, pelvis, arm, shoulder-blade, collar-bone, forearm, thigh, leg, knee-cap, ankle or ribs
- A dislocation of the shoulder, elbow, hip, knee, or spine
- An amputation of the hand or foot or of a substantial part of the hand or foot
- The serious impairment or loss of sight of an eye

- An internal haemorrhage receiving hospital treatment
- Burns receiving treatment from a registered medical practitioner
- An injury involving injection of hydraulic fluid and
- Asphyxia.

A major change programme is being undertaken by the NSW Department of Primary Industries to influence a change in industry in order to achieve significant improvements in OHS through a systematic performance based approach to managing risk. *"Industry has agreed that further OHS improvement will require an OHS culture change to close the apparent disconnect between OHS management systems and actual behaviour on site".*

2.12. Western Australian Mine Safety Performance

The West Australian Department of Mines and Energy again use different quantifiable safety parameters than those in Queensland and NSW. In order to make a fair comparison, between Queensland and NSW mines, the following safety indicators will be used.

- Fatalities and FIFR
- LTIFR
- Serious Injuries (SI) and
- Disabling Injuries (DI).

The information has been sourced from the West Australian Department of Mines and Petroleum Safety Reports from 2005-06 to 2009-10.

2.12.1 Fatalities, FIFR, LTIFR, Serious Injuries and Disabling Injuries In West Australian Mines from 2005-06 to 2010-11

The LTIFR and the Disabling Injury parameters in Western Australia are similar to those in Queensland and NSW, however the Serious Injury is defined as a Lost Time injury that results in the injured person being disabled for a period of two weeks or more whereas in NSW a person must only be absent from work for four days or more.

It may be observed from Table 2.6 that over the 5 year period from 2005-06 to 2009-10 the number of fatalities has varied from 2 in 2007-08 to 7 in 2007-08, however the FIFR improved from 0.044 in 05/06 to 0.024 in 09/10. Over the same period the serious injuries and disabling injuries have remained practically constant, however they are both showing a significant increase from 2008-09 to 2009-10 despite the decrease in employee numbers. According to the WA Department of Mines and Petroleum *"the statistics generated from resources safety for the year 2009-10 show a continued levelling out of injury performance indicators for the WA mining industry with a reversal of the previous year's improvements".*

Table 2.6 Fatalities and FIFR, LTIFR, Serious Injuries, Disabling Injuries and Fatalities in the West Australian Mining Industry

	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Fatalities	5	4	2	7	3	4
FIFR	0.044	0.031	0.014	0.047	0.021	0.024
LTIFR	4.1	3.7	3.2	2.8	3.1	N/A
Serious Injuries	349	348	331	316	340	N/A
Disabling Injuries	N/A	705	731	608	673	N/A
Employees	56,400	60,800	66,200	70,600	68,800	N/A

The analysis of the Queensland mining industry workers compensation has shown that the cost of workers injuries are significant. Due to the differences in reporting of workers compensation in NSW and WA it is not appropriate to make comparisons, however based on the Queensland result the cost of workers compensation in NSW and WA would be very similar, except that NSW could be higher due to the underground coal sector.

The safety performance of the three big mining States namely Queensland, NSW and Western Australia has been evaluated and a comparison of their safety performance will now be undertaken.

2.13. A Comparison of the Safety Performance in Queensland NSW and Western Australia

A detailed evaluation of the safety performance of the three large mining states is shown in Table 2.7 with particular reference to the following safety indicators:

- Fatalities
- FIFR
- LTIFR
- High Potential Injuries (HPI)
- Medical Treatment Injuries (MTI)
- Disabling Injuries (DI)
- Permanent Incapacities (PI)
- Serious Bodily Injuries (SBI)
- Notifiable Incidents (NI)
- Serious Injuries (SI)

Over the six year period from 2005-06 to 2010-11 it can be observed in Table 2.7, that 25 fatalities were recorded in WA compared to 16 in Qld and 11 in NSW, it is interesting to note that WA recorded practically the same number of fatalities as Qld and NSW combined. Queensland recorded a 13% increase compared to the six year average, NSW recorded a 40% increase and WA recorded a slight decrease of 2.5%. However when comparing 2005-06 with the six year average, the Queensland and New South Wales FIFR recorded no increase while Western Australia recorded a 25% decrease, Figure 2.7. The recorded LTIFR in all three states for the year 2010-11 is lower than the six year average.

The HPI in Qld have increased by 51% when comparing 2005-06 with the six year average while the frequency rate increased by 30%. The LTIFR has reduced by 19% and the MTI over the same time period have shown a 14% increase with a frequency rate of 9. The disabling injuries in Qld over the same time period have shown a 7% decrease with a frequency rate decrease of 19% whilst the permanent incapacities have recorded a 29% increase. The number of employees over the same time period has increased by 14%.

The LTIFR in NSW in 2005-06 of 12.4 compared to the six year average of 8.8 has decreased by 29%, the SBI over the same period have also reduced by 29%. However the notifiable injuries have increased dramatically when compared to the six year average by 292% with frequency rate of 170% and employee numbers increasing by 51%.

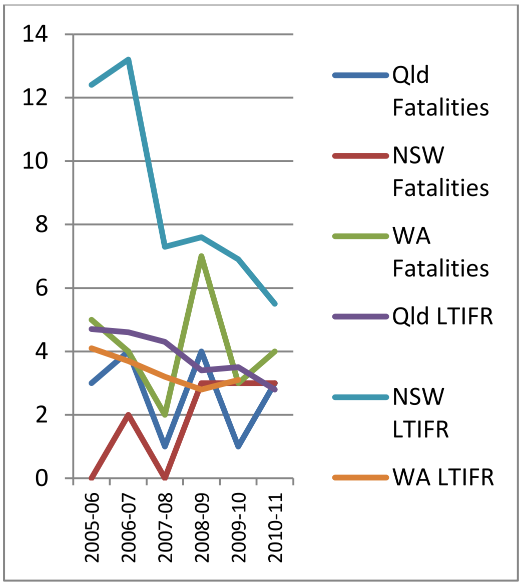
The 5 fatalities recorded in WA in 2005-05 when compared to the six year average is recording a decrease in the FIFR of 25%. The LTIFR in WA over the same time period has reduced by 17%. The serious injuries from 2005-06 when compared to the five year average show a slight decrease of 3% and the same result applies to the disabling injuries over the same time period.

The 10 fatalities in Qld, NSW and WA in 2010-11 and the increase in high potential injuries, permanent incapacities, and disabling injuries in Queensland coupled with the increase in notifiable injuries in NSW and the high fatality numbers in WA continue to cause concern to industry stakeholders. The fact that the LTIFR is decreasing and at the same time that fatalities are fluctuating demonstrate that there is no correlation between the LTIFR and Fatalities. This is illustrated in Figure 2.6 and Figure 2.7.

Table 2.7 Fatalities, FIFR, LTIFR, HPI, MTC, DI, PI, SBI, NI and SI in the Queensland, NSW and Western Australian Mines from 2005-06 to 2010-11

Queensland	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**6 Year Average**	**Total Fatalities**	**Percentage Increase + Decrease -**
Fatalities	3	4	1	4	1	3	2.6	16	
FIFR	0.04	0.05	0.01	0.05	0.01	0.03	0.04		0
LTIFR	4.7	4.6	4.3	3.4	3.5	2.8	3.8		-19
HPIs Frequency %	864 2.6	1163 3.6	1044 3.2	1022 2.7	1751 4.6	1979 4.4	1304 3.5		+51 +30
MTC Frequency %	758 2.3	1135 3.6	1166 3.6	924 2.4	403 1	811 1.8	866 2.5		+14 +9
DI Frequency %	510 1.6	572 1.8	422 1.3	417 1.1	427 1.1	505 1.1	476 1.3		-7 -19
PI	0	0	0	34	46	52	44x		+29
Employees	31900	31700	32700	38200	37600	45400	36250		
NSW									
Fatalities	0	2	0	3	3	3	1.8	11	
FIFR	0.04	0.03	0.04	0.03	0.02	0.03	0.04		0
LTIFR	12.4	13.2	7.3	7.6	6.9	5.5	8.8		-29
SBI	53	59	33	43	40	37	44		-17
NI Frequency %	567 2.4	1510 6.4	2448 7.8	2788 8.7	3009 8.6	3018 7.7	2223 6.5		+292 +170
Employees	20000	23500	33000	32000	35000	39000	30300		+292
WA									
Fatalities	5	4	2	7	3	4	4.1	25	
FIFR	0.04	0.03	0.01	0.05	0.02	0.02	0.03		-25
LTIFR	4.1	3.7	3.2	2.8	3.1	N/A	3.4		-17
SI	349	348	331	316	340	N/A	337		-3
DI	N/A	705	731	608	673	N/A	679		-4
Employees	54,400	60,800	66,200	70,600	68,800	N/A	64200		

Note the percentage increase + and decrease - is the 2005-06 result compared to the six year average. Permanent incapacities in Qld, marked x have been analyses over a three year period and the LTIFR, SI and DI results in WA have been compared to the 5 year average .



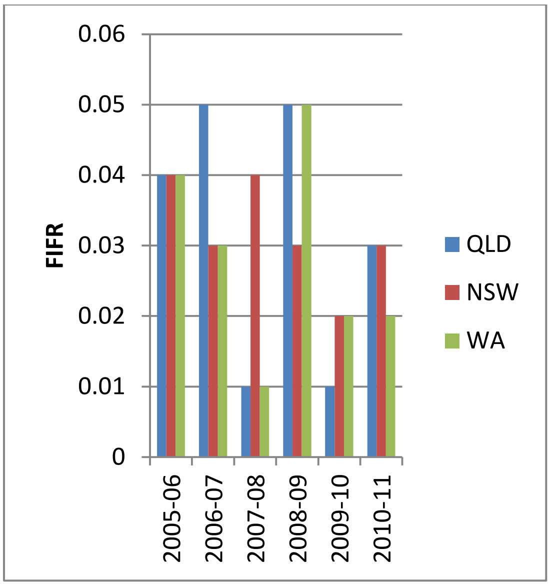


Figure 2.6 Qld, NSW and WA Fatalities and LTIFR from 2005-06 to 2010-11 and Figure 2.7 FIFR from 2005-06 to 2010-11

Having completed a comprehensive review of the safety performance in the Australian mining industry it is appropriate to examine the recent disasters in Australia, New Zealand and the United States of America in order to look for patterns and similarities that may assist in ascertaining the "lessons learned" in order to prevent these disasters occurring in the future.

2.14 The Impact of Disasters in New Zealand, Australia and the United States of America on the Mining Industry

Mining disasters in New Zealand, United States of America and Australia will be analysed along with the Gretley inrush inquiry in order to learn the lessons from these disasters and in doing so try and prevent similar accidents occurring in the future (Table 2.8). Gretley has been included because of its importance in the Australian mining industry with regard to new legislation being implemented after the judicial inquiry.

The term disaster is usually reserved for those accidents which result in five or more fatalities. They are sometimes referred to as 'high consequence/ low probability' events. There has been some debate as to whether disasters are different to ordinary accidents.

According to Seymour (2005) *"Perhaps the answer can be found by looking at the circumstances surrounding past disasters".*

Table 2.8 Analysis of Recent Disasters in Coal Mines in New Zealand (NZ), the United States of America (USA) and Australia

Year	Mine	Mineral	Cause	Fatalities
2010	Pike River, NZ	Coal	Explosion	29
2010	Upper Big Branch Mine, West Virginia, USA	Coal	Explosion	29
2006	Darby Mine No 1 Kentucky, USA	Coal	Explosion	5
2006	Sago Mine, West Virginia, USA	Coal	Explosion	12
2001	No. 5 mine, Jim Walter Resources, Alabama, USA	Coal	Explosion	13
			Total	88
	Australian Mines			
1994	Moura No. 2	Coal	Explosion	11
1986	Moura No. 4	Coal	Explosion	12
1979	Appin	Coal	Explosion	14
1975	Kianga	Coal	Explosion	13
1972	Box Flat	Coal	Explosion	17
			Total	**67**
1996	Gretley	Coal	Inrush	4

It can be observed from Table 2.8 that between 2001 and 2010, 88 fatalities have occurred in coal mines in the USA and NZ due to explosions. Also it may be observed in Table 2.8 that between 1972 and 1994 that there were 67 fatalities recorded which were due to explosions and 4 fatalities due to an inrush in Australian coal mines. Explosions are a particular risk in coal mines due to methane and other gases which are released when mining coal. A gas explosion requires the presence of two factors – an accumulation of gas which has reached explosive concentrations (5-15%) and an ignition source to set off the explosion. A gas explosion can propagate a coal dust explosion with extremely serious consequences.

Despite intense research, and a growing number of regulations, gas explosions continue to occur – the most recent disasters in NZ and the USA taking place in 2010.

2.14.1 Pike River Mine

The Pike River Mine disaster occurred in November 2010. The mine is located near Greymouth in the South Island of NZ. The underground mine lies high in the rugged Paparoa Range on the West Coast of the South Island. Access to the mine workings was through a single 2.3 kilometre long stone drift which ran upwards through complex geological faulting to intersect the Brunner coal seam. The first explosion occurred in the mine on the 19th of November when some 31 miners and contractors were present in the mine. Two miners managed to walk from the mine with moderate injuries. The remaining 29 miners, (16 miners and 13 contractors) were believed to be at least 2.3 kilometres from the mine entrance. Following a second explosion on the 24th of November the remaining 29 miners were believed dead by the police. A third explosion occurred on the 26th and a fourth explosion occurred on the 28th of November 2010 after which the mine was sealed. The Pike River Mine is the worst N Z mining disaster since 43 men died at Ralph's mine in 1914. According to the Royal Commission on the Pike River Coal Mine Tragedy which can be accessed on the following web site http://pikeriver.royalcommission.govt.nz *"New Zealand's health and safety record is inferior to that of other comparable countries. The rate of workplace fatalities is higher than in the United Kingdom, Australia and Canada, worse than the OECD average and has remained static in recent years".* A history of NZ underground coal mine tragedies is shown in Table 2.9.

Table 2.9 A History of NZ Underground Coal Mine Tragedies

Year	Mine	Fatalities
1879	Kaitangata	34
1896	Brunner (Brunner Seam)	65
1914	Huntly, Ralph's Colliery	43
1926	Dobson (Brunner Seam)	9
1939	Huntly Glen Afton No 1	11
1967	Strongman	19
2010	Pike River (Brunner Seam)	29

A royal commission was established to report on the following broad terms of reference;

- The cause of the explosion and loss of life
- Why the tragedy occurred
- The effectiveness of the search and rescue and recovery operations
- The adequacy of NZ mining law and
- How NZ law is practiced compared to other countries.

The commission found that the immediate cause of the first explosion was the ignition of a substantial volume of methane gas. A roof fall in the goaf could have expelled sufficient methane into the mine roadways to fuel a major explosion. It is not possible to be definitive, but potential ignition sources include arcing in the mine electrical system, a diesel engine overheating, contraband taken into the mine, electric motors in the non-restricted part of the mine and frictional sparking caused by work and mine activities.
The commission of inquiry determined that the company had violated fundamental safety standards and failed to take corrective action to prevent the catastrophic explosion. The following are the main contributing factors;

- A serious problem was the workers' practice of bypassing safety devices on mining machinery so work could continue regardless of the presence on methane. This was reckless unacceptable behaviour putting production before safety. There were also reports of other conduct and incidents caused by inexperience, inadequate training and failures to follow procedures. There was also a culture of production before safety which was due to the drive for coal before the mine was ready and thereby created the circumstances within which the tragedy occurred.

- The main fan was installed underground. Placing a main fan underground in a gassy coal mine was a world first. The decision was neither adequately risk assessed nor did it receive adequate board consideration. A ventilation consultant and some Pike River staff voiced opposition, but the decision was not reviewed. The commission of inquiry stated that *"Putting the fan underground was a major error"*.
- Methane management at Pike River was totally inadequate; this statement is substantiated by an email which was sent to management by a mine deputy *"History has shown us in the mining industry that methane when given the correct environment will show no mercy. It is my opinion that it is time we took our methane drainage…more seriously and redesigned our entire system"*
- Regulations require a gassy mine to have a restricted zone where all electrical equipment must be incapable of igniting methane, this was not the case at Pike River and
- There were numerous warnings of potential catastrophe at Pike River. The underground deputies and workers reported incidents of excess methane and in the last 48 days before the explosion there were 21 reports of methane levels reaching explosive volumes. These reports continued up to the very morning of the tragedy. The warnings were not heeded.

In order to reduce the risk of future tragedies the commission of inquiry made 16 principal recommendations and concluded that;

New Zealand has a poor overall health and safety record compared with other advanced countries. The lessons from previous tragedies have been forgotten; however the commission stated that *"This time the lessons must be remembered. Legislative, structural and attitudinal change is needed if future tragedies are to be avoided. Government, industry and workers need to work together. That would be the best way to show respect for the 29 men who never returned home on 19 November 2010, and for their loved ones who continue to suffer".*

2.14.2 Upper Big Branch Mine

The information for the mines in the US has been obtained from the Mine Safety Health Administration (MSHA) web site www.msha.gov/performancecoal/performance.

In April 2010 a longwall face methane ignition at the Upper Big Branch Mine (UBBM) - South in West Virginia transitioned into a small methane explosion that propagated into a massive coal dust explosion. Twenty nine miners were killed and two miners were seriously injured in the most deadly US coal disaster in nearly 40 years. It was determined by the Mines Safety & Health Administration (MSHA) Accident Investigation that methane had accumulated at the tailgate of the longwall. When the shearer cut out at the tailgate, worn shearer bits and missing water sprays created an ignition source for methane on the longwall. Evidence, indicated that the flame from the initial methane ignition then ignited a larger accumulation of methane in the tailgate area, triggering a localized explosion. Coal dust, including float coal dust, propagated the explosion throughout the northern area of the mine.

The Mines Safety & Health Administration (MSHA) Accident Investigation team determined that the explosion occurred because the coal company violated fundamental safety standards and failed to take corrective action to prevent the catastrophic explosion. The operator concealed its highly non-compliant conduct in a number of significant ways;

- The operator provided advance notice of MSHA inspections, allowing foremen to correct violations before inspectors arrived to detect them
- It concealed several occupational injuries by failing to report them to MSHA as required
- The operator recorded hazards in internal production reports rather than in the books required by MSHA standards and
- Finally, it intimidated miners into not reporting hazards to MSHA, therefore compromising the miner’s ability to participate in the identification and correction of hazards, as provided by the Mine Act.

The Federal Mine Safety and Health Act of 1977 states that mine operators, with the assistance of the mine workforce, have the primary responsibility to prevent unsafe and unhealthful conditions and practices in the nation's mines. MSHA has the responsibility to develop and promulgate mandatory safety and health standards, inspect mines to determine whether there is compliance with those standards, and investigate accidents to determine their causes. An internal review found that MHSA District 4 did not follow established policies and procedures when carrying out its responsibilities under the Mine Act at UBBM, and that they were limited by their inexperience, inadequate direction, training and supervision. The following is a list identified by the review;

- MSHA budgetary constraints beyond its control resulted in significant reductions in the inspection workforce that compromised the Agency's ability to perform its mission.
- Inspector inexperience was found to be a contributor to the Agency's ability to carry out its function according to the Mine Act
- Inspectors did not identify deficiencies in the Operator's programme for stone dusting and
- On the job training for entry-level inspectors was found to be inadequate.

2.14.3 Darby No 1 Mine

In May 2006 and explosion occurred in the sealed area of Darby No 1 Mine in Kentucky, resulting in fatal injuries to five miners and serious injuries to one miner. At the time of the explosion, six miners were underground during a non-production shift. Two miners rode a non-permissible battery-powered personnel carrier down the return airway with a set of oxygen - acetylene torches for the purpose of removing metal roof straps from the roof that intersected the No1 and No 3 seals. A methane explosion occurred behind the seals which were caused by the cutting of a metal roof strap that passed through the seal which resulted in fatal injuries to two miners and complete destruction of the seals. Four miners who were working nearby attempted to evacuate the mine when they encountered thick smoke. They donned their self-rescuers and attempted to evacuate the mine, two of the miners intermittently removed their mouth pieces in order to communicate. This resulted in one miner surviving and three died from smoke inhalation.

According to MSHA the accident occurred because;

- The operator did not observe basic mine safety practices and because critical safety standards were violated. Mine management failed to ensure that proper seal construction procedures were utilized in the building of the seals.
- Mine management also failed to ensure that safe work procedures were used while employees attempted to make corrections to an improperly constructed seal. Furthermore, mine management failed to adequately train miners in escape way routes and proper self- rescue usage.

2.14.4 Sago Mine

On the 2nd of January 2006, an explosion occurred inbye the 2 North Mains seals at Wolf Run Mining Company's Sago Mine in West Virginia. The explosion resulted in fatal injuries to 12 miners and serious injury to another miner. Sixteen additional miners who were working underground at the time of the explosion safely evacuated the mine.

It was determined by MSHA that methane had accumulated in the 2 North and 2 left mains sealed areas. Lightning had been determined to be the most likely ignition source of the methane. The ensuing explosion generated forces well in excess of 20 psi and destroyed the seals, filling parts of the mine with toxic levels of carbon monoxide. One miner died of carbon monoxide poisoning shortly after the explosion. Eleven other miners attempted to evacuate which proved unsuccessful; they had barricaded themselves in order to survive. Tragically, the barricade was not able to prevent high levels of carbon monoxide from reaching the miners before they could be rescued. As a result, 11 additional miners died and one miner survived and was rescued.

At the time of the explosion the area in the vicinity of the mine was experiencing a storm accompanied by heavy rain and lightning. Before entering the mine, some of Sago miners observed lightning strikes near mine property. The potential for electromagnetic energy created by a horizontal lightning discharge to radiate through the earth and induce a voltage in a conductor had not previously been recognised.

As a result of this incident the following actions were taken;

- Each underground exposed power conductors, telephone wires that lead underground shall be fitted with suitable lightning arrestors
- It was established that the previous use of 20 psi for explosion proof seals was found to be inadequate and needed to be re -evaluated
- Miners need to be trained in the proper use of self- contained self- rescuers and that they should only barricade themselves when all escape ways and alternate entries are blocked and
- MSHA's inspection and management controls needed to be reviewed.

2.14.5 Jim Walter Resources No 5 Mine

In September 2001, two separate explosions occurred at the Jim Walter Resources No 5 Mine in Tuscaloosa Alabama resulting in fatal injuries to thirteen miners. At the time of the explosions, thirty-two miners were underground during a non-production shift on a Sunday afternoon. Prior to the first explosion, three miners were building cribs to address deteriorating roof and rib conditions near the scoop battery charging station. A roof fall occurred at the intersection near the scoop battery charging station, releasing methane and damaging a scoop battery. A methane explosion occurred within minutes after the roof fall which was ignited by arcing of the damaged battery. Although the high-voltage electrical circuit was de-energised the track haulage block light system remained energised. The second explosion occurred when methane was most likely ignited by the block light system which then propagated into a coal dust explosion which ultimately resulted in the death of thirteen miners.

Although mine management were aware that an explosion had occurred which had resulted in damage to critical ventilation controls, they did not implement the mine evacuation plan. Had the mine evacuation plan been implemented the severity of the accident and loss of life would have been reduced or prevented. The dust samples taken after the accident revealed that most samples did not meet the regulatory requirements for incombustible content. Violations had been issued preceding the incident.

The causes of this incident are failures of management as follows;

- Failure to implement the mine evacuation system early enough and to ensure that mine practices and procedures are reviewed so that the responsibilities and responses to mining emergencies are clearly delineated so that all underground personnel should be aware and familiar with the procedures
- Failure to determine the seriousness of roof conditions
- Underground electrical configuration to be review for better isolation procedures and
- Failure to have adequate pre-shift examinations.

2.14.6 Moura No 2 Mine

In August 1994 eleven miners died at Moura No 2 mine in Queensland as a result of an underground explosion caused by spontaneous combustion. In the twenty-two years from 1972 to 1994 some fifty three miners in Queensland have lost their lives in four separate disasters due to underground explosions. Three of these disasters were at Moura with a loss of thirty six lives. It was therefore inevitable that given this loss the inquiry into the Moura No 2 disaster would be the focus of considerable public attention and concern.

On Sunday the 7th August 1994 an explosion occurred in the Moura No 2 underground coal mine. At the time there were twenty-one persons working underground ten men escaped within thirty minutes of the explosion, but eleven men failed to return to the surface. A second and more violent explosion occurred two days later, rescue and recovery attempts were abandoned and the mine sealed at the surface. The inquiry found that the first explosion originated in the 512 panel of the mine and resulted from the failure to recognise, and effectively treat, a heating in that panel. This, in turn, ignited methane gas which had accumulated within the panel after it was sealed.

Contributing causes to the first explosion were identified as a number of failures in responses, approaches or systems at the mine (Windridge et al. 1996). These were;

- *Failure to prevent the development of a heating within the 512 panel*

- *Failure to acknowledge the presence of the heating*
- *Failure to effectively communicate and capture and evaluate numerous tell-tale signs over an extended period and*
- *Failure to treat the heating or to identify the potential impact of sealing with the panel consequently passing into the explosive range due to the methane gas accumulating in the panel.*

Ultimately there was a failure to withdraw persons from the mine while the potential existed for an explosion.

The above mentioned failures can be classified as organisational failures, when analysing these failures (Hopkins 1999) summarised his findings below;

1. There was no adequate system for communication of decisions down the mine hierarchy.
2. There was no adequate system of communicating information about warning signs up the hierarchy.
3. The feedback mechanism for those people reporting warnings or hazards was non-existent.
4. The production figures were better communicated than the system for communicating safety information.
5. There was a misplaced reliance on oral communication and personal experience and a tendency to ignore written reports.
6. There was a culture of denial at the mine site.
7. There was a culture at the mine site that unless warning signs were confirmed they could be ignored.
8. When warning signs were detected no specific actions were required.
9. The company's auditing process was found to be completely inadequate and
10. No one was identified as being responsible for critical, safety-related decisions.

Good communication at any place of work depends on the transfer of information both written and oral, which was deficient at Moura No 2 mine. The transfer of information must be structured in such a way as to ensure that the appropriate message is effectively communicated and not reliant on the overlapping of a shift system, which was demonstrated at Moura where at weekends no overlap was achieved. The Moura disaster occurred because vital information was rendered ineffective, by both the inadequate information processing system and by a culture that neutralised it. Reasons theory which is very applicable to Moura stated that major accidents occur when;

"latent failures, arising mainly in the managerial and organisational spheres, combine adversely with local triggering events (weather, location etc) and with active failures of individuals at the sharp end (errors and procedural violations)" (Reason 2000).

The organisational problems discussed earlier at Moura are identified as latent failures, especially the problems with communication. In this case, the triggering event was the heating and the failure of individual managers to acknowledge that a heating might be taking place on the night of the explosion. According (Reason 1990) It is the responsibility of organisations to manage risk in what is termed organisational accidents. When investigating the events at Moura No 2 human behaviour is very much a part of the failures that have been discussed. Reason states;

"that human error can never be eradicated and that it is the responsibility of the organisation, senior managers and supervisors to put effective safety management systems, barriers and defences in place to buffer our basic and somewhat defective, cognitive behaviour."

There was no action plan and no effective system in place to effectively manage and control events at Moura No 2. The system for managing catastrophic risk was totally inadequate.

When summing up the state of affairs regarding organisational failures the Moura Report stated;

"It is the opinion of the Inquiry that events at Moura surrounding assumptions as to the state of knowledge of the night shift on the 7th August, and the safety of those at the mine, represent a passage of management neglect and non-decision which must never be repeated in the coal mining industry. Mine workers place their trust in management and have the right to expect management to take responsible decisions in respect of their safety. They also have the right to expect management to keep them informed on any matter likely to affect their safety and welfare.

It is regrettable that the air of caution, arising out of uncertainty, which was exhibited at the mine in order to bring forward the sealing of the 512 panel did not extend to the general safety and welfare of the workforce and, in particular, to informing and keeping persons out of the mine for a time subsequent to that sealing."

The Moura Wardens Inquiry report took approximately two years to complete, it made 24 recommendations, which encompass sixteen subject areas, which were aimed at preventing the occurrence of a similar incident. In order to ensure the safety of those employed in the industry the inquiry made comment on other key areas, which needed investigation. Following the release of the report the Minister for Mines made a commitment to implement all the recommendations. An implementation Committee was established to oversee the development and implementation of the recommendations. In order to review the recommendations and report back the findings the Chief Inspector of Coal Mines established five task groups.

2.14.6.1 Task Groups Review of Recommendations

1. Task Group 1 was responsible for developing guidelines for Mine Safety Management Plans and a Spontaneous Combustion Management Plan for the key risks of ventilation, spontaneous combustion, gas management, methane drainage, emergency evacuation and strata control.

2. Task Group 2 was responsible for developing guidelines for the protocols for governing withdrawal of persons, re-entry, conduct of emergency procedures and exercises, notification and approval prior to sealing a part of the mine.

3. Task Group 3 was responsible for the development of protocols for governing the training of coal mine workers in hazard awareness, spontaneous combustion, risk management, communication and emergency procedures. Refresher training was to be conducted every five years. Competency requirements for statutory functions governing refresher training would need to demonstrate their fitness to retain their certificates of competency on a regular basis.

4. Task Group 4 was responsible for the identification and selection of Self Rescuer Breathing Apparatus which would effectively address the use and alternatives to the filter type self-rescuer and guidelines for industry covering life support for escape and emergency escape facilities.

5. Task Group 5 was responsible for the identification and selection of effective inertisation systems and protocols for use in Queensland mines. The design and installation and maintenance of seals and ventilation control devices including the provision for rapid sealing of a mine when conditions warrant such action.

2.14.6.2 Inquiry Comments

The concept of 'duty of care' is sound and should be promulgated in any new legislation. It rightly puts the onus on every person in the work environment to take reasonable care to ensure their own safety and health and not to endanger the safety and health of others. Mine management has the responsibility to form rules and to ensure that they are complied with. The inquiry stipulated that any self-regulation should be established in a framework of legislation that prescribes minimum requirements in respect to safety. It also suggested that high probability, low consequence matters might be suitably addressed by self-regulation but that low probability, high consequence matters should remain subject to prescriptive legislation. The inquiry made comment regarding the need for common legislation in NSW and Queensland in order to facilitate a common level of knowledge of legislation in both states in order to ensure if nothing else a consistent approach.

The 24 recommendations have all been implemented except one, which was for the development of a mines rescue escape vehicle. This project has been the recipient of three separate Australian Coal Association Research Projects (ACARP). A prototype is currently being developed and is expected to be completed by 2016.

2.14.7 Moura No 4 Mine

Twelve miners died due to an underground explosion attributed to an ignition caused by a flame safety lamp at the Moura No 4 Mine in Queensland in July 1986. The accident happened in a panel where pillars were being extracted. The practice at Moura No 4 was to leave the extracted areas unventilated so that they built up methane levels above the explosive range.

The inquiry found that a roof fall had occurred in the goaf and that a wind blast from the fall blew a mixture of methane, air and coal dust into the working area. An explosive atmosphere developed in the working area and in particular around a deputies flame safety lamp. An ignition occurred creating a violent explosion which was caused by the velocity of air passing through the metal gauze of the deputies flame safety lamp. While controversial, the conclusion was supported by forensic evidence and resulted in the banning of flame safety lamps in Queensland. However, it is interesting to note that the Garforth GR6S flame safety lamp was still used in 2015 in the underground mines in the United Kingdom.

2.14.8 Appin Mine

Fourteen miners died as a result of a gas explosion which occurred during a pre-planned ventilation change at the Appin Mine in New South Wales (NSW) in July 1979. A rearrangement of the ventilation flow resulted in an accumulation of gas in a roadway. The ignition source was never definitively established. The ignition occurred as the auxiliary fan was being re-started. The two principle candidates was a starter for the exhaust fan motor which was found to be non-flame proof and the deputies flame safety lamp. The explosion resulted in the death of all fourteen miners working in the section.

The NSW Department of Mineral Resources said they would implement all the recommendations of the judicial inquiry. These included new regulations, improved gas management and monitoring and the employment of a ventilation officer.

2.14.9 Kianga Mine

The Kianga Mine at Moura in Queensland suffered thirteen fatalities in September 1975 following an underground explosion after an outbreak of spontaneous combustion. Indications of a fire from spontaneous combustion resulted in a decision to seal off the area involved. After the ventilation was cut off the methane content in the sealed section inevitably rose to the explosive limit of 5%. When it reached the explosive range, it was ignited by the fire and exploded. All thirteen men working on the seals were killed.

This disaster resulted in significant changes to legislation; the establishment of an autonomous safety in mines research organisation (SIMTARS); and the requirement of mines to have a means of analysing air samples.

2.14.10 Box Flat Mine

In July 1972 at Box Flat Mine near Ipswich in Queensland, seventeen miners were fatally injured when a major explosion occurred during the process of fighting an underground fire. The fire had started by spontaneous combustion in fallen coal in a cross cut between two intake airways. When first discovered, it was described as a very small fire but grew rapidly. Initial attempts to extinguish the fire with water were unsuccessful. Attempts to seal off the rapidly growing fire were also unsuccessful.

The official inquiry concluded that that explosive gases built up eventually causing an explosion, which then propagated into a larger coal dust explosion. The explosion killed fourteen men underground and three on the surface. The impact of this disaster resulted in new mine rescue protocols being introduced.

2.14.11 Gretley Mine

On the 14 November 1996 at the Newcastle Wallsend Coal Company (NWCC) Gretley mine, four men of a team of eight were in the process of developing a roadway with a continuous miner weighing between 35 and 50 tonnes which inadvertently broke through into flooded workings of an old abandoned mine and the four miners died in the inrush of water. The remaining four miners survived the disaster by being in the crib room at the time of the inrush. Several years' earlier Gretley mine management had obtained mine plans from the

Department of Mineral Resources, unfortunately those plans were incorrect, indicating that the old workings were 100metres further away than they actually were. The mine manager and the surveyor at the time assumed that the mine plans from the department were accurate. Two years later at the time of the incident the mine had a new mine manager and surveyor, both these individuals assumed that the plans were accurate, relying on the judgements of their predecessors. The faulty maps were produced by a departmental draftsman for another purpose (Hopkins 2005). Sixteen years after the Gretley mine began operations the drafting error resulted in four fatalities

Following a judicial inquiry the findings indicated "widespread and serious short comings" at every level of management at the NWCC. These included the following;

- Failure to check the accuracy of mining plans used by the company to determine the location of deserted mines in the area. The mine surveyor did not investigate the position of the old mine.
- Failure to act on the reports made by the deputy on three separate occasions on the considerable amount of water at the coalface.
- Failure by management to inform miners of the vital information on the deputy's reports and that they were working towards old workings. The miners should have been told that they were working towards an old mine filled with water.
- Failing to carry out advanced drilling or to sink bores to determine the whereabouts of the deserted Young Wallsend mine and
- Not undertaking a risk analysis even though management was aware of numerous abandoned mines in the area.

During the inquiry management admitted that if it had undertaken forward drilling or investigated the reported presence of water, the disaster would have been avoided. The findings were also critical of the Department of Mineral Resources for issuing inaccurate plans and failing to investigate the position of the old mine in question.

The Gretley judicial inquiry took nine months and made 43 recommendations which included;

- research into mine plans

- storage of records
- prevention of inrush
- mining approvals process
- colliery abandonment plans
- investigations, and
- Prosecutions.

The NSW government response to the report findings provide a clear reminder that responsibility for safety lies with industry and includes intelligent, objective planning, management and worker commitment, monitoring of safety concerns, dedicated training and regular reviews.

The presiding judge at the inquiry referred the evidence to the Crown Solicitor in order to determine if the company and managerial staff should be prosecuted under the Occupational Health and Safety Act. The subject of prosecutions from the inquiry has had a major impact on the way safety is managed throughout the mining industry and will be discussed later in this thesis.

2.15. Summary of the Lessons Learned in the New Zealand, USA and Australian Mining Disasters

It can be observed from Table 2.10 that the deficiencies which contributed to the event or its severity at the ten mines which have been reviewed are;

- Safe Work Procedures
- Compliance
- Training
- Violations
- Hazards
- Risk Assessment

The lessons learned from these disasters at all the mines being reviewed indicate that;

- safe work procedures were not being followed at all events under review
- compliance with regulations was deficient at many of the disasters
- in almost all the events, lack of adequate training was deficient
- in many of the events violations of the regulations were found to be the case
- the hazards in most of the events under review were not recognised and
- had risk assessments been carried out at all the disasters under review, they may have prevented the subsequent loss of life.

Table 2.10 Deficiencies which Contributed to the Event or its Severity

Mine	Safe Work Procedures	Compliance	Training	Violations	Hazards	Risk Assessment
Pike River	x	x	x	x	x	x
Upper Big Branch	x	x	x	x	x	x
Darby Mine No 1	x	x	x	x	x	x
Sago	x		x		x	x
Jim Walter No 5	x	x	x	x	x	x
Moura No 2	x	x	x		x	x
Moura No 4	x		x			x
Appin	x		x		x	x
Kianga	x		x		x	x
Box Flat	x					x
Greatly	x	x	x		x	x

It was established that New Zealand's health and safety record is inferior to that of other comparable countries and legislative, structural and attitudinal change is needed if future tragedies are to be avoided. The adequacy of NZ mining law and the way it is practiced compared to other countries were among the commission of inquiry findings. At the Upper Big Branch Mine an internal review found that MHSA District 4 did not follow established policies and procedures when carrying out its responsibilities under the Mine Act at UBBM, and that they were limited by their inexperience, inadequate direction, training and supervision. Also MSHA budgetary constraints beyond its control resulted in significant reductions in the inspection workforce that compromised the Agency's ability to perform its mission. On the job training for entry-level inspectors was found to be inadequate and that MSHA's inspection and management controls needed to be reviewed.

The findings regarding the Greatly mine incident were also critical of the Department of Mineral Resources for issuing inaccurate plans and failing to investigate the position of the old mine in question. The adequacy of inspections and inspectors was found to be inadequate in all above mentioned cases.

Having learned the lesson from recent disasters in NZ, USA and Australia and their impact on safety in the mining industry, it is now appropriate to analyse the impact of fly in fly out and drive in drive out work practices on the safety performance in the Australian mining industry.

2.16 Impact of Fly – In Fly Out (FIFO) / Drive - In Drive Out (DIDO) Work Practices in the Mining Industry

FIFO and DIDO workforces have been a feature of the mining industry landscape since the early 1980s. However the current resources boom, and the associated skills shortage has led to the adoption of FIFO and DIDO work practices on an unprecedented scale.

According to Story (2010) *"the concept of 'fly-in/fly-out' is a generic term to describe a variety of long distance commuting work practices whereby workers travel by air or some other mode of transport (e.g. car or bus) to and from worksites that are typically in remote areas and are often a distance from existing communities"*

Key characteristics of FIFO/ DIDO work practices include:

- Working in relatively remote locations where the resource company typically provides and funds accommodation, food and other services for workers but not their families at or near the worksite
- A work roster with a fixed number of days at the worksite followed by a fixed number of days at home
- Worker place of origin is usually a large city, coastal community or large established town
- The employer typically organises and pays for transportation to and from the worksite and
- Transport normally involves flying but may involve alternative modes of transport such as a car (drive-in drive-out) or bus (bus-in bus-out or BIBO).

(Sibbel 2010; Story 2010).

The generic term FIFO will be used to refer to this set of work practices irrespective of the mode of transport used. Thus, FIFO can be formally defined as:

"*Circumstances of work where the place of work is sufficiently isolated from the workers place of residence to make daily commute impractical*." (Watts 2004)

2.16.1 Prevalence of FIFO

As indicated earlier 'Long distance commuting' to work, is not a new phenomenon and has existed in the resources and mining sector for more than 25 years. Today FIFO has become a common work practice in regional Australia, especially for new mining and resource developments located in remote locations. This approach has been encouraged by the expansion of mining into increasingly remote areas at a time when corporate interests were focusing on "lean" and "flexible" modes of production and when governments were unwilling to support the development of new single-industry in remote areas. The Chamber of Minerals and Energy Western Australia (CMEWA) contend that *"the increase in FIFO employment in recent years has been driven by a tighter and more competitive labour market, increasing volatility in the resource sector, increased disparity between the relatively large construction workforces and smaller operational workforces in new projects, and increased dispersion of resource operations"* (CMEWA 2011).

The short-term nature of construction versus ongoing operations, the relatively short life of some new mines, the cost of building towns with a limited life and with no alternative economic supports, and the reality of workers seeking individual lifestyle choices for themselves and their families, requires that many new and expanding mines be operated by long-distance commuting workforces.

Queensland and Western Australia are the two major mining states where a substantial proportion of their operations are carried out with FIFO work practices. Recent studies have indicated that the magnitude of the FIFO workforce has become very substantial and is expected to increase further (Morris 2012). Table 2.11 provides a snapshot of FIFO growth trends in Queensland and Western Australia from 2011.

Table 2.11 FIFO growth trends in Queensland and Western Australia

Region Percentage of employees on FIFO rosters

	2011	2015
WA mining sector	**52%**	**57%**
Qld Bowen Basin mining sector	**46%**	**54%**

WA information sourced from (CMEWA 2011). Qld information sourced from (KPMG 2011).

The rapid expansion of FIFO work arrangements especially in recent years has raised many concerns particularly in mining based communities throughout Australia. As a result it has attracted considerable criticism in the media:

The Australian Medical Association says mining companies should pay more to improve the health and well-being of FIFO workers when it made its submission to the Federal inquiry into FIFO. West Australian president of AMA, Dr David Mountain, says he was amazed that the inquiry terms of reference did not cover health implications:

"*There was no mention of medical problems, medical issues or medical services, yet we know that FIFO work has major effects on health of workers themselves and also on the communities that host those workers….*

There are major issues related to their mental health and wellbeing, it's quite a stressful way of working and it's quite disruptive socially and hard for them to stay in touch with wife, family and friends…

On top of that, because there's a lot of down-time and a lot of money involved, particularly for younger workers, there's a higher incidence of the use of alcohol and drugs and a high risk sexual behaviour " McHugh (2012).

A comprehensive review of FIFO literature has been undertaken by Lenny (2010) and Watts (2004). These reviews consider the effects of FIFO work practices at two levels:

1. The individual level impact on the FIFO worker and his/her family largely in terms of health, wellbeing and relationship effects; and
2. The community level impact in terms of its social, economic and infrastructure effects and the implications for community sustainability.

The literature overview provides a dot point summary of issues raised at each level.

2.16.2 Impact on FIFO employees and their families

Amongst the adverse effects suggested in the literature are:

- Increased stress levels and poor health including depression, binge drinking, recreational drug use and obesity
- Poor quality relationships leading to increased break-ups and divorce
- Family disruption and stress
- Reduced social and community interaction by FIFO workers
- Reduced socialisation by partners and
- Feelings of loneliness and isolation.

Overseas research has supported the view that FIFO workers are more likely to experience health issues compared with daily commute employees (Morris 2012). It appears that work roster patterns and the availability of support networks for employees and their families are two key factors that play an important role in determining the extent that potentially negative effects of FIFO work practices are experienced at the worker partner and family level.

The beneficial impacts noted in the mainstream literature are:

- Improved financial circumstances from high wages and lower living costs and living away from mining based towns thereby lowering financial stress
- The availability of cheap housing for FIFO workers at worksites
- The opportunity for workers to make lifestyle choices for themselves and their families or to pursue volunteer, recreational or leisure activities and

- A heightened sense of empowerment by FIFO employee partners.

2.16.3 Impact of FIFO at Community Level

In the limited academic literature on the effects of FIFO on local communities is has been argued that from an economic perspective FIFO can be simultaneously:

- Beneficial to capital cities and large regional centres by adding to their economic diversity
- Destructive to local communities if they are unable to meet infrastructure and service demands generated by a non-resident workforce
- A problem for local communities where there has been a shift from a permanent resident workforce to a largely FIFO workforce if it reduces the economic viability of local infrastructure services and businesses and
- Erosive to communities or regions bordering 'host' or 'home' communities if workers relocate to take advantage of FIFO work arrangements.
  (Hogan and Berry 2000; Maxwell 2001; Story 2010).

In North West WA practically all the workforce come from somewhere else not like the traditional mining towns of Norwood and Emerald. They come for days, weeks, months and occasionally a few years. They often live in dongas and work camps or they inhabit sprawling towns which are growing at a rapid rate and many of those who service the towns, including doctors, live the same way. According to Swan (2012)

"the dislocations that the FIFO worker is subject to are significant, the east west time difference can cause early waking and fatigue. Diet can be very different in camps and special accommodation, 'cruise ship-style' food and grog are available in rude abundance, cheaply or free. Many FIFO workers get lonely, homesick or depressed. Some take sexual (and thus marital) risks.

One of the sadder sites is a young man sitting on a slab of beer outside the Pizza Hut talking to his toddler on his mobile phone as if he were at home and wishing he were. In the Pilbara FIFO workers lose contact with their GPs and often haven't seen one for years. Eating, *smoking and drinking they forego their health. The doctors clearly run similar risks in that there are never enough of them and the hours are long. Many are isolated so often in the Pilbara you have strangers treating strangers".*

The central Queensland town of Moranbah has been portrayed as a frontier town, inhabited by thousands of miners living in work camps; its businesses boarded up; its residents fleeing to the city, selling up and driven out by astronomical property prices. According to Smith (2012) *" the population across the region has exploded to a level that, based on natural growth, should only have occurred by 2042"*

Dr Nieuwoudt who runs the Moranbah medical clinic has rallied against the way economic forces, unleashed by this new found prosperity, are threatening local health services, not just his clinic, but the hospital, the pharmacies and even the paramedic crews. His clinic's patient numbers have risen fivefold in just four years. He realised a year ago that they were running into a crisis situation in terms of medical services. It is very difficult to attract doctors since accommodation is more expensive than capital cities. Last year Moranbah's GP workforce totalled four, equating to a patient doctor ratio of about 2750-1, when the FIFO population is included, patient ratio is 4800-1. (Smith 2012).

According to ACTU President Ged Kearney about 40% of the Australian workforce is in insecure work and this rise of insecure work in Australia over the past few decades has made employees less able to speak up for their rights and consequently made workplaces less safe. The creeping rise of insecure work is a threat to mine safety when considering labour hire, casualization and contracting out, along with FIFO and DIDO. A lasting safety culture cannot be created with a mobile, temporary workforce and it is well known that a lack of job security makes it more difficult for people to speak up for their rights, particularly about occupational health and safety. Industry studies point to a link between a lack of safety in mines and the growth of contract employees in the industry (CFMEU 2012).

Having discussed in some detail the impact of FIFO on mine workers, their families and the communities and the medical health issues, particularly those concerning mental health and wellbeing of FIFO workers, it is appropriate to investigate mental health in more detail.

2.17 Mental Health in the Minerals Industry in Australia

This thesis will examine the concepts of mental health and mental illness, and place these in context, initially within NSW and then in the mining industries in Queensland and Western Australia.

Mental health is an essential component of good health and being mentally healthy enables individuals to function well in life generally and at work. Mental illness and mental health problems can affect an individual's capacity to work productively, their physical health and their risk of injury. Poor mental health impacts on workplaces through increased absenteeism, less than optimal productivity while at work (presenteeism), and increased workplace injury. It can also have an adverse effect on work colleagues, family members and the community (University of Newcastle and Hunter Institute of Mental Health 2012).

Mental illness like many forms of illness, have a range of causes. The workplace is often the place where problems can become evident, or where the effects of a mental illness or mental health problems are first identified. Therefore the workplace presents a key setting for early detection and effective response and also for support. The nature of work practices can exacerbate symptoms or provide support to a person with a mental illness to return to full recovery. Thus the workplace has the potential to have both a positive and a negative influence on mental health and wellbeing.

Mental health is state of wellbeing in which the individual realises his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community (World Health Report (2001).

A mental illness is a clinically diagnosable medical condition which describes a range of behavioural and physiological conditions, with the most common illnesses being anxiety, mood disorders such as depression, and substance use disorders. The less common mental illnesses include schizophrenia, bipolar disorder and other psychoses and a range of other conditions such as eating disorders and severe personality disorder. While the common mental illnesses are experienced by 20% of the population in any one 12 month period, it is estimated that 2-3% are affected by the less common mental illnesses such as schizophrenia and bipolar disorder with less than 1% experiencing a psychotic illness (National Mental Health Report 2010).

2.17.1 Common Mental Illnesses in the Community

According to the National Survey of Mental Health and Wellbeing (2007), in any twelve month period 20% of Australians will have experienced a mental illness. Australians between the age of 16-85 in relation to the three most common categories of mental illness in a twelve month period, it is estimated that;

- 14% will experience an anxiety disorder
- 6% will experience a mood disorder such as depression and
- 5% will experience a substance use disorder

The risk factors for mental illness and health are compounded by living alone, lack of local networks and for men, high physical demands. Long working hours and associated fatigue have been demonstrated to be associated with increased risk of depression and anxiety (Virtanen et al 2011). The current trend of working 12 hour shifts and four and seven days on and off have also contributed to concerns about lack of social connectedness. This could (or have the potential to) contribute to a range of social and family problems and mental illnesses such as depression and substance abuse (Petkova et al 2009).

According to Petkova et al (2009) "*Communities with higher proportions of itinerant workers such as fly-in fly-out or drive-drive-out workers may have a greater risk of mental illness. In these instances, population turnover has occurred as families leave communities because of lack of non-mining employment opportunities and also where there has been a rapid increase in population (often with a greater ratio of males to females) requiring housing for singles".*

2.17.2 The Impact of Mental Illness in the NSW Mining Industry

Based on the fact that 20% of Australians experience a mental illness in a twelve month period we can assume that in the last twelve month period in the NSW mining industry with an average of 39,000 people employed in 2011, it is estimated that between 8,000 and 10,000 employees experienced a mental illness. Therefore the impact of mental health on mining is as follows;

- An estimated average of between 8,000 and 10,000 employees experienced a common mental health illness like anxiety, depression or substance abuse over a 12 month period
- It is estimated that people from across all mining employment categories are affected equally, from managers and professionals through to machinery operators and drivers
- Estimated costs to the industry including lowered productivity are between $320 million to $450 million per year (University of Newcastle and Hunter Institute of Mental Health 2012). These stated costs to industry may well be understated.

If we now extrapolate the data for NSW and compare it with Queensland and WA it may be observed in Table 2.12 that in a 12 month period an average of 9000 people in NSW suffered a mental illness at a cost of $385 million, 10,477 people in Qld suffered a mental illness at a cost of $448 million and 16,200 people in WA suffered a mental illness at a cost of $693 million.

Therefore in the three largest mining states 35,677 people suffered a mental illness in a 12 month period at a cost to the industry of $1.526 billion. Also, this means that 23% of total employees in the NSW, Qld and WA mining industries suffer from a mental illness in a 12 month period.

Table 2.12 The number of people and the cost attributable to Mental Illness in the mining industry in NSW, Qld and WA

	Number of Employees 2011	Projected Number of people with Mental Illness	Estimated Cost attributable to Mental illness $M
NSW	39,000	9,000	385
QLD	45,400	10,477	448
WA	70,000	16,200	693
Total	154,400	35,677	1,526

2.17.3 A Principles and Strategies Approach for Mental Health

The principles and strategies which are needed to drive a comprehensive integrated approach to mental health and wellbeing in the mining industry, which were outlined by the University of Newcastle and Hunter Institute of Mental Health (2012) aim to achieve the following:

- Increasing the knowledge and skills of employees in relation to mental health and wellbeing and mental illness
- Improving the attitudes of mine workers towards mental health and wellbeing and mental illness
- Endeavour to increase the number of employees who access treatment for mental health problems and mental illness
- Increase the number of employees with a mental health problem and mental illness who return to work and
- Reduce the costs associated with mental illness in the mining industry.

In the mining industry in Australia large numbers of the employees and their families are being affected by mental illnesses and it is costing the industry in terms of absenteeism, presenteeism and lost productivity. The cost to industry as indicated in Table 2.10 suggests the need for the mining industry throughout Australia to take a proactive approach to addressing mental health and wellbeing in the sector through comprehensive and integrated policy and programmes.

2.18 Discussion

An historical overview of NSW and Queensland mining legislation has been included in this chapter because it is necessary to understand the impact that this legislation has had on safety performance and the setting of rules in the mining industry.

The States have adopted different approaches to workplace health and safety arrangements; however they do all broadly follow a similar pattern and that is a move away from detailed technical specification or prescriptive standards. The new regulatory framework in NSW commenced in February 2015. The enforcement principles adopted by the Department are to protect the safety and health of the mining workforce and those who may be affected by mining in a firm, fair and reasonable way consistent with community attitudes and the promulgation of acceptable standards and compliance with those standards. The primary responsibility for health and safety lies with the mine operators.

One of the major changes of the new legislation in Queensland has been that operations must be carried out at an "acceptable level of risk" which means that management and operating systems must be put in place in order to achieve this objective. However under this system risks are kept at a level considered by experts to be 'acceptable'.

According to the Queensland Ombudsman's (2008) Report

"We were informed that in many cases, experts can differ over the level to which risk in an activity can reasonably be reduced and that, in reality, a serious injury or death can still occur in a situation where mining experts agreed the risk was at an acceptable level".

Western Australia and NSW to a lesser extent have also moved to risk based systems.

The Robens report has been discussed because of its impact on safety legislation throughout the mining industry. One of the most important benefits to emerge from the report was the creation of safety committees which have contributed to many aspects of improvements in safety performance which has had a major impact in changing the safety culture within the industry. It is interesting to note that "*at the core of the CFMEU's long running dispute with BHP Billiton-Mitsubishi Alliance in the Bowen Basin is managements insistence on appointing health and safety officers who do not represent a workforce that is increasingly contract driven" (Kearney 2012).*

The lack of uniformity in Australian legislation has been a concern for some time within the mining industry and as a consequence in 2005 the Ministerial Council established a tripartite group to guide the development and implementation of a national framework for mine safety. The National Mine Safety Framework (NMSF) was developed to deliver greater consistency in mine safety and health regulations across Australia. Most industry stakeholders agree that a consistent law across all States and Territories would be a benefit to the health and safety of all mineworkers. The NMSF recognises that there are different legislative arrangements for mine safety in the different jurisdictions in Australia and that it will take some time to achieve the goal of a consistent law across Australia; however progress is being made towards that objective. It is interesting to note a comment made by the President of Australian Institute of Mining and Metallurgy on this subject: "*Over the past few years, governments have disappointed in the promise to deliver nationally harmonised and improved safety legislation"* (Clark 2012).

The number of fatalities and serious injuries in Australian industry remains unacceptable, it has been shown in Figure 2.1 and 2.2 that Australian work related fatalities range from 267 in 2003-04 to 286 in 2008-09. In 2008-09, 18 fatalities were recorded in the mining industry which compares very favourably with the 73 in Agriculture/Forestry, 66 in Transport/Postal, 45 in Construction and 26 in the Manufacturing Industries. In 2008-09 45% of all fatalities were due to 'vehicle incidents' followed by 16% of all fatalities being due to 'being hit by moving objects' and 12% of all fatalities were due to 'falls from height'. Over the past three years the most common causes of fatalities in the mining industry were from vehicle incidents and falls from height.

It has also been shown that the mining industry compares very favourably when comparing it to the Australian frequency rate by industry. In 2008-09 the Mining Industry recorded a frequency rate of 6 compared with Wholesale Trade on 7.7, Health and Community Services on 10, Manufacturing on 11.3 and Agriculture/Forestry and Fishing on 12.6 Figure 2.4. A detailed evaluation of the safety performance of the three large mining states namely Queensland, NSW and Western Australia has been undertaken, Table 2.7, with particular reference to the following safety indicators:

- Fatalities
- FIFR
- LTIFR
- High Potential Injuries (HPI)
- Medical Treatment Injuries (MTI)
- Disabling Injuries (DI)
- Permanent Incapacities (PI)
- Serious Bodily Injuries (SBI)
- Notifiable Incidents (NI)
- Serious Injuries (SI)

Over the six year period from 2005-06 to 2010-11 it can be observed in Table 2.7, that 25 fatalities were recorded in WA compared to 16 in Qld and 11 in NSW, it is interesting to note that WA recorded practically the same number of fatalities as Qld and NSW combined. Queensland recorded a 13% increase compared to the six year average, NSW recorded a 40% increase and WA recorded a decrease of 2.5%. The recorded LTIFR in Qld and NSW is lower than the six year average and in WA it is lower than the 5year average. However when comparing 2005-06 with the six year average the Queensland and New South Wales FIFR recorded no increase while Western Australia recorded a 25% decrease. The recorded LTIFR in all three states for the year 2010-11 is lower than the six year average.

The HPI in Qld have increased by 51% when comparing 2005-06 with the six year average whilst the frequency rate increased by 30%. The LTIFR has reduced by 19% and the MTI over the same time period have shown a 14% increase with a frequency rate of 9. The disabling injuries in Qld over the same time period have shown a 7% decrease with a frequency rate decrease of 19% whilst the permanent incapacities have recorded a 29% increase. The number of employees over the same time period has increased by 14%.

The LTIFR in NSW in 2005-06 of 12.4 compared to the six year average of 8.8 has decreased by 29%, the SBI over the same period has also reduced by 29%. However the notifiable injuries have increased dramatically when compared to the six year average by 292% with frequency rate of 170% and employee numbers increasing by 51%.

The 5 fatalities recorded in WA in 2005-05 when compared to the six year average is recording a decrease in the FIFR of 25%. The LTIFR in WA over the same time period has reduced by 17%. The serious injuries from 2005-06 when compared to the five year average show a slight decrease of 3% and the same result applies to the disabling injuries over the same time period.

The 10 fatalities in Qld, NSW and WA in 2010-11 and the increase in high potential injuries, permanent incapacities, and disabling injuries in Queensland coupled with the increase in notifiable injuries in NSW and the high fatality numbers in WA continue to cause concern to industry stakeholders. The fact that the LTIFR is decreasing and at the same time that fatalities are fluctuating demonstrate that there is no correlation between the LTIFR and Fatalities.

The data for workers compensation in the Australian mining industry for 2008-09 was 2% of all serious claims across all industries in Australia. This equated to 14.7 serious claims per 1000 employees which is 13% higher than the national rate of 13 serious claims per 1000 employees because the employees in the mining industry work much longer hours than average hours in Australian industries.

The median serious injury claims over the six years from 2003-04 to 2008-09 is 2518 and at approximately average cost per claim of $12,000 would equate to a cost to the industry of over $30m per year. Over 78% of serious claims were the result of sprains and strains of joints followed by fractures and crushing injuries and the most common diseases arose from deafness which caused 11% of all serious claims. Information is sourced from Safe Work Australia (2011). It has been estimated that the real cost of these work related injuries and illnesses is many times greater than these amounts. The additional costs would be mainly due to lost production time and equipment damage.

The 10 fatalities in Qld, NSW and WA in 2010-11 and the increase in high potential injuries, permanent incapacities, and disabling injuries in Queensland coupled with the increase in notifiable injuries in NSW and the high fatality numbers in WA continue to cause concern to industry stakeholders and suggest that overall safety performance is not improving, which supports my hypothesis that safety is not improving in the mining industry.

The recent mining disasters in New Zealand, United States of America and Australia have been analysed along with the Gretley inrush in order to investigate the circumstances surrounding past disasters so that the 'lessons learned' can be implemented in order to try and prevent similar occurrences from occurring in the future. The deficiencies which contributed to the event or its severity at the eleven mines which have been reviewed were;

- Safe Work Procedures
- Compliance
- Training
- Violations
- Hazards
- Risk Assessment

The lessons learned from these disasters at the eleven mines being reviewed indicate that;

- safe work procedures were not being followed at all events under review
- compliance with regulations was deficient at many of the disasters and in one case the regulations need a complete review.
- in almost all the events, lack of adequate training was evident
- in many of the events violations of the regulations was found to be the case
- the hazards in most of the events under review were not recognised and
- had risk assessments being carried out at all the disasters under review it may have prevented the subsequent loss of life.

Today FIFO has become a common work practice in regional Australia, especially for new mining and resource developments located in in remote locations. Queensland and Western Australia are the two major mining states where a substantial proportion of their operations are carried out with FIFO work practices. Recent studies have indicated that the magnitude of the FIFO workforce has become very substantial and is expected to increase further (Morris 2012).

The rapid expansion of FIFO work arrangements especially in recent years has raised many concerns particularly in mining based communities throughout Australia. Amongst the adverse effects suggested in the literature are:

- Increased stress levels and poor health including depression, binge drinking, recreational drug use and obesity
- Poor quality relationships leading to increased break-ups and divorce
- Family disruption and stress
- Reduced social and community interaction by FIFO workers
- Reduced socialisation by partners and
- Feelings of loneliness and isolation.

Overseas research has supported the view that FIFO workers are more likely to experience health issues compared with daily commute employees (Morris 2012). It appears that that work roster patterns and the availability of support networks for employees and their families are two key factors that play an important role in determining the extent that potentially negative effects of FIFO work practices are experienced at the worker partner and family level. According to Cleary (2011) FIFO workers maximise mine efficiency, at a cost to the community. They live in Dongas which is defined as a "makeshift shelter" (or a portable aluminium shed) which is used to house thousands of miners who live in sprawling work camps near mines. The biggest concentration of work camps is in Karratha, which has 11,000 Dongas and the Bowen Basin where a clutch of coal centres have work camps with 6000 Dongas. In many instances each donga means two workers because of rotating 12 hour shifts. FIFO has serious implications for regional development, as towns near the mines now only gain a small fraction of the income generated. The regions are left with the harmful effects of mine production while getting little of the mining multiplayer effect along the way and the extra traffic generated by the DIDO workers along with the freight being moved into mining regions is making road networks crowded and therefore more dangerous. However on the positive side, the beneficial impacts noted in the academic mainstream literature on FIFO are:

- Improved financial circumstances from high wages and lower living costs and living away from mining based towns thereby lowering financial stress
- The availability of cheap housing for FIFO workers at worksites
- The opportunity for workers to make lifestyle choices for themselves and their families or to pursue volunteer, recreational or leisure activities and
- A heightened sense of empowerment by FIFO employee partners.

This thesis has demonstrated that mental illnesses are common in the community and in workplaces throughout the mining industry in Australia, affecting a significant proportion of mine employees and contractors in all employment categories. It has been further demonstrated that the impact of mental illness in the workplace results in significant costs which are related to productivity, absenteeism, presenteeism as well as costs to individuals, their families and their colleagues. The risk factors for mental illness and health are compounded by living alone, lack of local networks and for men, high physical demands. Long working hours and associated fatigue have been shown to be associated with increased risk of depression and anxiety.

It may be observed in Table 2.12 that 35,677 people suffered a mental illness in a 12 month period at a cost to the industry of $1.526 Billion. Assuming the growth trends in Table 2.11 then in the 12 month period in 2015:

- 9000 people in NSW will suffer a mental illness at a cost of $385 million
- 11,315 people in Qld will suffer a mental illness at a cost of $484 million and
- 17,010 people in WA will suffer a mental illness at a cost of $728 million.

This means that a total of 37,325 people will suffer a mental illness in a 12 month period at a cost to industry of $1.596 Billion.

Therefore it makes good business sense to adopt a holistic approach to mental health and wellbeing and mental illness in the industry. Despite the treatment of common mental illnesses being effective, only a small percentage of people with one of the common mental illnesses seek treatment. The barriers to treatment in the community and in workplaces relate to availability of appropriate assessment and treatment facilities (GP's, psychologists and mental health services) and the lack of knowledge about mental health, mental illness, symptoms, treatment and stigma. *"In workplaces and in particular in blue collar workplaces, the macho culture demonstrated by the 'we're tough' attitude is a significant impediment to addressing mental health and well-being and mental illness".* NSW Mineral Council (2012).

When addressing mental illnesses in the workplace, it requires multiple strategies that target individuals and the workplace systems, policies and structures. It requires a strong commitment from industry to take action in order to strategically address mental health and well-being and mental illness which is supported by a range of policies and programmes. It would seem that NSW is demonstrating a leading approach regarding mental health and well-being and mental illness by adopting a roadmap approach to this important topic.

The next chapter will discuss the mine safety environment.

CHAPTER 3

3. THE MINE SAFETY ENVIRONMENT

3.1 The Mine Safety Environment

When examining the mining safety environment it is necessary to understand the Occupational Health and Safety Culture on mine sites. Some examples of catastrophic accidents will be discussed which involve the culture of the organisation and the lessons that can be learned. Some examples of mine site culture will also be discussed. It is very important to understand the attitudes of mine workers regarding their behaviour towards their safety at work. Human error will also be discussed in some detail and its effects regarding the safety behaviour of workers. This chapter will also examine and give positive and negative examples of the Safety Management Systems and Risk Management Systems with regard to safety improvement in the mining industry.

3.2 Safety Culture

Two different regulatory systems in Chapter 2 have been discussed which incorporate both prescriptive and performance based or enabling legislation. It could be argued that regardless of the system adopted in the Australian mining industry the number of fatalities and serious injuries is still unsatisfactory. Safety improvement has plateaued and may be deteriorating. Fatigue and awareness issues are having a major impact on safety at work, which is particularly evident when people are working 12 hour shifts and associated rosters. The industry has agreed that if safety performance is going to improve it needs to change the safety culture of the industry and implement programmes that achieve the objective of changing the attitudes and behaviour of the workforce on mine sites.

Culture may be defined as *“the collection of beliefs, norms, attitudes, roles and practices shared within a given social grouping or population*” (Pidgin 1991). The beliefs and values of an organisation can be defined as organisational culture.

Safety “culture” can be thought of as a sub set of organisational culture, where the beliefs and values specifically refer to matters of health and safety (Clarke 1999).

Reason 2000 stated that a workable definition of Culture was:
Shared values (what is important) and beliefs (how things work) that interact with an organisation’s structure and control systems to produce behavioural norms (the way we do things round here).
According to Reason a safe culture is:

- *An informed culture*
- *An informed culture is one that knows where the “edge” is without having to fall over it first.*
- *An informed culture is preoccupied with the possibility of failure and works continuously to become resilient to operational hazards.*

He says a safe culture must also be just. People must know that they can admit honest mistakes without the least fear of punishment. At the same time, there must be clear procedures for dealing with flagrant breaches of guidelines. It is a difficult balance that can only be achieved if there is an agreed line between acceptable and the unacceptable.

The other source of safety is the proactive process of identifying conditions most in need of correction leading to steady gains in a company’s resistance to danger. Reason likens it to a long term fitness programme where the correction programmes focus on the most common causes of failure, such as hardware, design, maintenance management, procedures, error reinforcing conditions, housekeeping, incompatible goals, communications, organisation, training and defences.

A prerequisite for a just culture is that all members of an organization should understand where the line must be drawn between unacceptable behaviour, deserving of disciplinary action, and the remainder, where punishment is neither appropriate nor helpful in furthering the cause of safety. This is no easy task and continues to challenge the criminal justice systems of the civilized world (Reason 1998).

The safety culture of an organisation is the product of individual and group values, attitudes, competences and patterns of behaviour that determine the commitment to, and style and proficiency of, an organisations health and safety programmes. Organisations with a positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety and the confidence in the efficacy of preventative measures. A poor safety culture has been found to be a key determinant underlying accidents (Hidden 1989).

In order to achieve a safe, healthy and productive workplace, occupational heath and safety must be integrated in all aspects of mine site activities ensuring no one is harmed through the involvement of all employees. In order to achieve an injury free workforce all employees including contractors must be encouraged to think about their own individual safety at work and what they can do to ensure that all their operational activities are carried out safely. A safe workplace is usually the most productive. Occupational health and safety must be built into the role of every employee and the day to day activities. In same context The Advisory Committee of the Safety of Nuclear Installations Study group in Britain (1999) proposed:

"The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health safety and management."

This statement is very true, not only in the mining industry, but it equally applies to all other industries.

The differences between individual accidents and organisational accidents may be observed in Figure 3.1 (Reason 1997).

Table 3.1 The Differences Between Individual and Organisational Accidents

Individual Accidents	Organisational Accidents
Frequent	Rare
Limited consequences	Widespread consequences
Fewer or no defences	Many
Limited causes	Multiple causes
Slips, trips and lapses	Product or new technology
Short 'history'	Long 'history'

Having made reference in regard to safety culture and the differences between individual and organisational accidents it is appropriate to analyse five significant incidents where safety culture was highlighted as a major problem.

According to an article in the New Scientist regarding the Space Shuttle Columbia in September 2010, which stated that the "culture" at NASA was to blame for the accident.

3.2.1 Space Shuttle Columbia

When the space shuttle Columbia disintregrated on re-entering the Earth's atmosphere on February 2003, the immediate cause of the incident soon became clear. A piece of foam had come off during launch and cracked the wing, allowing hot gases to distroy the structure. However there was another more insidious factor that was overlooked.

Prior to launching, NASA engineers had spotted the impact of this problem and dismissed the risk that it posed. The accident team found that the engineers had consistently taken into account all the indicators that the foam did not pose a risk and then went on to ignore that it did. This was a classic example of a phenomenon psychologists call groupthink. They conclude that the safety "culture" at NASA that had allowed this accident to happen was as much to blame for the accident as the foam. According to (Melis 2012*) "the key lesson to* *come out of Columbia was that her crew were lost to a design flaw that was embeded in the vehicle in the late 1970's and it flew for nearly 25 years before it stung us".*

3.2.2. Piper Alpha

On July 6th 1988 the Piper Alpha platform in the North Sea exploded killing 167 men with only 61 survivours. The platform was operated by Occidental Petrolium (Caledonia) Ltd.The platform began production in 1976 first as an oil platform and then later changed to gas production. Total insured loss was approximately US$3.4 billion. At the time of the disaster, the platform accounted for approximately ten percent of North Sea oil and gas production, and was the worst offshore oil disaster in terms of lives lost and industry impact.

An investigation revealed serious deficiencies in the organisational structure at Occidental Petroleum. The accident occurred after workers inserted a metal disc into a pipe in place of a faulty safety valve. Workers on the next shift pumped gas into the pipe not realising that the valve was absent. The disc failed, causing an explosive leak. The lack of proper communication channels between workers on different shifts was indicative of a much broader problem. Other organisational problems also contributed. For example, two nearby platforms continued to pump gas to Piper Alpha, even after their crews saw the explosion, believing they did not have the authority to turn off the supply.

3.2.3. Deepwater Horizon

On the 20th April 2010 the Deepwater Horizon offshore oil drilling rig was drilling at the Macondo Prospect when an explosion occurred on the rig caused by a blowout killing 11 crewmen and ignited a fireball visible from 56 kilometers away. The resulting fire could not be extinguished and on 22 April 2010 , Deepwater Horizon sank, leaving the well gushing at the seabed and causing the largest offshore oil spil in U.S. history. Deepwater Horizon was a ultra-deepwater offshore drilling rig owned by Transocean and was leased to BP from 2001 to 2013. In September 2009, the rig drilled the deepest oil well in history at a vertical depth of 10,683m. At the time of the accident Deepwater was drilling about 66 kilometers off the south east coast of Louisiana, at a water depth of of approximately 1500m.

In September 2010 BP published its own investigation into the Deep Horizon blow-out. It concluded that the failure of eight technical systems designed either to prevent this kind of disaster or mitigate its effects were to blame. The report makes no mention of how the company manages safety and whether this may have contributed to the accident.

This has surprised safety experts. According to (Hollnagel 2010)

"The fact that BP has failed to identify its organisational structures as a factor in the accident is itself an indication of a problem with its safety "culture"

In 2005 an explosion at BP's oil refinery in Texas City killed 15 people and injured 170 others. A review panel later highlighted numerous problems with the company's safety culture (Mullins 2012).

3.2.4. King's Cross Underground Fire

Shortly after evening rush hour on 18 November 1987 a fire of catastrophic proportions in the King's Cross underground station claimed the lives of 31 people and injured many more. It is clear from the evidence that people continued to smoke in the underground in spite of a ban in February 1985 following a fire at Oxford Circus station. They lighted up on the escalator as they prepared to leave the station. There had been 46 escalator fires between 1956 and 1988 and in 32 instances the cause was attributed to smoker's materials. Gaps were observed between the treads and the skirting boards on escalator 4 at Kings Cross. They were caused by the crabbing movement of the escalator, thus there were gaps which a lighted match could pass through. Over 30% of the cleats were missing making the path for a lighted match much easier.

The running tracks should have been cleaned and lubricated. They were not. There was an accumulation of grease, dust, fibre and debris on the tracts which constituted an ideal opportunity for fire to flourish (Railway Archives 2005).

According to (Fennell 1998) the London Underground was struggling to shake off the rather blinkered approach which had characterised its earlier history and was in the middle of what the Chairman and Managing Director described as a change of “culture”. Management remained of the view that fires remained inevitable on the oldest and most extensive underground system in the world.” *In my view they were fundamentally in error in their approach”.*

3.2.5 The 1986 Chernobyl Accident

According to the “(United Nations Scientific Committee on the Effects of Atomic Radiation 2000)” an accident occurred at the Chernobyl nuclear reactor in April 1986 which was the most serious accident ever to occur in the nuclear power industry. The reactor was destroyed in the accident and considerable amounts of radio active material were released to the environment. The accident caused the deaths of 30 workers and radiation injuries to over 100 others. The authorities evacuated about 115,000 people from areas surrounding the reactor. Subsiquently about 220,000 people were relocated from Belarus, the Russian Federation and Ukraine.

The accident caused serious social and psychological disruption in the lives of those affected and vast economic losses over the entire region. Large areas of the three countries were contaminated with radioactive materials, and radionuclides from the Chernobyl release and were measurable in all countries of the northern hemisphere.

The Chernobyl reactor accident happened during an experimental test of the control system as the reactor was being shut down for routine maintenance. The operators, in violation of safety regulations, had switched off important control systems and allowed the reactor, which had design flaws, to reach unstable, low power conditions. A sudden power surge caused a steam explosion that ruptured the reactor vessel, allowing further violent fuel-steam interactions that destroyed the reactor and severely damaged the reactor building. An intense graphite fire burned for 10 days which allowed large releases of radioactive materials.

The International Atomic Energy Agency in 1986 noted a “Poor Safety Culture” as a factor in the accident.

An example of an excellent safety culture was developed by the Shell International Brent Delta Redevelopment Programme which stated that;

- People took responsibility for their own and other colleagues’ safety
- People were individuals, not statistics
- Dialogue was open and honest
- People listened to each other
- Rule breaking was not supported
- Everyone was involved in the management of safety
- The workforce felt secure in the knowledge that their safety was put at the top of managements priorities.

3.3. Mine Site Safety Culture

One of the leading examples of a mine site safety culture would be that of Callide Mine in Central Queensland which addopted the safety culture of Shell International. This mine set the standard with regards to changing the culture of the workforce by focusing on a “no blame” culture and adopting a team approach to all aspects of minesite operations. In the late eighties Callide Mine worked 12 months without incurring a single lost time injury and according to the Queensland Department of Resource Industries, this set a national record for any large operating mine in Australia (Parkin 1991). Callide Mine had set the LTIFR safety standard in the coal mining industry and was awarded the Shell Australia Chairman’s Safety Award in 1991 and the Mineral Council of Australia’s MINEX Highly Commended Award in 1997. The author was the mine manager at Callide mine at the time the awards were presented.

The mine adopted the Shell framework for management of safety and health. This framework is Shell’s Principles of Enhanced Management Programme, which is now encapsulated in the Health Safety and Environment Management System of the Royal Dutch Shell Group of Companies, 1985.

The Health Safety and Environment Management System requires all parts of the business to adopt a structured and disciplined approach to the management of occupational health, safety and environment with particular emphasis on risk management and hazard identification. The Health Safety and Environmental Management System elements are:

- Leadership and Commitment;
- Policy and Strategic Objectives;
- Organisation, Responsibilities, Resources, Standards and Documents;
- Hazards and Effects Management Process;
- Short Term Planning;
- Policies and Procedures;
- Communication and Implementation;Monitoring and Corrective Action;
- Audit and
- Review

The abovementioned elements were developed as a result of major significant incidents such as the Piper Alpha oil rig explosion in 1988 and the Exxon Valdez oil spill in 1989, which led to an increased awareness by industry and authorities that better and more effective management systems should be put in place to avoid major catastrophic accidents. In 1990 the Cullen Inquiry Report into the Piper Alpha accident recommended the development of integrated safety management systems and safety cases based on a full safety assessment of each major risk. The Shell Group of Companies were one of the first to address these issues.

"This system is essential to address the key Health Safety and Environment (HSE) concerns – such as the high level of fatalities, deficiencies in asset integrity, substantial losses and unnecessary exposure and risk. A HSE Management System, and especially HSE cases for critical activities, establishes appropriate controls for HSE hazards, including the essential HSE competencies for responsible staff and contractors. The result will be that every person is accountable for agreed standards and procedures in their area of responsibility. Our policy guidelines require HSE Management Systems in every operating company" (Jennings 1995)

According to Santo (2000), who had conducted a report on safety culture at Callide Coalfields, a positive safety culture required the following focus:

- Higher management commitment to safety
- Open communication channels
- A stable, experienced workforce
- High quality housekeeping
- A safety emphasis in training
- Full-time safety personnel reporting to top management

The Callide safety culture is assisted by the fact that the mine is located in a small rural farming town called Biloela, which is in the heart of a rich mining and agricultural region and the workforce is stable. The economy is driven by pastoral agricultural enterprises, and by the coalmines, but is not considered a "mining town" The town population is fixed rather than being transient.

The safety culture at Callide Coalfields is driven by four major components;

1. Visible management commitment
2. Involvement of the Workforce
3. Communication and
4. Housekeeping

3.3.1. Visible Management Commitment

The actions and attitudes of management is one of the most important factors in influencing the safety culture of any organisation. Management commitment is expressed through a formal policy statement and includes management's attitudes and observed actions. This policy must be communicated through to the workforce so that everyone in the organisation must own this policy.

For any successful attempt at improving safety in any organisation management attitudes and conduct (by setting the example) are the most important. Since the late 1980's all

serious incidents or potentially serious incidents have been treated as a major event and operations have ceased whilst corrective action has been taken and a detailed incident investigation has been carried out.

The strong demonstration of the importance of safety management to the company has been shown by the general manager stopping all operations and conducted employee briefings when significant safety issues and incidents have occurred. The Shell Board of Australia would summon Managers to the Board meetings in Melbourne in order to discuss serious and potentially serious incidents and the actions that need to be taken in order to prevent a recurrence.

Injury and rehabilitation employee schemes are now common place in the industry, however these schemes have been available to Callide Coalfields employees since the late 1980s. The perceptions of senior manager's actions are influential in the development of a positive safety culture Leeming (1997) states,

"That the major influences to the safety culture at any location are the attitudes and behaviour of management. The perceived attitudes and behaviour are more important than the actual attitudes and behaviour".

A positive safety culture at Callide Coalfields can best be described as a way of doing business, where employees see senior management people out in the field on a regular basis. Management lead by example and also enforce the rules and regulations at all times. The best examples of visible management commitment are as follows;

- Safety before production
- Safety being the first item on all meeting agendas
- Holding meetings and training sessions during production time
- Senior management being seen out in the field on a regular basis
- Discipline being exercised fairly and consistently

It is interesting to note that Du Pont have a similar attitude regarding workplace culture. According to Du Pont (1993) the workplace culture they want is one in which all employees were empowered to demonstrate flexibility and initiative in the completion of work assignments, took an active interest in their own health and development and that of their fellow employees and had an interest in the success of the business unit through adoption of a "continuous improvement" ethos.

3.3.2. Involvement of the Workforce

At Callide Coalfields all employees are involved with the safety decision making process and this includes the development of safe operating procedures, and all safety programmes which are associated with their work place. They are also involved with the conduction of safety audits and the risks associated with their work group. This means that employees will more readily accept ownership of the of any safety outcomes if they are involved at the outset. According to the Health and Safety Executive UK 2010 *"the action they have taken to influence the active involvement of the workforce in the health and safety system, and the action they have taken to promote a shared understanding between management and employees that worker involvement is fundamental to achieving healthier and safer working practices and workplaces".*

3.3.3. Communication

The operations with a positive safety culture have effective forums of communications with the workforce. Regular toolbox talks by supervisors and state of the company talks by senior management will generate immediate feedback from employees. The more communication between management and the workforce, the more ownership of safety will result. In order to foster a healthy work team environment the lines of communication are kept open and employees are encouraged to discuss issues that concern them.

The quality and quantity of communication that occurs between management and employees is likely to significantly affect the amount of ownership the employees will accept. There is a need to regulate how the attitudes are transmitted to ensure that management commitment is being accurately perceived (Clarke 1990).

3.3.4. Housekeeping

Housekeeping at Callide Coalfields has always had a very high priority since a clean and tidy work area makes a safe and productive environment. Inspections are conducted on a regular basis by employees, supervisors and senior management. Following an accident whereby a mine worker fractured his ankle whilst getting off a truck, an access committee was formed which consisted of members of the workforce from different disciplines. The outcome resulted in the first set of inclined steps on dump trucks in coal mines. This development proved so successful that in the early 1900's an industry access committee was formed to investigate accidents and incidents in Queensland.

3.3.5 Safety Decision Making Process

All employees are involved in the decision making process. This includes the development of safe operating procedures, safety programmes, conducting safety audits and being involved in the risks associated in their work group. If employees are involved with work groups they will more readily accept the safety outcomes.

When summing up the question of safety culture it is appropriate to note the concluding remarks from Parkin & Pitzer (2000) at a Northern Territory Minerals Industry Safety Conference;

- Safety is good business, our safety efforts must protect our most important asset – our people;
- Think about safety all the time and build it in to everything you do;
- It's about individual behaviour, responsibility and accountability;
- A strong safety performance will promote team work, build good morale, generate confidence and at the same time save costs and
- The relentless pursuit of excellent safety performance is critical for success in this vital area.

Ian Macdonald the Minister responsible for Mineral Resources in NSW announced in 2010 the start of a new pilot programme to develop a more mature Occupational Health and Safety culture in the New South Wales mining industry. He went on to say that the push for a world leading safety culture and performance came from a CEO Safety Culture summit in 2008 where industry , unions and Government looked ahead to achieving world-leading performance in safety and health in 10 years' time;

"The industry has realised that if it is to reduce safety incidents and fatalities it must tackle the culture. A mature culture supports systems which anticipate problems and controls them before they eventuate. An immature culture only reacts after the event".

3.3.6 'Macho' Culture in the Mining Industry

These improvements in safety culture are very necessary since according to Carter (2012*) "A 'MACHO' culture in the mining industry is a significant impediment to recognising and treating mental illness despite thousands of people being affected, a report has found".*

Researchers have estimated that 8000-10,000 people working in the minerals industry in the state of NSW alone experienced a mental health problem in the past 12 months. Most did not seek help, with only one third accessing care, University of Newcastle and Hunter Institute of Mental Health (2012).

"The culture of 'we're tough, this doesn't happen to us' combined with 'she'll be right mate' attitude was described as common in the mining industry" the report authors said.

The authors went on to state that absenteeism reduced productivity and injury due to mental illness cost the industry $320-450 million annually and amounted to $300,000-400,000 for a mine of 170 employees which was discussed extensively in Chapter 2.

According to the researchers the mining industry 'macho culture' stopped workers from accessing treatment, getting support and disclosing diagnosis, but this could be improved through workplace health and safety programmes addressing mental health. Stigma and job security concerns were barriers, with nearly half of mine employees not answering questions on mental health status in company screening.

3.4. Human Error

3.4.1. Human Error

According to Reason (2000), who is one of the world's leading organisational psychologists in the nature of human error, comments that the problem of human error can be viewed in two ways: the person approach and the system approach. Each has its model of error causation, and each model gives rise to different philosophies of error management. Understanding these differences has important practical implications for coping with the ever present risk of mishaps in the workplace.

Human error can best be defined as "the failure of planned actions to achieve their desired ends – without the intervention of some unforeseeable event." (Reason 1990).

3.4.2. Person Approach

The long-standing and widespread tradition of the person approach focuses on the unsafe acts, errors and procedural violations of people on the front line. These unsafe acts are arising primarily from aberrant mental processes such as forgetfulness, inattention, poor motivation, carelessness, negligence and recklessness. The associated countermeasures are directed mainly at reducing unwanted variability in human behaviour.

These methods include poster campaigns that appeal to people's fear of writing another procedure (or adding to an existing one), disciplinary measures, threat of litigation, retraining, naming, blaming, and shaming. Followers of these approaches tend to treat errors as moral issues, assuming that bad things happen to bad people, what psychologists have called the "just-world hypothesis" (Lerner 1970).

Reason describes the variability error paradox in which;

- Error is implicated in 70-80% of accidents

- The elimination of human error is seen as the primary objective by many system managers
- As with technical unreliability, managers must strive for greater consistency of human action
- However human variability protects the system in a dynamic uncertain world.

Violations are deviations from safe operating procedures and in mining are frequently encountered which involve cutting corners to get the job done. (Reason 1997)

There are four violation types;

- Routine violations (corner cutting)
- Optimising violations (for ‘kicks)
- Necessary violations (to get the job done)
- Exceptional violations (one-offs)

3.4.3 Error Producing Factors

Reason gives examples of local-error producing factors in the work place in order of impact;

- Inadequate tools and equipment
- Perceived pressure or haste
- Environmental considerations
- Convenience
- Knowledge, skills & experience
- Communications
- Procedures

The best people sometimes make the worst mistakes and if you have a well-trained and well-motivated workforce, situations are easier to fix than people. The same situations keep on provoking the same kinds of errors, regardless of who is involved. The aviation industry acknowledges the following error rates in aviation which have been derived from observing error rates in 44 flight hours Figure 3.1;

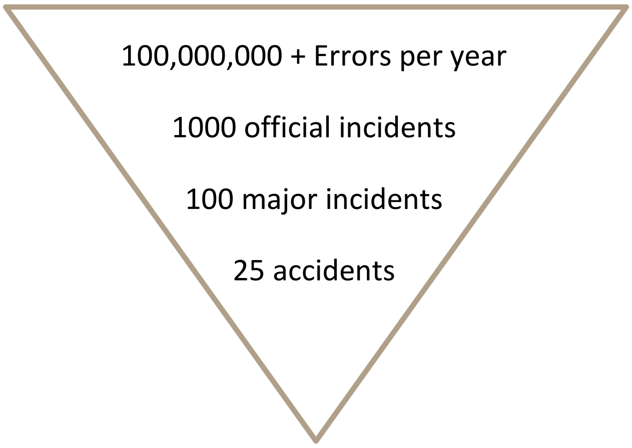


Figure 3.1 Error Rates in Aviation

Rules can essentially be categorised into three groups;

1. Good rules; are those which fit the individual and organisational requirements in order to get the work carried out safely
2. Bad rules; are inappropriate for the operation or incorrect
3. No rules; it is not possible to have a rule to cover every situation

According to Reason people violate good rules for the following reasons;

- Illusion of control: ‘I can handle it.’
- Illusion of invulnerability: ‘I can get away with it.’
- Illusion of superiority: ‘I am very skilled.’
- Feelings of powerlessness: ‘I can’t help it.’
- Feelings of consensus: ‘everybody does it.’
- Feelings of consent: ‘they’ll turn a blind eye

Situational factors which provoke violations are;

- Time pressure to get the job done
- High workload
- Unworkable procedures
- Inadequate equipment
- Bad working conditions
- Supervisors turn a blind eye

3.4.4 System Approach

According to Reason the systems approach is that humans are fallible and errors are to be expected, even in the best organisations. Errors are seen as a consequence rather than causes, having their origins not so much in the perversity of human nature as in “upstream” systematic factors. These include recurrent error traps in the workplace and the organisational processes that give rise to them.

Counter measures are based on the assumption that although we cannot change that human condition, we can change the conditions under which humans work. A central idea is that of system defences. All hazardous technologies possess barriers and safeguards. When an adverse event occurs, the important issue is not who blundered, but how and why the defences failed.

3.4.5 Evaluating the Person Approach

Blaming individuals is emotionally more satisfying than targeting institutions. People are viewed as free agents capable of choosing between safe and unsafe modes of behaviour. If something goes wrong, a person (or group) must have been responsible. Seeking as much as possible to uncouple a person's unsafe acts from any institutional responsibility is clearly in the interests of managers.

The person approach has serious shortcomings and is ill-suited to the medical domain. Indeed, continued adherence to this approach is likely to thwart the development of safer health care institutions. Although some unsafe acts in any sphere are egregious, most are not. In aviation maintenance—a hands-on activity similar in many respects to medical practice—about 90% of quality lapses were judged blameless (Marx 1997).

Effective risk management depends crucially on establishing a reporting culture (Reason 1997). Without a detailed analysis of mishaps, incidents, near misses, and “free lessons,” we have no way of uncovering recurrent error traps or of knowing where the edge is until we fall over it. The complete absence of such a reporting culture within the Soviet Union contributed crucially to the Chernobyl disaster (Medvedev 1991).

Trust is a key element of a reporting culture, and this in turn, requires the existence of a just culture—one possessing a collective understanding of where the line should be drawn between blameless and blameworthy actions (Marx 1999). Engineering a just culture is an essential early step in creating a safe culture.

Reason (2000) says that the weakness in the person approach is that by focusing on the individual origins of error, it isolates unsafe acts from their system context. As a result, two important features of human error tend to be overlooked. First, it is often the best people who make the worst mistakes—error is not the monopoly of an unfortunate few. Second, far from being random, mishaps tend to fall into recurrent patterns. The same set of circumstances can provoke similar errors, regardless of the people involved. The pursuit of greater safety is seriously impeded by an approach that does not seek out and remove the error-provoking properties within the system at large.

Defences, barriers, and safeguards occupy a key position in the system approach. High-technology systems have many defensive layers: some are engineered (alarms, physical barriers, automatic shutdowns), others rely on people (surgeons, anaesthetists, pilots, control room operators), and yet others depend on procedures and administrative controls. Their function is to protect potential victims and assets from local hazards. They are mostly effective at this, but there are always weaknesses.

In an ideal world, each defensive layer would be intact. In reality, they are more like slices of Swiss cheese, having many holes—although, unlike in the cheese, these holes are continually opening, shutting, and shifting their location. The presence of holes in any one "slice" does not normally cause a bad outcome. Usually this can happen only when the holes in many layers momentarily line up to permit a trajectory of accident opportunity—bringing hazards into damaging contact with victims (figure 3.2). The holes in the defences arise for 2 reasons: active failures and latent conditions.

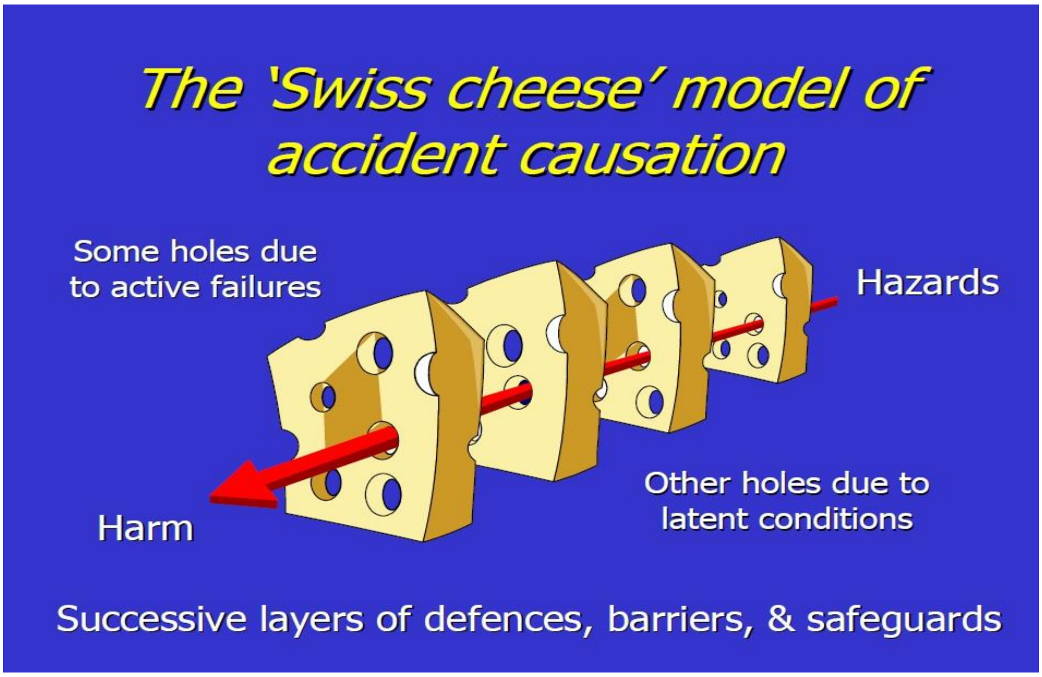


Figure 3.2 The Swiss Cheese Model – Human factors: A Personal Perspective Reason 2006

3.4.5.1 Active Failures

Active failures are the unsafe acts committed by people who are in direct contact with the individual patient or system. They take a variety of forms: slips, lapses, fumbles, mistakes, and procedural violations (Reason 1990). Active failures have a direct and usually short-lived effect on the integrity of the defences. At Chernobyl, for example, the operators violated plant procedures and switched off successive safety systems, thus creating the immediate trigger for the catastrophic explosion in the core. Followers of the person approach often look no further for the causes of an adverse event once they have identified these proximal unsafe acts. But, as discussed later, virtually all such acts have a causal history.

3.4.5.2 Latent Conditions

Latent conditions are the inevitable "resident pathogens" within a system. They arise from decisions made by designers, builders, procedure writers, and top-level management. Such decisions may be mistaken, but they need not be. All such strategic decisions have the potential for introducing pathogens into the system. Latent conditions have two kinds of adverse effect: they can translate into error-provoking conditions within the workplace, (time pressure, understaffing, inadequate equipment, fatigue, and inexperience) and they can create long-lasting holes or weaknesses in the defences (untrustworthy alarms and indicators, unworkable procedures, design and construction deficiencies).

Latent conditions—as the term suggests—may lie dormant within the system for many years before they combine with active failures and local triggers to create an accident opportunity. Unlike active failures, whose specific forms are often hard to foresee, latent conditions can be identified and remedied before an adverse event occurs. Understanding this leads to proactive rather than reactive risk management. According to Reason active failures are like mosquitoes. They can be swatted one by one, but they still keep coming. The best remedies are to create more effective defences and to drain the swamps in which they breed. The swamps, in this case, are the ever-present latent conditions. For each failed defence we need to ask the question was the failure due to an unsafe act. If so, what were the local factors that provoked it and what were the organisational factors that brought about the error provoking conditions figure 3.3.

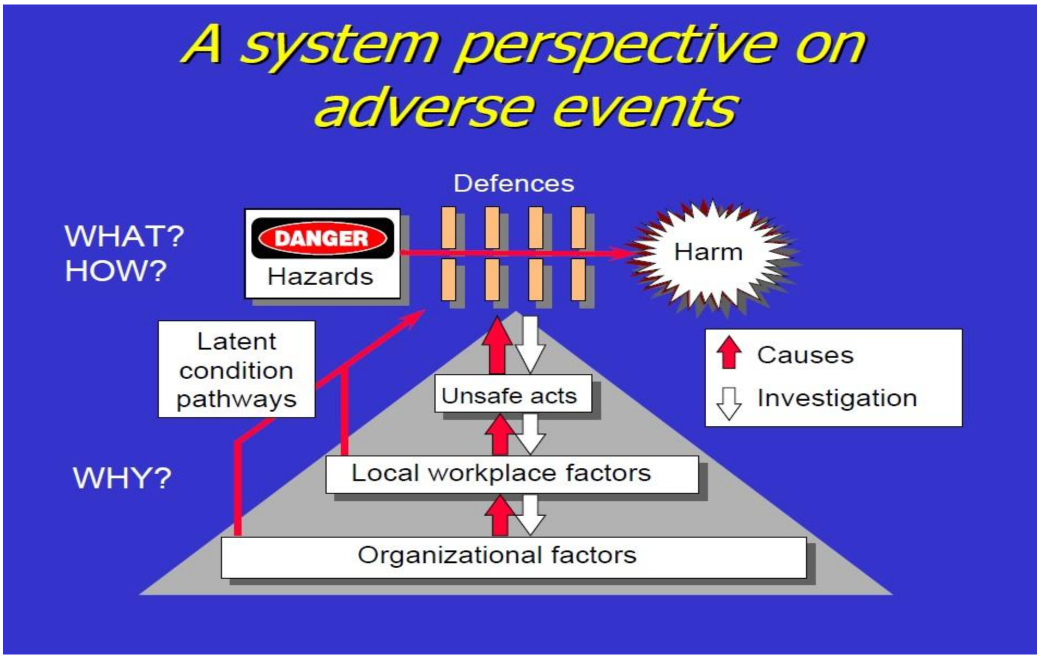


Figure 3.3 How and Why Defences Fail - Human Factors: A Personal Perspective Reason 2006

3.4.6 Error Management

In the past decade, researchers into human factors have been increasingly concerned with developing the tools for managing unsafe acts. Error management has 2 components: limiting the incidence of dangerous errors and— this will never be wholly effective— creating systems that are better able to tolerate the occurrence of errors and contain their damaging effects. Whereas followers of the person approach direct most of their management resources to trying to make individuals less fallible or wayward. Adherents of the system approach strive for a comprehensive management program aimed at several targets: the person, the team, the task, the workplace, and the institution (Reason 1997)

High-reliability organizations—systems operating in hazardous conditions that have fewer adverse events—offer important models for what constitutes a resilient system. Such a system has intrinsic “safety and health”; it is able to withstand its operational dangers and still achieve its objectives.

3.4.6.1 A Few Paradoxes of High Reliability

The safety sciences know more about what causes adverse events than about how they can best be avoided. In the past 15 years of so, a group of social scientists based mainly in Berkeley, California, and the University of Michigan at Ann Arbor has sought to redress this imbalance by studying safety successes in organizations rather than their infrequent but more conspicuous failures (Weick 1999).

These success stories involved nuclear aircraft carriers, air traffic control systems, and nuclear power plants. Although such high-reliability organizations may seem remote from clinical practice, some of their defining cultural characteristics could be imported into the mining industry.

Probably the most important distinguishing feature of high-reliability organizations is their collective preoccupation with the possibility of failure. They expect to make errors and train their workforce to recognize and recover them. They continually rehearse familiar scenarios of failure and strive hard to imagine novel ones. Instead of isolating failures, they generalize them. Instead of making local repairs, they look for system reforms (Reason 2000).

High-reliability organizations are the prime examples of the system approach. They anticipate the worst and equip themselves to deal with it at all levels of the organization. Individuals may forget to be afraid, but the culture of a high-reliability organization provides them with both the reminders and the tools to help them remember. For these organizations, the pursuit of safety is not so much about preventing isolated failures, either human or technical, as about making the system as robust as is practicable in the face of its human and operational hazards. They stay open-minded about the sources of risk; try to remain complexly sensitized to multiple sources of safety information (Dekker 2010).

3.5 Safety Behaviours and Attitudes

The importance of changing safety behaviour on mine sites as a means of improving safety performance is well understood by the mining industry. The concepts of safety "culture" and attitudes are less well understood. If the industry is able to improve the understanding of these concepts it could prove to be an important milestone for the mining industry to increase the focus on targeting these factors in its endeavour to improve safety performance.

It was argued at the Queensland Mining Industry Safety & Health Conference that;

"Industry initiatives to improve safety performance in mines will largely depend upon changing many of the attitudes and behaviours that make up the mine culture and codes, which in turn influence the way in which mineworkers perform their daily work" Jonson (1997)

Jonson says that it can be argued that unsafe acts and unsafe attitudes form part of a long chain of antecedent casual events which could lead to incidents higher up the safety ladder ranging from near misses and LTIs through to fatalities.

Accidents are generally investigated according to two principal approaches;

1. **1.** Accidents are caused by unsafe behaviour, and certain people are more prone to behave unsafely than others. Therefore accidents can be prevented by changing the ways in which people behave.
2. **2.** The systems approach to accident prevention has reduced the number of accidents. According to Margolis (1973), engineering solutions to accidents are in themselves, insufficient in the prevention of accidents. He stressed that individual attitudes of employees towards safety were directly related to management attitudes.

Mining companies have invested large sums of money in re-designing their systems to "engineer out" safety hazards and risks wherever possible and have invested enormous resources in developing "Job safe procedures".

According to Jonson (1977) despite this investment of money and resources, the incidence of fatalities remains relatively unchanged and governments, companies, employees and the market place all agree they continue to be "unacceptably high". Galvin (1998) reported that,

"A new technology produces more tonnes with less people, but introduces different types of hazards, and the probability of being killed underground has not come down dramatically".

In the underground coal and metalliferous mining industries remote controlled equipment was designed and introduced in order to reduce the risk of injury to employees working underground. This would help to achieve the objective of the systems approach which was to improve safe working by moving the operator from hazardous zones. However in reality the introduction of remote controlled equipment has caused an alarming number of operator injuries and fatalities.

Hopkins (1995) reported: *"Both government safety organisations and unions are quite simplistic on safety. They focus on equipment, not on the acts of people. In our experience, 95% of accidents occur because of acts of people. They do something they are not supposed to do and are trained not to do, but do it anyway. Changing this behaviour is much harder than focusing on equipment".*

Durham (2012) stated that *"a hazard is defined as something with the potential to cause harm, and that potential only becomes actual harm after some form of human involvement. A large number of accidents are the result of human behaviour, essentially someone doing something wrong. Even worse, in many cases the individual knew it was wrong or was observed by others who knew it to be wrong".*

In the Road Traffic Authority (1995) statistics it argued that 95% of crashes on the road involve human error.

Coyle (1995) reported *"that unsafe attitudes almost always precede accidents"* and that *"very little work has been undertaken to systematically measure expectations and attitudes towards occupational health and safety at various level of organisations"*

Coyle is very critical with the preoccupation of the current statistical measures and states: *"safety climate , the objective measurement of attitudes and perceptions towards Occupational Health issues, has been largely ignored and measures such has lost time injury frequency rate have been used to determine the efficacy of Occupational Health and Safety Programmes".*

3.6 Unsafe Attitudes and Acts

According to Jonson (1997) unsafe acts are the casual precursors to form part of a long chain of antecedent casual events which could lead to incidents higher up the safety ladder ranging from near misses and LTI's through to fatalities. It is therefore appropriate to treat unsafe acts and attitudes just as seriously as LTIs and fatalities. Over the years in the mining industry there has been a strong focus on the management of LTIs as a measurement of safety performance. This focus has resulted in a progressive reduction of LTIs. This is consistent with the principle "what gets measured gets managed". The industry now needs to apply the same disciplined focus and approach to the management of unsafe attitudes and acts in the workplace.

Reason (2000), when addressing unsafe acts, stated *"if you eliminate unsafe acts, you avoid bad events. But carelessness and 'bad attitude' play a very small part in organisational accidents".*

The position of unsafe acts and attitudes in the safety hierarchy is most probably best illustrated in a study of industrial accidents which was developed by Bird (1969) who analysed 1,753,498 accidents reported by 297 co-operating organisations in the USA, representing 21 different types of occupational establishment and employing 1,750,000 people who worked more than 3 billion man hours during the exposure period analysed. This resulted in the following "Safety Triangle" model:

- 1 fatality or serious injury
- 10 minor injuries
- 30 property damage incidents
- 600 inconsequential unsafe acts or incidents

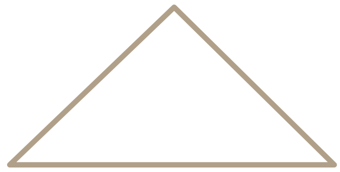


Figure 3.4 Safety Triangle Model

It may be observed in the above safety triangle Figure 3.4 that for every 1 fatality or serious injuries there are 10 minor injuries, 30 property damage incidents and 600 inconsequential unsafe acts or incidents.

The significance of this model is that major injuries are rare events and that opportunities are afforded by the more frequent less serious events to take actions to prevent the major losses from occurring. These actions are most effective when directed at incidents and minor accidents with a high loss potential.

According to Roughton (2008), ConocoPhillips Marine in 2003 conducted a similar study *"demonstrating a large difference in the ratio of serious accidents and near misses. The study found that for every fatality there are at least 300,000 at-risk behaviours, defined as activities that are not consistent with safety programmes, training and components on machinery".*

These behaviours may include bypassing safety components on machinery or eliminating a safety step in the production process that slows down the operator. With effective machine safeguarding and training, at risk behaviours and near misses can be diminished. This also reduces the chance of a fatality occurring, since there is a lower frequency of at risk behaviours. This applies equally to the mining industry.

- 1 fatality
- 30 lost workday cases
- 300 recordable injuries
- 3000 Near misses (estimated)
- 300,000 at risk behaviours (estimated)

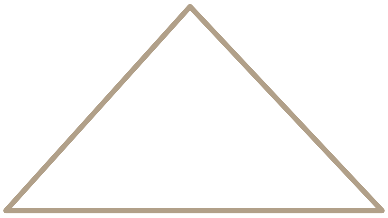


Figure 3.5 ConocoPhillips Marine Safety Pyramid

The above mentioned ratios in the marine safety pyramid would be very similar to those in the mining industry. To illustrate the unsafe act and attitudes in the mining industry, Jonson (1997) incorporated unsafe acts and attitudes using the 1995-1996 NSW underground coal industry data, which had 6 fatalities and 1158 LTIs that is about one fatality to 200 LTIs. The hypothesised triangle may look something like the following:

- 1 Fatality
- 200 Lost time injuries
- 600 Property damage accidents **x**
- 2000 Incidents with no visible injury or damage **x**
- 5000 Unsafe attitudes & acts **x**

X Represent hypothesised numbers only

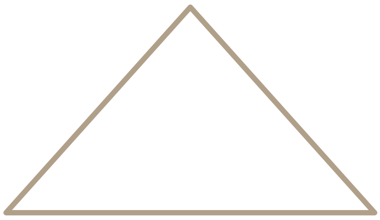


Figure 3.6 Unsafe Attitudes and Acts Triangle NSW Coal

It is therefore important for the mining industry to put in place systems and procedures to manage unsafe acts in the same way it has effectively managed LTIs. Unless we put the systems in place to identify and deal with unsafe acts people will continue to perform them since there are seldom immediate consequences for working unsafely.

When considering safe work behaviour and unsafe acts it is appropriate to examine a survey conducted by Laurence (2001) who conducted an attitudinal survey of approximately 500 miners in Queensland and New South Wales. The results of the survey were used to compare and contrast the attitudes and beliefs of mineworkers in various industry sectors and employee groups within those sectors. The responses provided guidance for both regulators and management for making better rules and regulations.

Also this allowed a safe behaviour model to be developed using the criteria which was established during the survey and correlated against safety performance data from each mine this allowed a link between the safe behaviour and safety performances to be established. Laurence was then able to develop a relationship between the concepts of the regulatory environment, mine site specific rules and the resultant safe behaviour of the workforce which can be illustrated by means of a wheel of safe behaviour.

A Wheel of Safe Behaviour (Figure 3.7) illustrates the link between;

1. The regulatory environment, imposed by government
2. Mine specific rules and procedures, carried out by mine management and
3. Safe behaviours displayed by the workforce.

The outer part of the wheel is the regulatory environment which includes risk assessment, safety management plans, guidelines, codes of practice, Australian standards, enforcement policy and general duties. The next part of the wheel is the effective rules which mineworkers believe are simple, concise, understandable, practical, relevant, easy to remember, well communicated, flexible, well documented, up to date, clear and unambiguous. The centre of the wheel is the miner's safe behaviour which displays the characteristics displayed or required of safety behaviour practitioners and include;

- having knowledge and understanding of rules
- being able to apply the rules at the right time
- diligence and vigilance in detecting hazards
- emergency preparedness
- establishing a 'what if' capability
- caring for fellow workmates
- education and training to suit the individual and his/her cognitive abilities

- refresher training which includes the use of computer simulation or virtual reality
- adopting safe work habits
- the mine worker being able to understand the rule and regulation process and the obligations for the mine.
- Being compliant with the rules and not deviating from them
- avoiding risks
- taking responsibility for their own safety and their workmates rather than being fatalistic
- agreeing to be involved in all safety matters which include involvement in risk assessments and safety management systems
- assessing hazards before commencing a task
- effective two way communication and
- mineworker's goals being the same as managements.

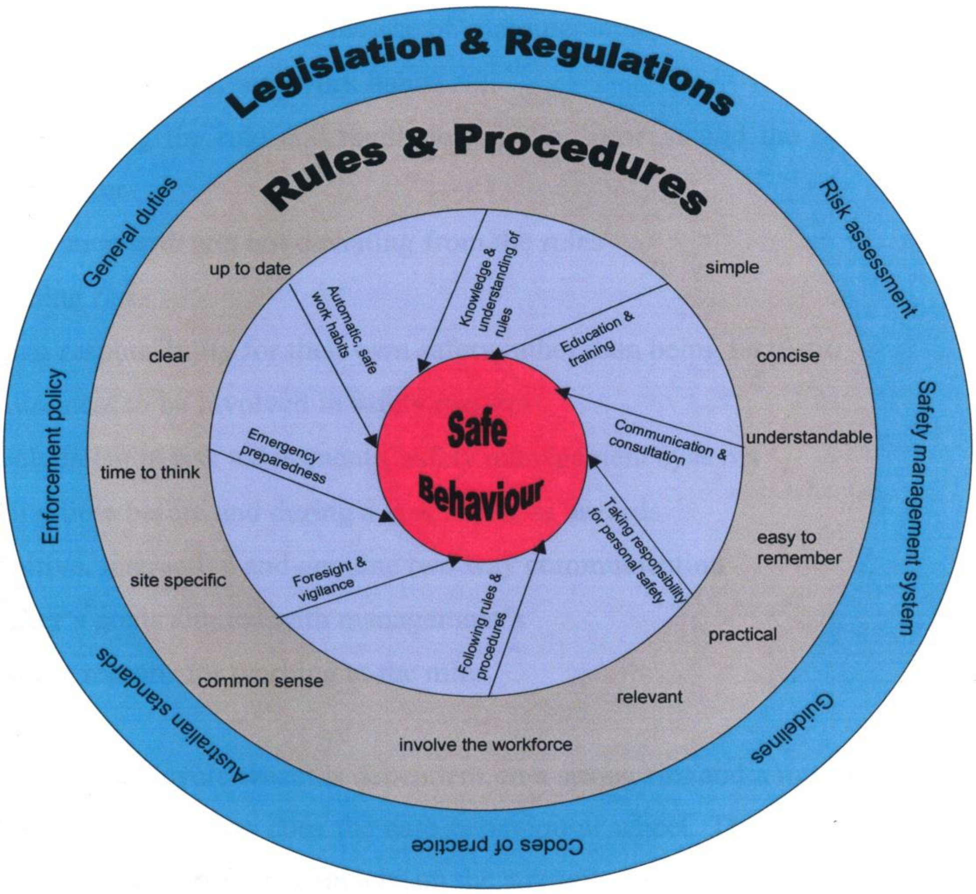


Figure 3.7 Wheel of Safe Behaviour - Laurence 2003

The model of safe work behaviours provides management with a tool to objectively measure the existing safety behaviour on a mine site and plan a programme for improvement.

3.7 Safety and Health Management Systems

Safety and health management systems introduce a documented and structured way in which safety risks and hazards can be identified, quantified and controlled and if implemented appropriately can lead to safety improvement. According to Hudson (2000) the requirement for organisations to develop Safety Management Systems grew out of the aftermath of a number of disasters, predominantly in Europe. The Flixborough accident in 1974, resulted in 28 workers being killed, 36 suffered injuries and a whole village was blown away as a result of an explosion at a production facility at a Nypro site in the UK, led to the development of the first Safety Case.

After the Piper Alpha incident in 1987, Lord Cullen identified the requirement for systematic *safety management*. Cullen's requirements were consistent with previous legislation and also developed the goal setting approach first laid out in the report of the Robins Committee Report in 1972 which resulted in the UK *Health and safety at Work Act* in 1974. Cullen recommended the following goal setting;

- Identify major accident hazards
- Estimate the likelihood of occurrence (risk)
- Provide controls to eliminate, reduce or protect from risk
- Independent verification of controls
- Management system to maintain control
- An underpinning series of regulations to give solidity.

From these recommendations an effective safety management system was able to be developed with documented and structured way for the safety improvement that was required.

According to Hudson (2000*) "the bad news is that creating a management system and keeping it alive is not a particularly easy task. The good news is that it is worthwhile, both in terms of lives and in terms of profits. The other good news is that it is not as hard as it may seem"*

Although Safety Management systems in the mining industry are a relatively new concept it is well recognised that in order to reduce the unacceptably high number of accidents and incidents, a more structured approach to safety management is required to take effect.

In this regard Reason (2000) stated that safety management systems must cope with the human and organisational risks as well as physical hazards. To do this effectively, they need to understand the nature of these risks;

- Individual verses organisational accidents
- Person verses system models
- Defences, barriers & safeguards
- Production verses protection problems and
- The variability paradox.

It is now a requirement in NSW and Queensland legislation that every mine must have a Safety and Health Management System (SHMS) in place that must provide for the basic elements of risk identification and assessment, hazard analysis, hazard management and control, reporting and recording relevant safety and health information data. The (SHMS) that each mine site adopts must ensure that *"risk is managed so that safety and health of persons who may be affected by the operation is at an acceptable level".*

The Australian Standard for Occupational Health and Safety is AS 4804 which provides guidance on;

- how such an occupational health and safety management system (OHSMS) may be set up
- how it can be continually improved and
- what resources may be used to do this.

The Standard OHSAS 18001 is a framework for an occupational health and safety management system which can help to put in place the policies, procedures and controls needed for an organization to achieve the best possible working conditions, and it sets out the minimum requirements aligned to internationally recognized best practice. The Australian Standard AS 4801 establishes an audit framework which can be used by third parties to conduct an independent audit. This framework can also be used as a reference point for internal auditing procedures.

3.7.1 The Enhanced Safety Management System

As discussed earlier one of the first and most comprehensive safety management systems that has been developed of recent times is by the Shell Group of Companies which was the Enhanced Safety Management System.

Today most mining companies must operate a safety and health management system similar to the Shell model "Enhanced Safety Management Programme" This programme is regarded as the eleven commandments of any safety programme which must be audited on a regular basis to ensure it meets its objectives. The key principles are as follows;

- Visible Management Commitment to Safety
- Sound Health, Safety and Environment (HSE) Policy
- HSE is a Line Management Responsibility
- Competent HSE Advisors
- High Well understood HSE Standards
- Measurement of HSE Performance
- Realistic HSE objectives and Targets
- Audits of HSE Standards and Practices
- Effective HSE Training
- Thorough Investigation and Follow Up of Injuries, Accidents and Incidents and
- Effective Motivation and Communication

The main objective of any safety management programme is to bring about a major improvement in safety performance that will be sustainable and ongoing. One such programme is the Shell Health, Safety and Environment Management System (HSEMS) (Jennings 1995).

3.7.2 The Shell Health, Safety and Environment Management System

Most recently Shell International introduced a broader health, safety and environment management system framework, influenced to some degree by the instigation of safety cases in oil and gas exploration and production business as a consequence of the Piper Alpha findings. This HSE management system builds on earlier Shell guidelines and experience. It also incorporates three new features which are necessary to successfully manage HSE in today's business environment:

- Quality Management principles, including improvement and feedback mechanisms which facilitate possible certification against quality standardisation bodies such as ISO 9000.
- A focus on the hazards and effects of the business and upon those activities critical to HSE via application of the Hazards and Effects Management Process (HEMP).
- Business integration via the application of management controls to all aspects of the business processes critical to HSE, resulting in accountabilities defined at every organisational level. Business Process Analysis is the key tool in this context. The three new features are illustrated in Figure 3.8.

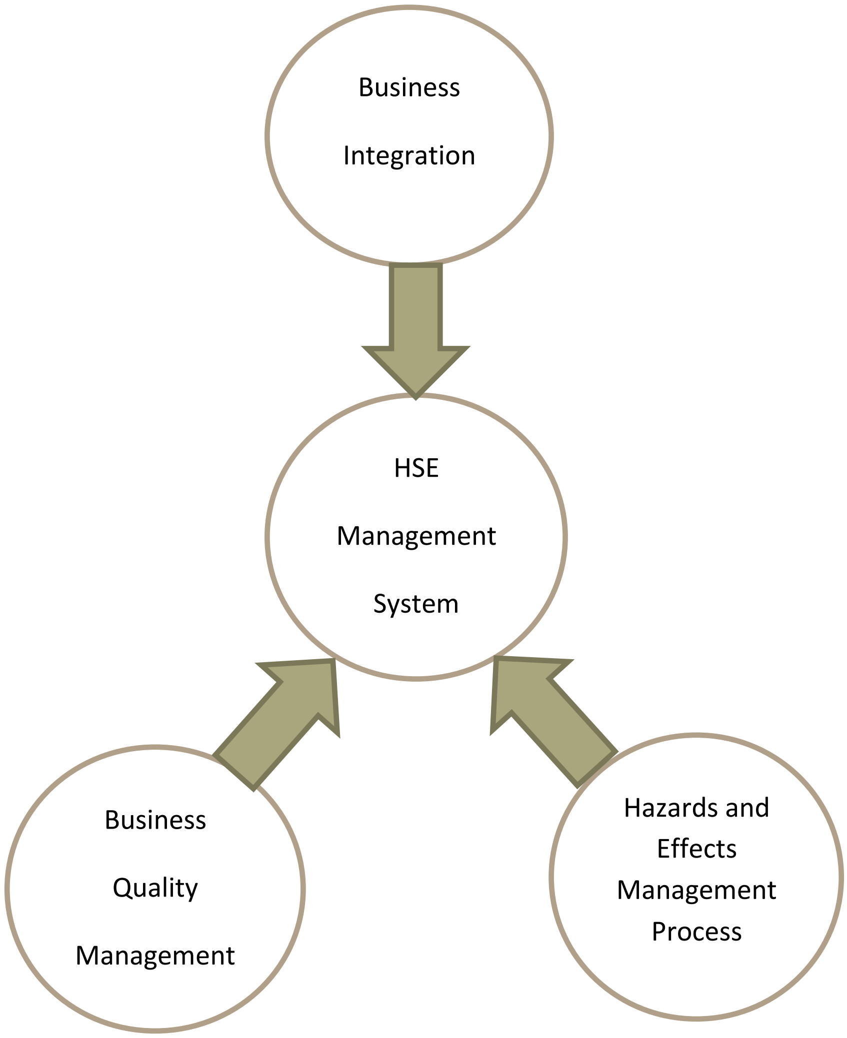


Figure 3.8 Features of The Shell HSE Management System

The underlying premise behind any Health, Safety and Environment management system is that it's based on sound management principles; it must be systematic and disciplined. It must form an integral aspect of the overall management system of the organisation in question.

The structure of the HSE management system is outlined below in figure 3.9.

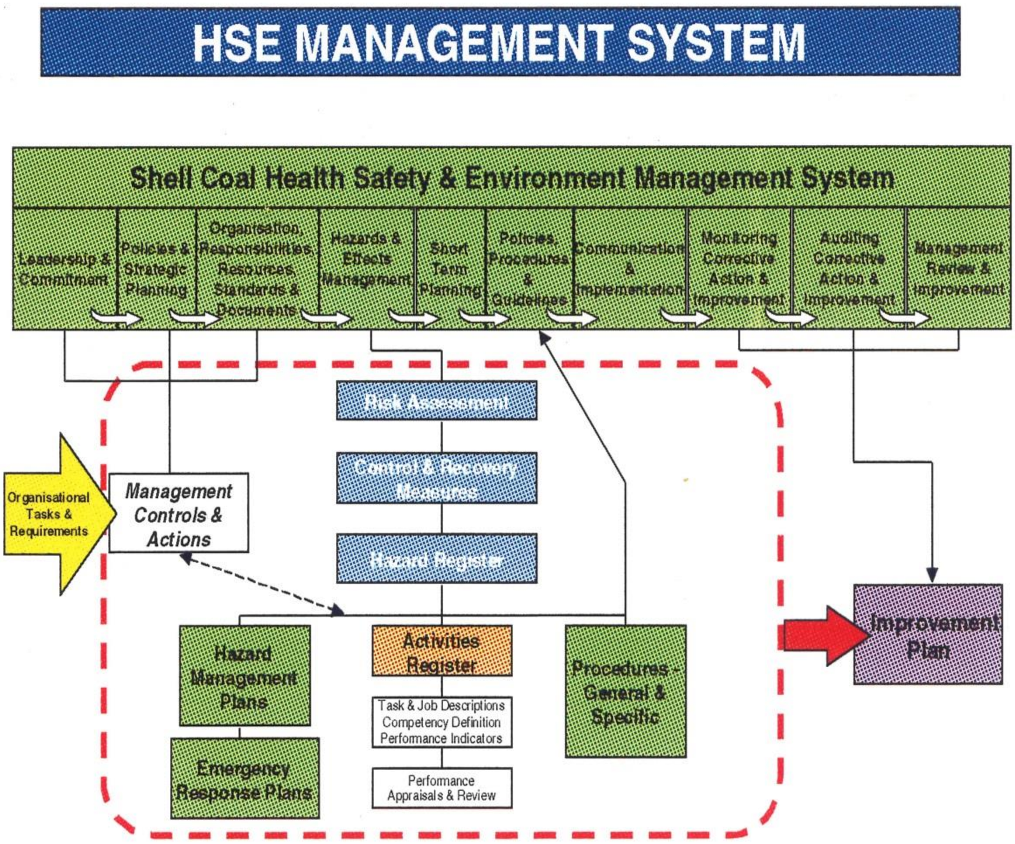


Figure 3.9 Structure of HSE Management System – Shell Coal 1998

The HSE Management System provides the main elements found in any quality management system from setting objectives to management review of the system. Application of the hazard and effects management process ensures that the identified risks to health, safety and the environment are adequately addressed and that focus is maintained on all those activities critical to HSE. The HSE Management System is part of the overall system for managing the business.

Below in Figure 3.10 is an example of a safety management system which is based on the Shell HSE Management System philosophy "The Safety Way" diagram that Anglo American currently use which depicts the hierarchy of controls from **Policy – Planning – Implementation and Operation – Checking and Corrective Action – Management Review** which leads to continual improvement Anglo American (2013).

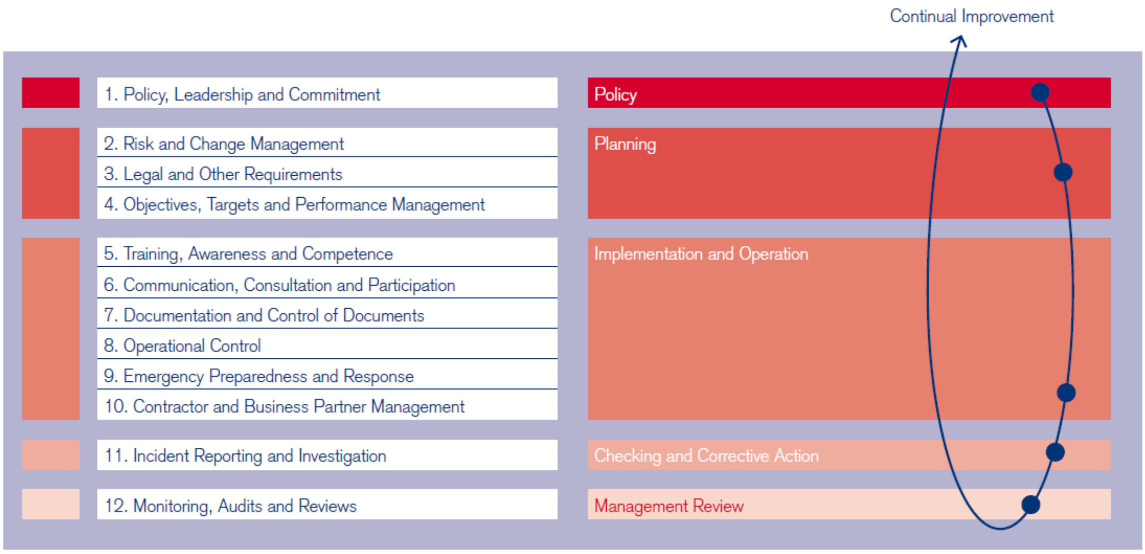


Figure 3.10 The Safety Way Diagram Depicting the Hierarchy of Controls – Anglo American 2013

The Hazards and Effects Management process is designed to identify and manage hazards and the adverse effects of these hazards. This process consists of four basic steps: Identify, Assess, Control and Recover which can be observed in table 3.2 below:

Table 3.2 Hazards and Effects Management

Identify		What is the root cause? What could go wrong?
Assess		How serious will it be? How probable is it?
Control	Prevent/eliminate Reduce probability	Is there a better way? How to prevent it?
Recover	Mitigate consequences Emergency response Reinstate	How to limit the consequences? How to recover?

The identification and assessment of hazards and subsequently ensuring adequate controls and recovery measures are integrated into the normal business activities of operations, which represent the core of the Shell HSE Management System which were adopted by Shell's and Anglo American coalmines. The application of these controls will be discussed in further detail later on in this chapter when discussing risk management.

3.7.3 Mining Occupational Health and Safety Management Plans

When producing an Occupational Health and Safety Management System (OHSMS) it is important that they are easily understood by the workforce and all levels of management. They need to be flexible enough in order to allow each individual mine to be able to manage the management of operations and the associated hazards.

The most important aspect of producing a Safety Management Plan is the process that is undertaken to achieve the final outcome, which includes involvement of the workforce at all levels. The plan incorporates the mine policy and procedures, training manuals, safe work procedures, records and various forms and the principle hazard management plans. The supporting documentation consists of the Mining Act and Regulations; Australian standards, codes of practice and industry guidelines. According to Health and Safety Executive in the UK (2010) "*There were ten fatal accidents in mines between 2006 and 2009, eight of them in large coal mines, following a period of only one fatal accident in six years. HSE's investigations indicate that many fatal and major injury accidents in the past few years can be traced back to deficiencies in the implementation of safety management systems and a lack of effective leadership".*

The International Council of Mining & Metals Safety and Health Conference in Santiago (2012) endorsed "*putting people first and that leadership is the primary enabler of good health and safety performance*".

3.7.4 Communication and Consultation

During the process of producing a Safety Management Plan (SMP) the most essential factors that are necessary, are communication and consultation with the people involved at all levels within the operation. Communication can best be described by the following statement:

"it is the transfer of meaning, which is evidenced by a message passing from sender to receiver. The mechanism or channel used to send the message will have an impact on how the receiver interprets the message. The design of the mechanism may convey one way or two way, synchronous or asynchronous, individual or group communication that is further supported by the type of media involved." (Leveritt 2005).

According to Leveritt consultation can be defined as *"the partnership principle of involving all those individuals with an interest in coming up with effective solutions to safety issues, which lead to acceptance and ownership. "*

Workforce involvement in the development of the SMP and in particular the principle hazards plan is crucial for the successful implementation of the plan. Without effective communication and consultation with the management and workforce, the process would be unsuccessful and ownership of the outcomes would not be forthcoming. It is essential that communication is a two way process, with employees having the right to question outcomes of any decision taken by management that effects their workplace.

Communication and consultation is proving to be very difficult regarding contractors who make up a significant proportion of the workforce at most operations today. One of the major challenges facing the mining industry is the rapid expansion of the industry with more fly in fly out operations and severe skills shortages which creates a situation where more people are coming in to and moving within the industry. According to Forbes and Wilson (2005)

"the industry has a large percentage of the workforce being transient compared to a workforce of several years ago where mines had long term employees and relatively stable and experienced people. The challenge this offers for any safety management system is how

should we communicate and implement the system for all to comprehend and comply with, especially those people that move from site to site on a regular basis".

3.7.5 Communication Mechanisms

In most mining communities the most popular communication mechanisms are meetings, memos, team briefings and notice boards, which may take the form of hard copy and or electronic formats. Other ways of getting the message across include the use of the internet such as email and videos, virtual meetings and focus groups.

According to industry practitioners one of the most effective ways to communicate and get the message across is the team briefing between the immediate supervisor and the worker because of the small group of people involved. It is therefore important that supervisors are trained in the communication process. Most mining operations use the following types of communication depending on the message being conveyed. For example if it was regarding safety information which includes accidents and incidents, the following methods would be used:

- Verbal communication
- Nonverbal communication
- Electronic communication
- Meetings and
- Stop work meetings

3.7.6 Successful Implementation of Safety Management Programmes

In 2001 a research programme was carried out which was designed to provide a frame work for the evaluation of the effectiveness, efficiency and appropriateness of safety programmes and initiatives at all levels in the coal mining industry and to identify the key factors that lead to success. The project was funded by the Australian Coal Association Research Programme (ACARP) along with additional cooperation and in kind support from

Simtars, Minerals Industry Safety and Health Centre and mines in New South Wales and Queensland. There were two parts to the project:

1. One investigated strategies used throughout the industry to plan and implement safety programmes
2. The second part considered five different programmes in place at mine sites. These programmes include training, health interventions, audit, risk assessments and behavioural and attitudinal change and cover basic safety programmes through to fitness for duty programmes.

Traditionally the coal industry has tended to look at the downstream outcomes of safety programmes such as accident statistics to ascertain the success or failure of a safety initiative. According to Bofinger et al (2001) the limitations of these "*statistics as a measure of programme effectiveness are recognised, however, such injury statistics and compensation data may be of benefit in prioritising workplace intervention strategies. When it comes down to safety, the mining industry is not plagued by new injuries, but rather finding effective solutions to existing problems"*

Understanding what drives a safety programme is one of the most important factors when trying to determine a successful outcome. Drivers assist in shaping the programmes goals

and objectives. According to Bofinger at least five factors may motivate the decision to implement programmes to address safety issues and these have been identified in one form or another as the drivers of safety programmes and these include:

- Employers enlightened self-interest
- Information on hazards and controls
- Injury costs and workers compensation
- Worker or union pressure and
- Legislation and Regulation.

Additionally the mining industry is now seeing an increased awareness of tort liability due to the growth in the number of cases involving litigation for injury and associated large payouts.

However once the drivers have been identified for any safety programme, it is important to identify both intrinsic and extrinsic motivating factors. The following four types of factors have been identified as determinants of workers safety motivation from the ACARP study which are:

- Safety climate of an organisation – safety climate refers to workers' interpretations of features, events and processes in the work environment that are relevant to their safety
- Task feedback – the rarity and delay of adverse effects from single tasks can lead workers to engage in increasingly unsafe acts as workers develop a sense of "unrealistic optimism" based on experience of innocuous outcomes of unsafe acts
- Workgroup norms – these norms are informal rules the groups adopt to regulate and regularise group member behaviour. Workgroup norms are most likely to have reached a high degree of consensus and intensity when there are common goals and independence within the team
- Organisational control systems – formal processes by which the organisation directs the members to action and monitors behaviour and results to ensure organisational goals are accomplished.

From the evaluation of the safety programmes at the mine sites the factors which were identified as the three most important for success were the identification of the need for the programme, actual and perceived commitment by management and the allocation of adequate resources. It is now appropriate to give some examples of the introduction of positive safety programmes on mine sites.

3.7.7 Examples of a Positive Safety and Health Management System

3.7.7.1 Consolidated Rutile Limited.

Consolidated Rutile Limited (CRL) has a 40 year history of sand mining on North Stradbroke Island. It mines 50 million tonnes of sand per year, which produces 94K tonnes of Zircon, 130K tonnes of Rutile and 200K tonnes limonite, which is sold internationally and locally. They employ 230 employees and approximately 110 contractors.

In 2005 Consolidated Rutile Limited (CRL) developed and implemented a comprehensive sustainable Safety Management System, which in turn has achieved a substantial improvement in safety performance. The plan identified the following issues that they needed to focus their attention on:

- People and behaviours
- Injury management
- Hazard identification
- Risk management and control
- Contractor management
- Incident reporting and accident investigation
- Document structure and control and
- Accessibility to information and fitness for work.

According to Carey (2005) people are the keystone of any company wanting to ensure a safe place of work and safe systems of work which is the focal point of employees returning home to their families at the end of their shift. The role of all employees and contractors is to ensure that the systems are utilised and not to place themselves or others at risk of injury or illness. In order to improve the transfer of safety information at the grass roots level CRL introduced the Positive Attitude Safety System (PASS).

All workgroups conduct a PASS meeting at the beginning of each shift, which has facilitated the participation and discussion of safety related factors prior to commencing work and has aimed at empowering all employees to have direct safety input into their workplace.

A proactive injury programme was initiated which not only focused on work related injuries but also recognised that employees knowledge could be utilised in other areas if they sustained a non-work injury or illness. This programme has proved to be very successful, whereby the injured person has been able to gain further knowledge and skills.

The Job Risk Assessment (JRA) has been used to plan and assess and control risk prior to commencing work. The use of the Take 5 was initiated to assist employees identify hazards that may be present prior to commencing all tasks.

CRL has developed a risk register that is reviewed monthly for risk associated to all sections of the business. The Take 5 programme will be discussed later on in this chapter when discussing risk assessment strategies.

According to Carey (2005)" *Contractor Management was recognised as an area of high risk to CRL".* A safety package is given to contractor companies prior to commencing work on site. This documentation also assists contractor companies develop their own safety management plans as a minimum requirement for conducting work at CRL.

To assist CRL contractor representatives an onsite training package was developed that outlined the responsibilities of the contractor representative and tools to assist them manage. Contract meetings are held on a monthly basis between representatives of the contract companies and the safety department. The aim of the meetings, being to provide open lines of communication for issues that contractors were encountering on site. CRL has commenced auditing the safety management systems of contract companies that supply services commencing with the high risk contractors that have been identified from the vendor pre-qualification process.

CRL has introduced the Incident Cause Analysis Method (ICAM) methodology for accident and incident investigation, which has improved the quality of investigations to determine the root causes and contributing factors.

In summation of the successful implementation of the Safety Management System Carey (2005) stated *"The Safety Management System at CRL has been through a major transformation over the past 30 months, which has reflected in an improvement in safety performance. There has been a significant shift in the culture and behaviours at all levels of the workforce. The major focus on risk assessment processes, consultation, involvement and communication has had a significant positive impact on the way that CRL is viewed internally and externally".*

3.7.7.2 Norwich Park Mine

Norwich Park mine is an open cut mine situated in the Bowen Basin near the township of Dysart. It is one of eight mines, which form the BHP Billiton Mitsubishi Alliance (BMA). It has a production capacity of over 7 million tonnes of metallurgical coal per annum. In an attempt to improve their safety performance and as part of their safety management system, they introduced the Zero Incident Process (ZIP). This is a psychological- based safety process that combines behavioural and cognitive safety theory to develop the intrinsic motivation to stay safe and modify participant's safety and wellbeing attitudes.

A full roll-out of ZIP was completed over a five month period and of the 120 site personnel, 106 attended one of the 9 ZIP courses. Data for injuries occurring 14 months prior to ZIP roll-out were used for this study. All injury frequencies decreased following the implementation of ZIP.

The results post ZIP was as follows:

All injury frequencies decreased following the implementation of ZIP
LTIs reduced 100% post training – LTIFR reduced from 19 – 0
Restricted Work Injuries reduced 66% post training
Total injuries down by 83% post ZIP
Total Injury Frequency Rate reduced from 38 - 7

According to Tindale (2007*)" All of the qualitative data and feedback suggests that the results are in line with the desired goals of ZIP and Norwich Park's mine journey towards Zero harm*".

3.8.7.3 Callide Coalfields

Callide Mines safety culture was discussed earlier in this chapter which reported that Callide has an impressive safety record and was described by Taylor (2000) as a bench mark for the industry. The safety management systems at Callide are essentially driven by the following safety strategy which includes:

- A clear separation of safety from industrial issues
- Asking an employee to behave in a certain way because they are valued as a person
- Use of a health and safety and Environment Management System incorporating hazard identification and risk management
- Discipline of those showing flagrant disregard for safety rules
- Reward and recognition for good safety performance
- Involvement of all levels of the workforce in OHS
- Safety is a line management philosophy devolved eventually to individual employees
- Participation of employees in hazard identification, review of procedures, training programmes, monitoring and auditing, and
- No distinction made between employee and contractor regarding safety expectations.

Safe Work Procedures (SWP) are one of the most important aspects of any safety management system. One of the major advantages of a SWP is that the workgroup undertaking the task is actually personally involved in the development of the procedure. As a result of worker involvement in the process, the task to be carried out is not only carried out in a safer manner but is completed much more efficiently. All SWP must be signed off by the individuals involved in the process.

3.7.8 Problems with Safety Management Systems

The increasing use of safety management systems has not been without criticism, due mainly to the issue of "paper compliance" since the audit process generates a huge amount of paper work which can have a negative effect on the achievement of a safer and more productive workforce. Another negative is that the process weakens the input of employees because of updating and other issues. This is despite the fact that safety management systems are now enshrined in legislation.

One of the major issues with the SMS is their complexity because there are many elements involved within the system. Because of their complexity the system can very quickly become out of date which was highlighted in the findings of the 1998 Longford Gas Plant explosion when a lack of current operating procedures and necessary knowledge were acknowledged as contributory factors which resulted in the explosion. One of the biggest problems is the lack of understanding by the workforce of the key elements due to the complexity of some SMS and the limited communication and consultation by management.

It is a well-known fact that written procedures should not only be readily available to operators but should be written such that they can easily be understood. According to Johnstone (1999), when reviewing SMS, found that in many cases safety improvements had not been forthcoming and that mineworkers saw the system as *‘a bit of a joke, something to keep the guys happy in corporate and not something we actually do’*

“Our safe work procedures tend to be a hotch potch of ideas. They are not readable and the guys can’t comprehend them at all. Its lots of paper and lots of people don’t know what’s in the procedures, and no one wants to be looking at 5 or 6 pages of bland document.” [Professional Staff]

“Workers have to be Philadelphia lawyers, they’re too complex. I got blokes underground who can’t read and others who have difficulty in reading basic literature”. [Foreman]

Another opposing argument to successful safety management systems was made by Forbes and Wilson (2005):

“We are required under the Coal Mine Health and Safety Act to make available for inspection by mine workers employed at a mine, a copy of the safety and health management system. I suggest that this is also not achieved, as most mines are spread over a large area and the work area is some distance from the main office or training centre. So many employees would not actually have the ability to inspect or review the SHMS if seeking information. It is therefore just becomes another system that sits in the site library or Safety Managers office collecting dust. Even if it were readily available for employees, it is usually such a large document that anyone reading it would not have the time available to them during the shift. It is also generally written in such a manner that it is difficult for them to understand or locate the information they require”.

One of the main challenges facing the industry is the number of people entering and moving within the industry. According to Forbes and Wilson (2005) a large percentage of the workforce is transient when compared to the workforce of several years ago when mines had long term employees who were relatively stable and experienced.

This problem is further exacerbated when one considers the large numbers of contractors now employed in the industry. The main challenge for any safety management system is how do we communicate and implement the system for all to comprehend and comply with, especially those that move from site to site on a regular basis.

This would suggest that people could be *overlooked "therefore relying on their own understanding and experiences or judgement to get them through, with little or no knowledge of the mines requirements".*

In order to illustrate the problems facing mines regarding the implementation of safety management systems it is necessary to look at a couple of examples. In 2001 after a serious injury at one of BHP Mitsubishi Alliance open cut coal mines the operation was closed down for a two week period in order for contractors to conduct a major examination of their safety systems. The reasons for this action was due to a number of serious and reportable incidents which had occurred over the previous six months and which had resulted in serious injury to personnel and equipment damage. The mine would remain closed until contractor management could operate the mine to satisfy the inspectorate and senior management to the standard expected and required to prevent incidents and injury.

A process of reviews was conducted by one on one interviews with all site employees and the outcome resulted in the following:

- The SMS had not been communicated to the workforce who had little knowledge of its content and a poor understanding of its purpose and the document was not readily available
- Little focus on processes and procedures; supervision was not being involved in any of the decision processes to do with the crews or work flow
- Management focus had been totally on production
- The supervisors had little or no understanding of their responsibilities and

- Risk management was non-existent and no training had been conducted with the workforce.

The above mentioned issues at the BMA open cut coal mine were very similar to those that existed at a small open cut coal mine in 2006 in central Queensland. After a serious incident concerning mobile equipment mine management agreed to suspend all operations for two weeks in order to implement a basic safety management system. Mine management were not able to implement even the basic safety management system because they did not have the resources available from the start of operations even though they are owned by a large mining organisation.

At a Coroners court in Rockhampton in the matter of an inquest into the cause and circumstances surrounding the death of a truck driver the coroner, Hennessy (2007), made the following comments:

"That coal mine operators critically review the effectiveness and implementation of their mine safety and health management systems as they are obliged to under the Coal Mine Safety and health Act 1999. It is recommended that particular attention be paid to how the mine system controls the activities of contractors and ensures they are carrying out their task in a safe manner".

Since the Site Senior Executive (SSE) at a mine in Queensland was not required to have any appropriate qualifications regarding safety management plans Hennessy in order to rectify this situation made the following statement;

"The site senior executive is required to have a competency in order to establish and maintain the mine Occupational Health and safety System".

It is now a requirement that all SSEs must have the appropriate competency in order to establish and maintain the mine Occupational Health and Safety System.

It is now a requirement in the mining industry that before a mine starts production a Safety and Health Management System must be implemented. According to Brady (2005) there are too many different standards, which make them very difficult to manage and that non standardization leads to confusion especially for contractors and service providers. All mine workers need to be properly trained since they do not understand their obligations under the SHMS and system audits should be conducted rather than compliance audits.

According to the Queensland Minister for Natural Resources Andrew Cripps (2013) when discussing new proposals to improve mine safety of the increasing number of contract workers in Queensland mines *“stated that recent data suggests contractors are more likely to be injured on our mine sites, sometimes fatally, which is why these new proposals will clarify that everyone, contractor or mine employee, is required to operate under a single safety and health management system on site”*
It is interesting to note that Shell International back in the late 1990s insisted that all contractors must operate under the same safety and health management systems as their permanent employees.

3.8. Risk Management Practices in the Mining Industry

In 1990 the Cullen report was published which recognised that following the Piper Alpha disaster, the offshore industry operated with a prescriptive approach where inspectors visited the platforms for compliance. It was established that a more effective approach to manage safety on offshore platforms would be for them to implement their own occupational and safety plan. This plan would be audited by inspectors. This approach caused a major shift in the way risk management was practiced. James Reason (2001) published an insightful article in which he made the following controversial statement: *“following safety procedures has killed people”* and he cites examples such as the Piper Alpha disaster as just one such case, where workers who strictly followed procedures were the ones killed in the fire, while those who jumped into the sea, against procedures, survived. This doesn’t imply that all safety procedures are wrong and shouldn’t be adhered to, but it does mean that human beings in high- risk work environments should first apply their risk skills and risk judgement.

Risk management techniques have been applied to the Australian mining industry for almost 20 years and are now an integral part of the way the mining industry operates. The current legislation in Queensland and NSW is part prescriptive and part self-regulating. In response to this approach the mining industry has developed strategies which include safety management systems, risk management strategies, safety management plans, principle hazard management plans and safe work procedures. The following discussion will expand on the introduction of risk management principles and give some examples of positive and negative outcomes in the Australian mining industry.

According to Joy (1999) risk management is *"the systematic application of management policies, procedures and practices to the tasks of identifying, analysing, treating and monitoring risk".*

3.8.1 Risk Management Principles

Earlier in this chapter hazards and effects management has been discussed which identified the hazard, assessed the risk, controlled the risk and recover or limit the consequences. This process forms the basic risk management system which is prevalent in the mining industry and is illustrated in Figure 3.11.

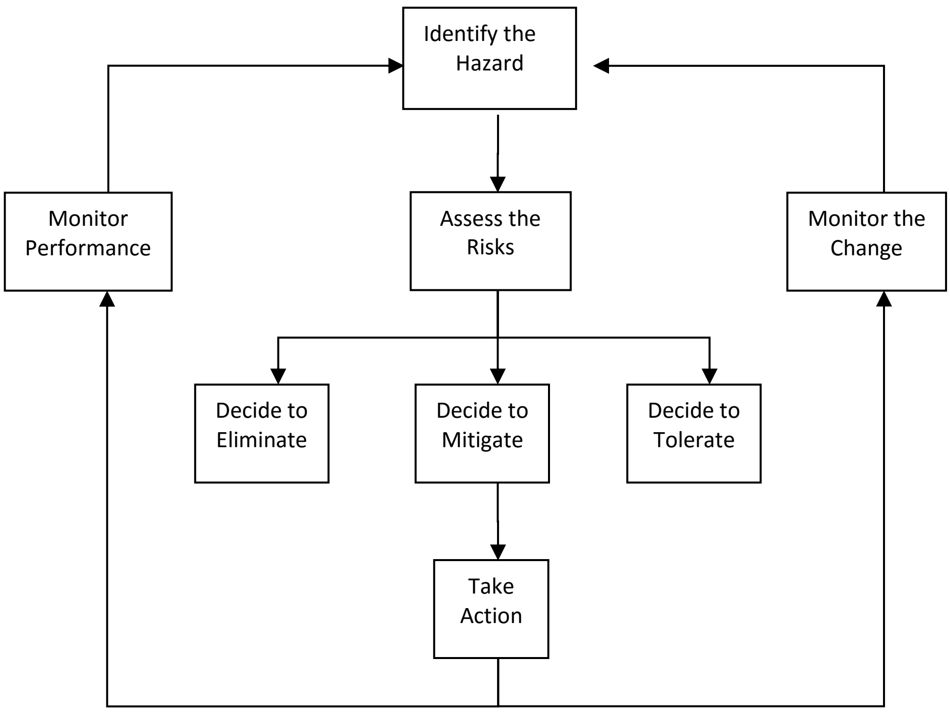


Figure 3.11 A Basic Risk Management System- Anglo American 2008

It is now a requirement in Queensland and New South Wales that before the introduction of a new piece of machinery or a new method of work, a risk assessment must be carried out.

A factor which must be considered during the risk assessment and management process is that of human error which was discussed at some length earlier in this chapter. According to the Minerals Industry Safety and Health Centre the impact of human error on the risk management process should be given a higher priority.

The Department of Employment, Economic Development and Innovation (DEEDI), Mine Safety group ran a seminar in 2010 looking at ways to improve the way risks are managed in the Queensland industry. The report contains a series of guidance points to assist in improving risk management:

- Selecting the most appropriate risk assessment tool
- Training and educating people to make effective decisions when applying and implementing risk management principles
- Inconsistent application and use of Job Safety Analysis
- Hierarchy of controls and control effectiveness
- There may be a need for some mines to improve their SHMS in respect to risk management processes. In particular the implementation of consistent risk management practices, review and document control.

According to one mining regulator, *"mining itself is an industry where hazards are large, risks are inherent and change is continual. Therefore successful management of risks associated with mining consequently requires a systematic approach".*

The above mentioned statement was shared by the Warden's Court Report (Windridge et al. 1996) on the 1994 Moura Mine Disaster, which recommended *"that mines be required to put in place Mine Safety Management Plans relating to key risk areas and that these plans should be based on detailed risk hazard analysis".*

In order to demonstrate how the introduction of risk assessment process in the mining industry has been successful it is appropriate to look at Crinum Mine which is regarded as having one of the best safety and operating standards in the Australian coal mining industry.

There is a very high degree of commitment to risk management and safety management plans because:

- Communication is a priority between miners, supervisors and management and
- Miners appreciate the fact that their experience and knowledge have contributed to the plan.

A standard risk analysis matrix is used to determine the risk category. The risk can then be categorised into intolerable; efforts must be made to reduce the risk further or tolerable; a level of risk that is low or can be managed as shown in Figure 3.12

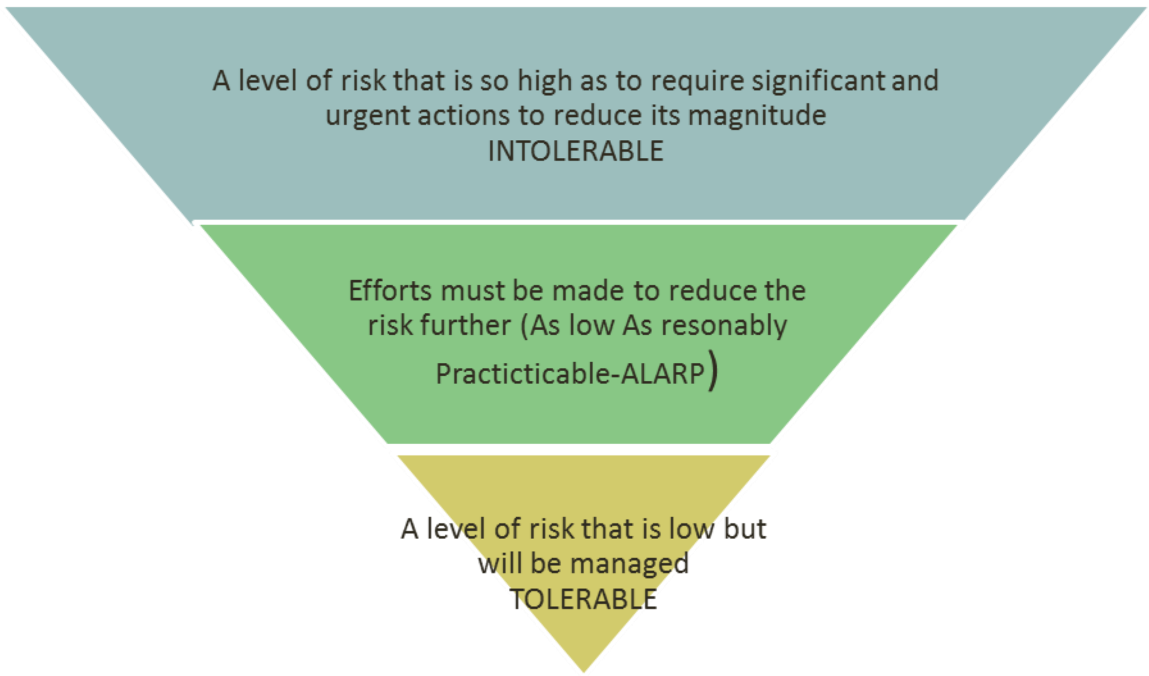


Figure 3.12 A Typical Risk Management Matrix – BMA Gregory Crinum Mine 2006

If a higher- level risk assessment or a Job Safety Analysis (JSA) has been carried out and the residual risks are (ALARP), then it is in order to proceed with the task.

One of the most important tools that is used at Crinum is The Take Five Process which is extensively used throughout the mining industry. It consists of five steps:

- Stop
- Think

- Identify
- Plan and
- Proceed

The process is detailed in Table 3.3

Table 3.3 The Take Five Process

1. STOP	Do I understand the task?
2. THINK	Is a documented procedure, JSA or work instruction available for this task Is there a current change to process, procedure or design? Am I trained, competent and authorised to do the task?
3. IDENTIFY	What hazards are associated with performing this task?
4. PLAN	What controls will I implement to reduce the risk of conducting the task to as low as reasonably possible
5. PROCEED	If the implemented controls reduce all residual risks to Low: Proceed with the task If the implemented controls DO NOT reduce all residual risks to Low: STOP and perform a JSA.

3.8.2 Industry Concerns Regarding Risk Management

Industry concerns regarding risk management and its application will be discussed in some detail. According to Cliff (2011) *"there are some concerns within the mining industry that risk management is not being properly or rigorously applied. Like many mature processes there is a risk of increasing complacency. There are examples where risk assessments appear to be done to reach an outcome and to avoid more work rather than control a risk. Some people seem to be doing Job Safety Analyses to meet quotas rather than to improve safety".*

Many safety practitioners have expressed concern to the author that the risk management approach only really satisfies the requirements of legislation and allows management to do some 'window dressing'. The risk assessment approach can tend to take away the ability of work groups to get on with carrying out the task safely. Also the fact that some miners have difficulty understanding or comprehending a document would question the use of this philosophy. The days when miners could use their initiative or think for themselves to solve a problem have long since gone. They are focused to use the system, in other words the miner becomes a robot. According to King (1999)

"It is not a matter of issuing instructions and expecting it to happen. People generally want to be actively involved in work and to use their brains and creativity. Too often, this is stifled by systems that allow no flexibility. One response is to become a robot, requiring detailed programming for every task thus making the job of management harder. A more sinister response is to find ways of causing the system to fail, or to find new and creative ways of beating the system. Both responses can result in increased injuries".

In the Minerals Industry Safety and Health Centre (2005) final report on the underlying causes of fatalities and significant injuries and the short comings of the risk assessment process resulted in:

- A lack of human error forgiveness in equipment and process operations. As human error is unavoidable in the longer term improving the tolerance of the presence of human error offers the opportunity to reduce the level of harm to people in the minerals industry.
- Lack of protection barriers to protect against human error
- A short-fall in maintenance strategies and implementation
- A lack of behaviour monitoring which, if strengthened, would reduce either the level of unsafe acts (Human Errors) or enable specific defences against the acts.

It is the author's and many other safety practitioners experience that the risk assessment methodology can be manipulated such that management can exert pressure on participants in a risk assessment in order to achieve a desired result. Therefore the whole process can be manipulated towards an outcome that suits management. In a submission to the 2005 Wran Mine Safety Review the Construction, Forestry, Mining and Energy Union (CFMEU) stated that;

"staff conducting risk assessments at site level are not properly trained to perform the task, nor take into account the full nature of risks".

The CFMEU and the Australian Workers Union have expressed negative attitudes to risk based legislation. They fear that risk will not be assessed and managed adequately and that the necessary enforcement to ensure that it is, may be deficient and therefore wish to retain prescriptive legislation.

According to Pitzer (2009) *"We create a myriad of rules and procedures that are supposed to defend us and create controls in the workplace and while it is largely successful, it eventually becomes a complexity of its own. Layer upon layer of risk controls actually create behavioural responses that expose the organisation in unpredictable ways".*

It is the Department of Natural Resources and Mines (DNRM 2013) contention;

"that safety standards are slowly eroding due to persons being appointed who do not adequately comprehend the task at hand. A process cannot be managed effectively without comprehending the process. This is being demonstrated, not only in the increasing number of concerning incidents, but also in the declining safety standards and reduced productivity being observed. People are being promoted to supervisor level and above who do not understand legislative requirements, hazard identification or the risk management process. The Queensland Mines Inspectorate, continually through investigations or audits, uncover a poor basic understanding of the processes these people are required to be managing or supervising.

It can be observed in Table 3.4 the Coal Industry Productivity Numbers for Queensland from 2000 to 2012 (sourced from data collected by the DNRM 2013) that in 2000 the tonnes per man raw was 20456 tonnes and in 2012 that had reduced to 6230 tonnes which is a 328% reduction in productivity. (the employees are mine site numbers and the productivity is plus or minus 20%).

Table 3.4 Coal Industry Productivity in Qld from 2000 to 2012

Year	Employees	Tonnes per annum (raw)
2000	8457	20457
2005	16786	13500
2010	28048	9816
2012	39975	6230

3.9 The Future

The future risk management processes will need to consider more than what can go wrong but also the consequences of an unexpected chain or coincidence of normal events. How can we detect and rectify small deviations from normal to prevent them from deteriorating into accidents and disasters.

Ross (2011) made the comment that that it is important to stay true to the intent of managing risk. We must make sure we do not get bogged down in processes and workshops which add little value, but instead think about why we want to perform a risk assessment in the first place.

Roche (2013) stated that *"there has been too much focus in some areas on process and tick-a-box compliance which has steadily eroded innovation and risk –based management practices".*

3.10 Discussion

The minerals industry has agreed that if safety performance is going to improve it needs to change the safety culture of the industry and implement programmes that achieve the objective of changing the attitudes and behaviour on mine sites. Five international accidents have been analysed namely:

- Space Shuttle Columbia
- Piper Alpha
- Deepwater Horizon
- Kings Cross Underground Fire
- Chernobyl Accident

The findings indicate that a poor safety culture was a factor in all five accidents and the deficiencies in organisational structure was also a major factor in the cause of these accidents. Poor communication was also a significant factor in all these accidents.

This chapter has attempted to demonstrate that one of the most important safety initiatives for achieving success in the mining regulatory environment is an effective safety culture and the important role that communication plays at all levels in the organisation and the involvement of the workforce. It has been demonstrated how mines with a positive safety culture can not only improve safety on mine sites but can also make big improvements in productivity at the same time. Also compliance with rules and regulations on mine sites will be more readily accepted and followed if the mine sites have a positive safety culture. It has

been shown that the four major components of a positive safety culture are visible management commitment, involvement of the workforce in all safety matters, communication and housekeeping.

The workforce needs to be able to observe the commitment of management to safety with open communication channels where information flows downwards from management and upwards from the workforce. They need to observe leadership by example. The workforce appreciates good leadership; they need to know exactly where they stand on all the issues that affect their day to day work environment. Examples of a good safety culture on mine sites have demonstrated how an effective safety culture can impact on safety performance by promoting teamwork, building good morale and therefore creating an appropriate safety environment. The workforce needs to be part of the solution to effective safety management and they need to be able to observe the attitudes and behaviour of management and they need to be able to observe management at all levels out in the field on a regular basis.

Human error has been discussed in some detail and can best be described as: “the failure of planed actions to achieve their desired ends – without intervention of some unforeseeable event” (Reason 1990). The importance of changing safety behaviour on mine sites as a means of improving safety performance is well understood by the mining industry. A recent analysis of incidents throughout the mining industry has identified that the majority of incidents causing injury are due to human error or unsafe acts or practices. Therefore attention to human error should go a long way to improving safety performance on mine sites.

Unsafe attitudes and acts have been discussed in some detail, it is therefore important for the mining industry to put in place systems and procedures to manage unsafe acts in the same way it has effectively managed LTI’s. It has been demonstrated that unless the mining industry puts systems in place to identify and deal with unsafe acts people will continue to perform them since there are seldom immediate consequences for working unsafely. A safety behaviour model has been discussed whereby a relationship between the concepts of the regulatory environment, mine site specific rules and the resultant behaviour of the workforce which is illustrated by a wheel of safe behaviour (Laurence 2001).

The key elements of safety management systems have been discussed and shown, how, if implemented, can appropriately improve safety performance. It has also been demonstrated how effective communication and consultation with the workforce can influence the positive outcomes of a safety management system, which help to create a positive partnership leading to acceptance and indeed ownership of the system. At different mine sites some examples of a positive implementation of safety management systems has been demonstrated. The discussion gives a few examples of the difficulties encountered when implementing these systems. It has also been demonstrated that the most important deficiencies are the amount of paper work generated during an audit process and the fact that this weakens the input of employees because of the updating all the elements of the system.

It has been suggested that Safety and Health Management Systems (SHMS) are so cumbersome that they become another system that sits in the library or the safety manager's office collecting dust. The physical size of the document has the potential to limit availability to the workforce and that it is usually written in such a manner that it is difficult for employees to understand or locate the information they require in order for them to appreciate their responsibilities under the management system. One of the biggest problems with SHMS is the lack of understanding by the workforce of the key elements due to its complexity and in some cases the limited communication and consultation by management. It has been illustrated that that some employees are unable to read and write and others have difficulty in reading basic literature. This problem is further exacerbated by the large number of contract workers who are now employed in the industry and in some cases are moving from site to site on a regular basis. This would suggest that some employees with little or no knowledge of the mine's requirements would have to rely on their own understanding and experiences of safety systems to get them through their work on a daily basis.

In order to demonstrate the issues with SHMS, two examples of mines being closed in order to improve safety performance have been discussed. It is therefore not unreasonable to suggest that there may be many more instances. After the death of a truck driver the coroner was very critical in her comments regarding the controls and activities in place in order to ensure that contractors are carrying their tasks in a safe manner (Hennessy 2007).

SHMS are now enshrined in legislation and consequently are part of the way forward. However in order to improve the implementation they need to be less complex more easily understood by the average mine worker and the elements need to be standardised across industry. Most importantly, mine workers need to be trained in order that they understand their obligations under the SHMS. In order to improve the safety outcomes system audits should be conducted rather than compliance audits. It is now proposed that in Queensland mine contractors will have to operate under the same SHMS as permanent employees.

Risk management techniques are now an integral part of the way the mining industry operates and as a consequence has been discussed in some detail and an example of a risk assessment process has been detailed. Also the problems with the risk management philosophy have been outlined in some detail. One of the main issues with the risk assessment process is that it takes away the ability of miners to think for themselves in order to carry out a task. They are forced to use the system which causes the miner to become like a robot, which may have serious consequences for safety improvement. These practices encourage supervisors to abdicate responsibility and just rely on the outcomes of the risk assessment.

In the discussion it has been demonstrated that risk assessments can be manipulated towards the outcome that suits management. The discussion has demonstrated that the CFMEU considers that *"staff conducting risk assessments at site level are not properly trained to perform the task, nor take into account the full nature of risks"* They would prefer a more prescriptive regulatory framework in order to improve the safety performance in the industry.

The mining industry is a hazardous and ever changing environment whereby there is always room for improvement in educating mine workers, in planning for safety improvement, communication and constant vigilance when carrying our day to day tasks.

It can be concluded from this chapter that the mine safety environment which includes mine site safety culture, safety management systems, risk assessments agrees with the hypothesis that safety performance in the mining industry may not be improving.

The next chapter will deal with fatigue management and hours of work in the mining industry.

CHAPTER 4

4. FATIGUE MANAGEMENT AND HOURS OF WORK IN THE MINING INDUSTRY

4.1 Fatigue Management and Hours of Work in the Mining Industry

This chapter will review the literature regarding fatigue management and work hours in order to understand the implications of these issues for safety improvement in the mining industry. As previously stated, fatigue and awareness issues are having a major impact on safety at work, which is particularly evident when people are working 12-hour shifts.

The rapid expansion of the mining industry has required the growing use of contractors which has created a more inexperienced workforce. According to the Queensland Mines Inspectorate “Consultation Regulatory Impact Statement 2013”

“The effective management of contractors is a continuing cause of concern of the Queensland Inspectorate. Alarming incidents and near misses involving contractors continue to occur. Coronial findings have emphasised the importance of there being only one safety and health management system at a mine and this needs to be followed by all workers whether employees or contractors. Eight of the nine deaths in Queensland coalmines and ten of the twenty deaths in Queensland metalliferous mines and quarries have been contractors since the current mining safety and health legislation came into force in 2001”.

On the whole, contractors tend to be less experienced in the mining industry than other workers. The increasing use of contractors and their overrepresentation (based on their proportion of the workforce) in fatalities indicates the importance that contractors be effectively managed on mine sites.

4.2 Definition of Fatigue

According to the Queensland Department of Natural Resources Guidance Notes for Fatigue Risk Management (2013), fatigue can be defined as a state of impairment that can include physical and/or mental elements, associated with lower alertness, reduced performance and impaired decision making. Signs of fatigue include tiredness even after sleep, psychological disturbances, loss of energy, irritability, moodiness and inability to concentrate. Fatigue can lead to incidents because workers are not alert and are less able to respond to changing circumstances, thereby putting themselves and others at risk. Fatigue can also impair decision making, and therefore cause errors of judgement. As well as these immediate problems, fatigue can lead to long-term health problems.

4.3 Causes of Fatigue

Fatigue is a complex multifactorial problem that can have many contributing factors and develops directly when there is insufficient sleep quality or quantity. There are a number of 'direct' causes of fatigue, due to insufficient sleep quality or quantity. The quality and quantity of sleep obtained prior to and after a work period can be influenced by:

- Activities outside of work, such as family commitments, a second job or recreational factors
- Individual factors, such as sleeping disorders, health and illness issues and
- Noise or other disturbances during sleep times.

Fatigue most commonly arises from periods of wakefulness without adequate rest and is usually considered to have two presentations:

1. Acute fatigue and
2. Cumulative fatigue.

Acute fatigue is usually experienced after a one-off or immediate episode of sleep loss such as an extended period of wakefulness, sleep disturbances or inadequate sleep. Ongoing lack of sleep, disruption of lack of restorative sleep can lead to sleep debt and hence cumulative fatigue, which increases the risk of fatigue related incidents or errors of misjudgement.

The effects of lack of sleep quality or quantity may be experienced as cognitive (or mental) fatigue, and may result in the following:

- Reduced alertness and coordination
- Changes in mental performance or decision making
- Changes in emotional function and
- Micro sleeps during tasks.

Fatigue can result from work related or non-work related causes, or a combination of both. Fatigue has known effects on certain tasks or tests but is not consistently measureable without specific and verified testing. Work related fatigue can and should be assessed and managed at an organisational level. The contribution of non-work related factors varies considerably between individuals and is best managed at an individual level (Queensland Department of Natural Resources Guidance Notes for Fatigue Risk Management 2013).

Work related causes of fatigue can include:

1. The length of time spent at work in work related duties
2. The time of day that work takes place
3. Work design (highly demanding workloads, mentally challenging work and monotony)
4. The type and duration of a work task, and the environment in which it is performed
5. Organisational factors leading to stressful work environments, such as bullying , harassment or other psychological factors
6. Roster design for example, too many consecutive shifts without sufficient restorative sleep
7. Working environment which includes noise or temperature extremes
8. Overtime, unplanned work, emergencies, breakdowns and call-outs and
9. Commuting times.

Non work related causes of fatigue can include:

1. Sleep disruption due to issues at home
2. Sleep disorders, insomnia and other co-morbidities

3. Strenuous activities outside work, such as a second job or other recreational activities impacting on the person's sleep patterns
4. Use of prescription medication, alcohol or illegal drugs and
5. Financial stress associated with domestic responsibilities.

Fatigue increases the risk of incidents and long term health problems due to physical and mental tiredness and lack of alertness. When workers are fatigued they are more likely to exercise poor judgement and have a slower reaction in order to carry out the task safely. Fatigued workers are less able to respond effectively to changing circumstances, leading to an increased risk due to potential human error. Fatigue also increases the risks off site, for instance when the person is driving back to his or her home or accommodation. According to the Queensland Department of Natural Resources and Mines Guidance Notes for Fatigue Risk Management (2013), cumulative or long term exposure to fatigue, associated with shift work have been linked to long-term health problems, such as:

- Heart disease
- Digestive problems and
- Stress and other psychosocial issues.

It is clear from the above discussion that a minimum amount of sleep is required to maintain a baseline waking function. Recent research has indicated that individuals who obtain less than six hours sleep per night for a series of consecutive nights will exhibit cognitive and physical performance impairment (Dinges 1995).

4.4 Cognitive Psychomotor Performance and Decrement Associated with Sustained Wakefulness (SW) and Alcohol Intoxication.

Since the industrial revolution shift work has become an increasingly common work practice. Research studies over the last twenty years have clearly identified shiftwork as an occupational health and safety risk factor (Akerstedt 1995). Reduced opportunity for sleep and reduced sleep quality are generally considered to be major risk factors associated with shiftwork related accidents (Akerstedt 1995; Leger 1994; Milter et al. 1988). Not surprisingly, the combination of these factors leads to increased fatigue, lowered levels of alertness and impaired performance on a variety of cognitive psychomotor performance tasks (Harrington 1978).

Experimental studies have shown that sustained wakefulness (SW) impairs several components of performance including hand-eye coordination, decision making, memory, cognitive, visual search performance and speed and accuracy of responding (Babkoff et al. 1988; Fiorica et al. 1968; Linde & Bergstrom 1992). In addition to cognitive factors, affective components of behaviour such as motivation and mood are altered as the duration of SW increases (Babkoff et al. 1988; Bohle, P. & Tilley 1993).

It is clear from the abovementioned studies that there is a consensus that cognitive psychomotor performance is impaired by sleep disruption and extended wakefulness associated with shift work (Akerstedt 1995). This performance impairment is associated with increased risk of accidents (Dinges 1995).

The western industrialised countries have generally not legislated to manage and control fatigue in a manner commensurate with the statistical risk associated with it. However this policy is changing particularly in the mining industry. Under both the Qld and NSW legislation fatigue is treated identically to alcohol intoxication, except that it is recognised that there is no universal community standard of wakefulness to test against. The current literature focusses on attentiveness and recognises the complex contributions of physical fatigue.

4.5 Fatigue Related Issues

Fatigue is a state of impaired physical and/or mental performance and lowered alertness arising as a result of inadequate restorative sleep. Other mediators of fatigue are time of day and length of time awake (Baker & Ferguson 2004).

Fatigue contributes to accidents by impairing performance and at the extreme of the scale by causing people to fall asleep. Some of the worst accidents in the past thirty years have identified fatigue as a major contributing factor to the incident. In the UK it is estimated by the Department of Transport that at least 20% of fatal road accidents on UK motorways are a result of drivers falling asleep at the wheel. In the USA driver sleepiness is estimated to have contributed to 57% of fatal accidents involving trucks according to the International Petroleum Industry Environmental Conservation Association (IPIECA 2007).

One of the most important determinants when trying to solve the shift rotation issues is the circadian rhythm and with most mines including underground mines working up to twelve hour shifts it is a very important part of the process. It is defined as follows:

"Human beings are programmed to sleep during the night hours and to be active during the day. The sleep/wake cycle is called the circadian rhythm. The term circadian comes from two Latin words, circa – About, and diem – a day. Thus circadian rhythms refer to physiological functions that cycle over a day.

Examples are the sleep/wake cycle, alertness and performance, body temperature, production of hormones like melatonin and cortisol and heart rate. These rhythms are generated by a clock in our brains, which controls their timing. Circadian rhythms do not generally adjust easily to shift work" (Baker & Ferguson 2004).

The Minerals Council of Australia commissioned this work by Baker & Ferguson to assist people in the mining industry to assess existing and proposed working arrangements, and identify fatigue related issues and concerns.

Sleep deprivation and fatigue are largely dependent on working time arrangements. Therefore in order to develop working time arrangements that aid sleep, health, wellbeing, work design, and fatigue it is important to obtain detailed information on the interaction between human physiology and working time arrangement.

4.6 Recent Research

Recent research has shown that shift arrangements can have significant consequences for health and safety of mine workers. Long working hours are associated with adverse health outcomes such as heart disease, sleep disorders, gastrointestinal disorders, and psychological illness and fertility problems (Wran 2007).

A study conducted for Japanese men workers (Liu and Tanka 2002) found that a dose-response relationship between hours of work and the risk of non-fatal acute myocardial infarction (heart attack) was evident. The longer the hours of work, the higher the risk of heart attack. Working more than 60 hours per week nearly doubled the risk of heart attack. The highest risk was found to be the number of days per week where workers had less than 5 hours of sleep. Two or more days per week with less than 5 hours sleep increased the risk of heart attack by three and a half times. The main messages from this study stated that:

- *Longer working hours were related to progressively increased risks of acute myocardial infarction (AMI)*
- *Insufficient sleep was also associated with increased risk of AMI*
- *Long working hours and insufficient sleep in the recent past were more strongly related to an increased risk of AMI and.*
- *The policy implications are to;*
    1. *Restrict working hours to 40 or less and*
    2. *Those working for a prolonged time should take sufficient sleep or take at least two days rest a month.*

The abovementioned data may even underestimate the risks associated with extended working hours (Newcombe 2007). Newcombe suggests that excessive working hours may in fact be influencing such health factors as body mass index, hypertension and high cholesterol levels.

The following study suggested that stress in the workplace is exacerbated when working long hours. According to Maruyama & Morimoto (1996) who compared managers working at similar organisational levels, it was found that those who worked more than 10 hours per day were more than two and a half times more likely to experience high job stress than those who worked less than 9 hours per day.

For those mines that operate outside of the standard working hours of nine to five, fatigue has been found to be a major hazard. Most mines operate seven days a week and shifts have duration of between 9 and 12 hours and in many cases sometimes even longer with overtime. These working arrangements are associated with increased risk of fatigue related errors and awareness issues compared to working day time-hours.

Reference will be made to the Digging Deeper Report, which was commissioned by the NSW Mine Safety Advisory Council and published in November 2007. This report is probably one of the most comprehensive that has been undertaken in the NSW or Queensland Mining Industry. During the research some 53 mines sites were visited, 583 people were interviewed and 1667 people completed questionnaires.

According to Dinges et al. (1997) Lamond and Dawson (1999) Harrison and Horn (2000) the consequences of sleep deprivation and fatigue are extensive and impact on a range of mood and performance variables. Some examples include: reduced concentration, impaired attention, poor judgement of own performance, inability to assess problems and determine solutions, impaired decision making, slower reaction times, poor hand eye co-ordination, poor communication skills, impaired short term memory, mood swings, loss of situational awareness and increased lethargy. This chapter will also review the research literature regarding long work hours and fatigue to assess their impact on health and safety of mine workers.

4.7 Hours of Work

Consensus in the existing research literature seems to suggest that exceeding a 48 hour working week, causes uncertainty over the pathways from work to psychological or physiological health. Previous studies have found: associations between the number of work hours and physical illness or symptoms, associations between variable shift ratios and effects of shift rotations on exhaustion and hinted at the importance of employees being able to influence the health effects of long hours.

The Australian Coal and Energy Survey (2012) highlights many aspects of mining and energy work that are subject to substantial change, including rapidly advancing hours and unpredictable shift patterns. This study reinforces evidence that variable shift patterns, and in particular night shift, are causing sleep disruption, which has significant health and safety implications. There also appear to be significant linkages between this variability and sleep disruption on one hand and physical health on the other. This study also indicates that for those workers who clearly want and are unable to attain fewer working hours, there appears to be significant impacts on depression and a greater use of sleeping tablets, antacids and anti-depressants.

It is now very clear that jobs in the mining industry are characterised by something with significant physical and psychological health implications and lack of control. Changes in the mining and energy sector have been underpinned and reinforced by a shift in power from labour to capital. Most employees now have very little say over their hours and shift arrangements and half of employees have no say at all. Despite the high level of exits from the industry as workers find the working arrangements too difficult, half of the mining and energy workers who remain in the industry would prefer to be working less hours than they are working, even after taking account of the impact on their income, leisure and domestic activities.

This lack of control, combined with tiredness, is not simply making mining and energy workers feel unsafe: it is having negative health consequences, including affecting psychological health. Workers with no control over their hours and shifts have more difficulty sleeping and are more likely to feel unsafe at work or on their way to or from work. They are more likely to feel too tired and too emotionally drained to do things they need to do at home. The low level of control and high level of preference for working shorter hours means that mining employees record a high level of disjuncture and interference between work and lifestyle. This lack of say over basic work-life decisions is having a flow on effect on partners of mining and energy workers, who often confirm that their spouses are indeed too tired or emotionally drained to function properly in the household, and which in turn has other adverse effects on partners.

The following are some comments made by the participants of the survey:

Sick of being treated like a machine or just another number on the employer's database. People don't get treated like people anymore, we are too replaceable. Employers are getting more demanding every year. The Australian way is no longer, it is now asking more and dob in a mate.

I don't understand how anyone can be allowed to work 12 hour rotating shifts. How can mining companies push safety so hard and pretend it's a priority then allow fatigued workers on the road. How can companies preach health and safety and then force workers to work 12-hour rosters. How can governments preach "stop revive survive" and then allow them to get away with it.

Camp life is unbearable but what else am I to do, it is the only option.

Concerns over crew members not getting enough sleep, falling asleep in machines and having accidents as well as moods, which influence job security.

I believe 12 hour 40minutes shifts are dangerous, especially for night shift, in the mining sector for fatigue purposes and should be outlawed. I see people pushing themselves through these shifts in an unsafe manner

A lot of the workers at my mine still on the rotating roster are tired all the time, falling asleep on day shift at lunch time.

Night shift is a risk both in terms of health and increased risk of an accident at work or driving to and from work.

Injuries appear to increase after midnight, as does the severity, which appears linked to work group fatigue.

12 hour shifts and FIFO is destroying families and communities. Community segregation is caused with mining camps which means that businesses are suffering.

The morale at work is terrible, management are not listening to their workers, they rule with a big stick.

Since the implementation of the Howard Government's industrial relations laws, which were introduced in 1996, there has been a move away from the traditional eight hour shift to the twelve hour shift. This has allowed companies to move to new rosters, which were originally rejected by union members because of the longer working hours. However mineworkers soon saw the advantages of these new rosters in that they could provide longer breaks from work. Examples of a 12 hour roster are working four days on and four days off, or seven days on and seven days off which means with holidays the mineworker works less than six months per annum. On days off mine workers are able to travel long distances, which has enabled a majority of mine workers particularly in Queensland to live preferably in coastal communities. In this regard Andrew Vickers of the CMFEU made the following statement which indicated that they are:

Aware of people travelling by car from mines in Central Queensland to as far away as the Hunter Valley in New South Wales, the Gold Coast, Sunshine Coast, Townsville and Cairns (Queensland tackles problems generated by the mining boom in our communities' 2006)

Although the miners admit to fatigue working these long shifts, because of life style considerations that these rosters provide for their families they would be very reluctant to move away from these shift arrangements. Recent mine expansions have led to miners working in areas where accommodation is limited which has led to more traffic on the roads and with a 12 hour shift it means that most of these mine workers are on the roads at peak morning and afternoon periods. With hot seat change-overs this means that some rosters have shift lengths of 12.5 to 13 hours.

The transportation of heavy mine equipment, fuel and oils to mining areas is not only a hazard in its own right but it is a hazard to persons travelling to and from work. This increase in traffic volume and the consequential accelerated deterioration of the road system are hazards that drivers must face travelling to and from work.

The above-mentioned long working hours and fatigue associated with them is at the forefront of industry's attention following a double fatality on Queensland roads in 2005. This incident is the subject of a coronial inquiry and it is expected that the findings will have a significant impact on the way these related issues are dealt with in the future which will be discussed later on in this chapter.

4.8 Mining Industry Rosters

In light of the abovementioned issues, hours of work in the mining industry require careful management. Many factors have been identified as contributing to potentially adverse impacts. These require special attention but only when the site specific-factors are included. The importance of site-specific factors reinforces the need for site management and workers to exercise their duty of care and not rely on generic guidelines or regulations.

Many different types of roster are being employed in the mining industry today, which predominantly has twelve hour shifts. These rosters allow mine workers to live in major centres and coastal communities and provide for up to seven consecutive days off which allow miners to commute long distances. For those who drive (which would be the majority) it exacerbates the issue of fatigue especially at the end of a shift sequence when the individual concerned is keen to get home. If one considers underground employees especially those doing hard physical work, the problem is exacerbated. Underground miners in particular admit to finding the twelve hour shift difficult; however the life style considerations overrule the safety and health issues at the expense of potential accidents and incidents.

According to Cliff (2006), who conducted a study of the relationship between hours of work and accidents and incidents in the Australian mining industry suggested that it is not possible to compare different rosters to see if one roster pattern had a lower incidence rate than another because there appears to be no uniform definition or application of definitions in reporting incidents between mines. It is not possible to assess the incident rates during overtime worked as overtime hours as they were not tracked in sufficient detail. The issue of contractors further exacerbated the problem especially short term contractors who are difficult to keep track of in the detail which is required. The concluding remarks from this study were as follows;

- Fatigue research has not yet produced a significant body of evidence based data that clearly delineates the relationship between work patterns, job/task demands, sleep duration and worker performance (Dawson, D. and Zee, P. 2005).
- Many studies are poorly designed and controlled and use poorly defined measures. This results in difficulty in drawing conclusions from the existing literature that could serve as a guide to policy advice. Hence there is a need to develop more specific multi-method exposure assessment tools to minimise the variability of measures and definitions used in fatigue research in general. This lack of specificity creates difficulty in drawing comparisons and meta-analysis for epidemiological purposes.

The Western Australian mine safety legislation review in 2003 described the nature of the mining industry in that state, in terms that are equally applicable to the mining industries in NSW and Queensland:

"*The mining environment, operations and culture are significantly different from industry generally. Mines are often located in distant and sometimes remote locations.*

Mines themselves are often very dusty, noisy and dirty places to work. The work can be highly repetitive, and sometimes physically demanding but not always mentally or intellectually stimulating or challenging. In most modern mines, shift arrangements mean that employees work extensive periods and many do not get regular or perhaps even adequate rest breaks".

4.8.1 Characteristics of Shift Patterns

According to the Digging Deeper Report (Wran 2007) the following specific characteristics of shift patterns that are known to influence fatigue are:

1. *Sleep opportunity*:

   An example of sleep opportunity is as follows;

If an individual is working a twelve hour shift and the commute time is 30 minutes each way then the sleep opportunity time is approximately eleven hours. In this period time will be spent engaging in personal, family, social and leisure activities.

2. Consecutive night shifts:
   A sleep debt can be accrued over a period of consecutive night shifts due to quality and quantity of sleep obtained during daytime hours. The risk of an accident increases with each consecutive night shift worked. According to Folkard & Tucker (2003) compared to the first night shift the risk is increased by 17% on the third night shift and 36% on the fourth.
3. *Start Times*:
   If people start before 6 am in the morning they have to truncate their sleep period in the early morning hours, due to the 'forbidden zone' for sleep in the early evening hours (Larvie 1986). It is very difficult to go to sleep earlier than normal in order to compensate for early starts. Early starts can lead to clock watching and may also require people to drive to work in the lowest point in their body's alertness rhythms, in the early hours of the morning.

4. *Shift Length*: If people are working long shifts it reduces the time for sleep as sleep is sacrificed in favour of other non-work related activities in order to maintain normality for shift workers. The shorter the sleep opportunity the less sleep will be obtained. Research has indicated that the risk of accidents occurring increases significantly from the 9^{th} hour of work (Folkard & Tucker 2003). Prior wake impacts on alertness and performance. A shift length of 12 hours will be associated with a prior wake of at least 13 hours and possibly longer depending on the travel time and therefore the time arising from sleep.

5. *Direction of Shift Rotation*:
   It is a well-known fact that forward rotating shifts day, afternoon and night are a better match for the body's natural rhythms and as a consequence result in less sleep disturbance (Knauth 1997).

There are a few devices for measuring and monitoring fatigue and some of these devices are being tested in the mining industry. However these devices do not prevent fatigue and therefore cannot be used as a preventive strategy. The strategies that will be discussed later on in this thesis will concentrate on fatigue management.

4.9 Sustained Wakefulness

Results from two studies conducted by the Centre for Sleep Research, South Australia 1998 supports the idea that Sustained Wakefulness (SW) may carry a risk comparable with moderate alcohol intoxication since approximately 50% of shift workers on eight hour shift patterns typically spend at least 24 hours awake on the first night shift in a roster (Knauth et al. 1980).

The highest level of impairment observed in this study equivalent to (0.096% blood alcohol level BAL) would occur at the end of a typical night shift (i.e. 0600-0900 hours) and would frequently coincide with a trip home for many shift workers.

According to Muller (2008) from the School of Public Health and Tropical Medicine at James Cook University, miners working more than eight consecutive 12 hour day shifts were fatigued beyond the impairment expected from a blood alcohol concentration of 0.05%.

The results from these studies support the proposition that performance impairment and the risks associated with SW are significant and are similar to those observed for moderate alcohol intoxication in social drinkers.

The current literature indicates that controlling the causes of fatigue is not just a question of working hours: it's about the time available for sleep recovery. Generally speaking, a good threshold for hours of sleep recovery is as follows:

1. People should aim to have between seven and eight hours sleep each night.
2. Less than six hours of sleep over a few nights will result in impaired performance.
3. In most cases sixteen hours of wakefulness will result in impaired performance.
4. The length of waking hours should not exceed the total amount of sleep in the previous 48 hours.

5. The loss of one night's sleep requires more than one nine-hour sleep to recover.

Controls are necessary for the assessment of fatigue related risk in the work environment and these controls must be based on organisation and personal factors such as working hours, shift design, quality and amount of rest prior to and after a work period, activities outside of work and other factors including sleep issues.

4.10 A Comparison of Work Hours in the NSW & QLD Mining Industry

The weekly hours of work in the NSW mining industry are high when compared to the mining industry as a whole, according to the Digging Deeper Report (Wran 2007). This is illustrated in Table 4.1 and clearly shows that people in the NSW mining industry are working long hours compared to the Australian mining industry as a whole.

Table 4.1 Average Hours of Work in the NSW Mining Industry

	NSW Mining Industry Mean (hours per week)	Australian Mining Industry Mean (hours per week)
Employed full time	50	46

When trying to compare statistics across national boundaries the information obtained is not always reliable due to working hours and definitions, however the following gives some comparative data. The United States of America mining industry in July 2007 worked 47.3 on average, which is over two hours less than the NSW mining industry. The highest average in Europe in 2006 was in Austria at 44.3, which is over five hours lower than the NSW mining industry.

A standard international definition has been developed for working over 48 hours per week and on that basis, the International Labour Organisation Report (2007), gives comparative statistics for twenty countries from 2000-2005. These statistics have been analysed and it was found that Peru had the highest percentage of employees working long hours with 51% of employees working more than 48 hours per week. The NSW mining industry is well in excess of this figure with 53% of employees working more than 48 hours per week. Based on the current information available it can be assumed that the situation in Queensland would be similar to that of NSW if not worse.

Significant differences between hours worked by the different occupations in the NSW mining industry was found in the Digging Deeper Study Survey. It can be observed from Table 4.2 that managers and undermanager's worked the longest hours, as one would expect with the administrative employees working the shortest hours. The data shows that generally speaking managers, supervisors, engineers and other professionals usually work longer hours than miners, tradespeople, equipment operators and labourers in the coal mining industry.

Table 4.2 Hours Worked in the NSW Mining Industry

Activity	Average Hours per week
Mine or quarry manager	55
Manager/undermanager	54
OHS manager/officer	52
Engineer	52
Deputy & other supervisors	52
Other professionals	51
Miners	49
Trade persons	49
Equipment operators & labourers	49
Administrative employees	44

The above mentioned long hours were reinforced by interviewees from staff groups during the survey who reported that they were fatigued as a result of their long hours of work and shift arrangements.

We work Twelve and a half hour night shifts – you only need bad concentration for a couple of seconds for something bad to happen. Fatigue is a really big problem. Twelve and a half hour day shifts are not too bad, night shift is dreadful. I don't know how truck drivers manage it (coal employee).

Excessive hours worked causes fatigue and needs to be looked at for people's safety (coal employee).

We have had lots of incidents; a truck ran off the road, lots of incidents falling asleep. Lots of people fall asleep and don't report it. You see marks, so you know what's happened. The consequences depend on who notices. If there is damage to the vehicle you have to report it, but otherwise people are too scared to speak up about it (coal operator).

I'm regularly doing 14 hour days. I am always tired; I always fall asleep driving home. I never get a full night's sleep. We don't get a break through the day. I fall asleep on the job and don't remember stuff (metalliferous supervisor).

4.11 Fatigue Risk Factors

According to the Wran (2007) report there is a significant difference in the levels of fatigue depending on the shifts being worked. The biggest problems regarding fatigue and work performance were on night shift. The findings that both night shift and afternoon shift have negative effects on work performance, alertness and the ability to concentrate would suggest that the current shift arrangements are not adequately managing the risks associated with shift work. The data shows that of those who work night shift:

- One third have problems with fatigue.
- Nearly one quarter have problems with work performance.
- Nearly one third have problems with alertness; and
- Nearly one third have problems with their ability to concentrate.

The results of these responses suggest that for employees working these shifts, coupled with the long hours that they are working, would indicate that there are substantial ramifications for health and safety improvement in the mining industry. The most important roster risk factors on mine sites were found to be attributable to:

- Starting times especially before 6am;
- The number and length of breaks during the shift;
- Seasonal changes in roster pattern;
- Fly in Fly out and Drive in Drive out rosters;
- Commute times, some exceeded an hour each way and
- Financial incentives.

In NSW each mine site was assigned a risk rating based on the roster arrangements using the abovementioned criteria. It can be observed from Table 4.3 that given the difference in the roster arrangements between the extractive sector and the other two sectors, it is not surprising that the rosters used at most extractive sector sites are in the low risk category. Metalliferous rosters are distributed across the rankings and most coal rosters are in the medium category.

Table 4.3 Roster Risk Parameters

Sector	High risk	Medium risk	Low risk
Coal	4	10	3
Metalliferous	4	2	3
Extractive	3	4	18

4.12 Industry Issues with Fatigue and Long Work Hours.

Although mine sites in NSW are now using a systematic approach to risk management for hours of work and fatigue some shift supervisors are working 14 hours on site and then have to commute up to one hour to and from work which reduces their sleep opportunity well beyond safe limits. Even though the NSW mining industry is usually located near residential centres, these extended shifts and commuting times considerably limit sleeping opportunity:

We have people who travel to Cessnock so, on top 12 hour shifts, with shower and travel they can be away from home for 14.5 hours (coal manager) (Digging Deeper Report).

Long hours of work and fatigue are causing safety and health problems in Queensland. The wealth that has been generated from the mining boom in Central Queensland has been at the centre of media and public attention. According to the Queensland CFMEU President Andrew Vickers the boom is creating serious social consequences for people in the industry and the communities in which they live. This rapid expansion, coupled with compressed work schedules, has caused a dramatic increase in road usage in areas not designed to cope with the volumes of traffic that these roads now have to handle.

Vickers also stated that employers are moving away from providing proper accommodation in the mining centres, which had resulted in some cases with workers sleeping in cars and under bridges. Because of limited affordable housing mining companies are attempting to provide single person accommodation for employees which has resulted in more families relocating to nearby centres in Mackay, Rockhampton and Yeppoon. This problem has been further exacerbated with all companies moving from eight to twelve hour shifts, which means that most mine workers commute to these centres after completing a roster sequence. According to Vickers:

"Employers can't say in 2007 we are going to put a mine in Central Queensland and we will provide you with single person accommodation we don't care where you live where your family is and you get yourself to and from work the best way you can it's not our responsibility" (Smith 2007).

The dramatic increase of traffic on the highways where workers are driving to and from work, has proved to be a major safety issue. Police figures show that the Central Queensland region accounted for sixty percent of all fatigue related road crashes in the state in 2006 and the traffic on the Capricorn highway which is the gateway to the mining region had increased by 30% in the same period (Smith 2007).

An international conference in 2007 was told that not enough drivers know about fatigue and its impact on driving. This conference followed a double fatality and another incident in Central Queensland in 2005 and is the centre of a Coronial Inquest which was held in Rockhampton. The inquest was trying to ascertain if fatigue played a part after it was revealed that the mineworker had been awake 17 hours when attempting to drive the 250-kilometre journey home to Yeppoon. Andrew Vickers made the following comment regarding fatigue:

"People will have to accept the fact that they're going to have to sleep before they can take off on a long journey, for example after concluding a 12-hour night shift. It's simply

intolerable that people would work for 12 hours straight and then start off on a 10 or a 15-hour road trip. It's ludicrous". (Smith 2007)

According to David Logan (2013) fatigue is a serious issue in mining, particularly once mine workers get into a car to drive often long distances home after working long hours. Central Queensland Coroner Annette Hennessy recently made 24 recommendations for the industry following her investigation into the two separate fatal road accidents, one in Yeppoon in 2005 and the other in Dysart in 2007. She stated that driver fatigue was a potential factor in both incidents where coal miners were driving home following work.

4.13 Analysis of Vehicle Incidents in Queensland, New South Wales and Western Australian Mines

The contribution of these abovementioned issues and in particular "fatigue" associated with vehicle incidents will be investigated in Table 4.4. The table illustrates the fatal, significant and high potential incidents from 2001-2013 where human behaviour and other factors can be identified. These reports are listed on the web pages of the Mines Inspectorate in Queensland, New South Wales and Western Australia.

These incidents have been caused by the following issues:

- Vehicle Collisions
- Vehicle Loss of Control
- Fatigue
- Not complying with safe work procedures
- Lack of awareness of rules and procedures
- Repetitive duties when operating equipment
- Design of haul roads
- Inappropriate traffic plans
- Disconnect between managements perception of compliance and on the job reality
- Inappropriate barriers
- Lack of supervision and

- Lack of communication

These incidents would increase considerably if all incidents regarding vehicle collisions and loss of control were reported. Very few operators will admit to fatigue unless there is a witness or there is damage to the vehicle concerned, since these mainly dump truck operations, particularly in open cut mining, are repetitive and consequently can cause the operator to suffer weariness, boredom and fatigue particularly so when working 12 hour shifts.

Table 4.4 Serious Incidents, High Potential Incidents and Safety Alerts in Queensland, New South Wales and Western Australia from 2001-2013 (Sourced from Departmental Web Sites).

1.QUEENSLAND	**2001-2013**
VEHICLE COLLISION	**INCIDENT CAUSE**
DRIVING WHILE FATIGUED	A mines inspector was driving on the Bruce Highway when a vehicle travelling in the opposite direction veered into his path. With a head on collision very likely the inspector braked and steered off the highway into a creek bed. **The driver of the offending vehicle was found to have had a micro sleep. Two fatigued persons had decided to undertake a 5 hour journey and then they intended starting a 12 hour shift, putting themselves as well as their workmates at risk.**
TRUCK COLLIDES WITH DUMP TRUCK	On the first nightshift an operator of a loaded dump fell asleep on entering a left hand bend, crossed the lanes and collided with an approaching empty rear dump truck. **The inspectorate gave credit to the operator for admitting he was asleep.**
LOADER BACKS INTO A DUMP TRUCK	A radio communications-mix up resulted in a Komatsu WA 500 loader backing into a Cat 771 dump truck.
DRAGLINE COLLIDES WITH LIGHT VEHICLE	During a dragline cable move the right hand front shoe of the dragline collided with an unoccupied Toyota Land Cruiser.
CONTACT BETWEEN EXCAVATOR AND TRUCK	A dump truck operator jarred his neck and shoulders when an excavator bucket contacted the truck tray during loading.
DOZER REVERSES INTO DRAGLINE	A Cat D11 Dozer was pushing material in front of a dragline reversed into the front left side of the dragline.
LOADER REVERSES INTO LIGHT VEHICLE	A Cat 992 loader reversed into a surveyor's light vehicle that had been given permission to park 20m from the loader. The loader pushed the occupied vehicle 3m sideways before the loader operator was alerted by a nearby Dozer operator.
COLLISION BETWEEN TWO TRUCKS	A medium sized rigid truck collided with the rear of a water truck which stopped suddenly.
VEHICLE LOSS OF CONTROL	
TRUCK VEERS INTO BUND	An operator of a Hitachi 4000 dump truck had a micro sleep and veered into the bund on the side of the haul road.
TRUCK STRADDLES BUND	A loaded dump truck travelling down a ramp straddled the bund when the offside wheels caught in the soft material on the edge of the ramp.
LIGHT VEHICLE RUNS INTO WALL	A light vehicle rolled forward 5m and collided with the decline wall when the driver fell asleep while waiting to collect another worker.
TRUCK DRIVES OFF HAUL ROAD	A loaded quad dog trailer attached to a Mack B double rolled onto its side when the truck drove off the haul road as it was leaving a quarry.
TRUCK LOSES CONTROL	A loaded Komatsu dump truck travelling down a ramp picked up speed, peaking at 88kph, before the operator applied the service brake to bring the truck under control
TRUCK ROLLED OVER	On night shift an empty explosive transport light vehicle rolled over after exiting an underground mine.
LOADER LOST TRACTION	While reversing up a 1in 4 drift a fully loaded Eimco loader lost traction and slid about 100m down the drift.

2.NEW SOUTH WALES	2001-2013
INCIDENT	**INCIDENT CAUSE**
COLLISION BETWEEN TRUCK & LIGHT VEHICLE	A truck collided with and ran over a light vehicle on a main haul road at an O/C mine. The incident happened at midnight on a weekend shift which resulted in the death of the light vehicle driver. **The incident is currently being investigated but the two obvious causes are visibility, fatigue, speed of both vehicles and not following safe work procedures (SWP).**
LIGHT VEHICLE CRUSHED BY DOZER	A dozer reversed over a light vehicle that had entered the work area of the dozer. **This incident is currently being investigated however, safety procedures were not being followed, communication was deficient and fatigue may well have been an issue.**
UNDERGROUND VEHICLE COLLIDES WITH LIGHT VEHICLE	A loader (LHD) operating between an ore pass and a tipple collided with a light vehicle. The loader operator failed to see the light vehicle entering the tunnel. **Safety procedures were not being followed. The inspectorate said that there appears to be a 'disconnect' between managements perception of procedural compliance with SWP's and on the job reality.**
DEPUTY CRUSHED BY LOAD HAUL DUMP TRUCK	A deputy sustained a crush injury when the bumper bar of a stone duster pod attached to an (LHD) crushed him against the side of the roadway. **There was no communication between the operator and pedestrians. Compliance with safety rules was not being followed and people needed to be reminded of their obligations under the mining regulations.**
A WATER TANKER ROLLOVER AT A ROAD INTERSECTION	A water tanker failed to negotiate a 90 degree left hand turn at a T-intersection and rolled over on to its right side. **The driver was not wearing a seat belt and was travelling too fast when he attempted to make the turn. The driver had completed 10 hours of work on his first day shift after a seven day rostered break. Haul road design was also a factor.**
A LIGHT VEHICLE DRIVES OFF BENCH IN OPEN CUT MINE	A light vehicle drove off a bench in an O/C mine, then on exiting the bench, drove over a low wall and then landed on its roof. It was the operator's first shift back after a break. **The inspectorate recommended that operators should be familiar with their work area and before entering this work area must receive positive communication from the supervisor and should also be wearing seat belts.**
DRIVER INJURED IN DUMP ROLL OVER	The driver of a dump truck sustained severe injuries when he lost control while travelling down a hill, failed to negotiate a bend when he rolled down an embankment coming to rest at the edge of a dam. **The haul road did not have any safety windrows or barriers. Safe Work Procedures were inadequate and the lack of periodic testing of brake systems had not been carried out.**
LUCKY ESCAPE FROM UNDERWATER TRUCK	A truck driver sustained injuries when the vehicle he was driving lost control and rolled over a highwall into a water reservoir which was 7 metres deep. **The inspectorate recommended that fit for purpose barriers are in place to prevent vehicles going over embankments and redundant roadways should be barricaded to avoid inappropriate access.**
FATAL TRUCK ACCIDENT AT A QUARRY	A truck driver was fatally injured at a quarry when the truck he was driving failed to negotiate a corner and rolled down an embankment. **Safe work procedures were found to be inadequate including the proper design of haul roads, wearing seat belts and fit for purpose barriers. Operators to be reminded of correct speeds when descending and regular review safety critical components.**
HAUL TRUCK TIPS ON TO BACK WHILE DUMPING AT STOCKPILE	A rear dump truck rolled over and landed on its tray. The truck had slid 2m down the side of a stockpile when the operator exited the cabin before the truck rolled over the edge. **Risk assessment standards, safe work procedures, training, inspection, maintenance, wearing of seat belts and supervision were found to be inadequate.**

3.WESTERN AUSTRALIA	2001-2013
INCIDENT	**INCIDENT CAUSE**
LIGHT VEHICLE STRUCK BY UNDERGROUND TRUCK IN DECLINE	As an underground light vehicle travelling up a decline approached a blind bend, the driver saw the headlights of a truck coming down the decline when he tried to exit the decline via a pump cuddy. As the truck passed the pump cuddy its right hand side collided with the rear side of the light vehicle. **The inspectorate recommended that the site's traffic management plan be updated by establishing appropriate signage along the decline, an adequate number of passing and parking locations and restrict access to decline locations that are not suitable for parking locations.**
LIGHT VEHICLE COLLIDES WITH STATIONARY LOADER	A worker was returning to a mine site after being off site, he was driving a light vehicle along a gravel road having just made a 90 degree left turn. His next recollection was waking up in while crashing in to a stationery loader. **The inspectorate was of the opinion that the worker experienced a micro-sleep and consequently was suffering from fatigue and that employers and employees need to be aware of the many casual factors that may increase the likelihood of experiencing micro-sleep episodes.**
UNATTENDED VEHICLES ROLLING AWAY	A supervisor parked a designated light vehicle parking area and alighted from the vehicle without engaging the hand brake or placing the vehicle in gear. A short time later the unattended vehicle rolled over a half metre bund and crashed into the side of a transportable office causing significant damage.
UNATTENDED VEHICLES ROLLING AWAY	An operator was loading the rear trailer of a road train when he noticed the truck and trailer going downhill. The operator tried to stop the road train but failed and the truck came to rest in a creek about 120m from the loading area. On inspection after the incident, the truck park brake was disengaged.
	In both the abovementioned incidents the inspectorate were of the opinion that failure to apply the park brake, may have been caused by complacency, fatigue, tiredness, inattention, forgetting, hurrying and lack of knowledge of the potential hazard. It was recommended that mines develop suitable and designated parking area's for trucks, vehicles and mobile plant and fit for purpose barriers should be installed to prevent uncontrolled vehicles and plant coming into contact where people may be located.
VEHICLE OVER STOPE EDGE	A Toyota personnel carrier was reversed into an ore drive in an underground mine, where it went over the bench edge of an open stope. The driver was badly shaken up by this incident and was fortunate not to have sustained serious or fatal injuries. **It was found that current work practices and procedures were deficient and that safe systems which include appropriate precautions are put in place in order to prevent a recurrence near vertical opening locations.**
HAUL TRUCK AND LIGHT VEHICLE COLLIDED	An unloaded haul truck and light vehicle collided at a controlled mine intersection. The truck ran over and crushed the light vehicle and in doing so caused the driver to sustain fatal injuries. Cutting equipment was used to free the light vehicle driver. **It was recommended that regular documented traffic management audits and risk assessments on all intersections to identify potential collision hazards are undertaken. The development of a site traffic management plan ensuring that appropriate signage is implemented and that inspections are carried by a competent person.**
TRUCK RAN OVER LIGHT VEHICLE	A mine haul truck ran over a light vehicle following a hot seat driver change. The light vehicle received approval to approach and park 5m away from the haul truck despite pit permit rules and procedures which resulted in the light vehicle being crushed and the driver sustaining severe injuries. **The inspectorate found that that safe work procedures were deficient and recommended that haul trucks and light vehicle parking bays be installed with separation bunds at suitable locations around the mine and that the mine has an appropriate updated traffic management plan.**

A more detailed analysis of these incidents is illustrated in Table 4.5. The causes of the incidents have been divided into two areas, namely:

- Primary Cause
  Collision or Rollover
- Secondary Cause
  Fatigue, Safe work procedures, Risk assessments, Design, Communication, In adequate safety barriers and Inappropriate traffic plans

Of the 32 incidents analysed the causes all of these incidents were found to be as follows:

- Collision 78%
- Rollover 22%
- Fatigue and potential fatigue 100%
- Safe work Procedures 100%
- Communication 44%
- Inadequate safety barriers 18%
- Inappropriate design 12%
- Inappropriate traffic plan 9%
- Lack of risk assessments 6%

It can be concluded from the above analysis of the 32 incidents that have been investigated that 78% are related to collisions and 22% to rollovers and all related incidents are attributable to fatigue, potential fatigue and lack of safe work procedures. Lack of communication resulted in 44% of the incidents followed by inadequate safety barriers on 18%, inappropriate design 12%, inappropriate traffic plans 9% and lack of risk assessments 6%.

Table 4.5 Analysis of Incidents in Queensland, New South Wales and Western Australia from 2001-2013

Incident Qld	Primary Cause		Secondary Cause						
Vehicle Collision	Collision	Rollover	Fatigue	SWP	Risk Assessment	Design	Communication	Safety Barriers	Traffic Plan
1	x		x	x					
2	x		x	x			x		
3	x		y	x			x		
4	x		y	x			x		
5	x		y	x			x		
6	x		y	x			x		
7	x		y	x			x		
8	x		y	x			x		
Vehicle loss of control									
9	x		x	x			x		
10	x		x	y			x		
11	x		x	y			x		
12	x		x	y					
13	x		x	y					
14	x		x	y					
15	x		x	y					
NSW									
1	x		x	x			x		
2	x		x	x			x		
3	x		x	y			x		
4	x		x	y			x		
5		x	x	x					
6		x	x	y					
7		x	x	y				x	
8		x	x	y				x	
9		x	x	y				x	
10		x	x	y	x				
WA									
1	x		x	y		x			x
2	x	x	x	x					
3	x		x	x		x		x	
4	x		x	x		x		x	
5		x	x	y	x				
6	x		x	y		x			x
7	x		x	y				x	x
% of the total	78%	22%	100%	100%	6%	12.5%	44%	18%	9%

Note that x, denotes Fatigue and y denotes potential fatigue.

According to a study published by Caterpillar Global Mining, Viewpoint (2007) when considering the perspectives on mining fatigue stated that "*up to 65% of truck haulage accidents in surface mining operations are directly related to operator fatigue*".

In view of the fact that the high potential or near misses incidents are on the increase in Queensland, New South Wales and Western Australia and that many of these incidents could have resulted in serious or fatal injuries had the circumstances been slightly different. It is reasonable to say that safety in the mining industry is not improving and the potential for serious injury is very high.

According to the WA State Mining Engineer Simon Ridge (2013) who stated that *"the number of serious injuries and near misses is still very high and many of them could have resulted in a fatal accident had the circumstances been slightly differen*t".

In April 2014 the Deputy Director General of the Queensland Department of Natural Resources stated to the author that they were receiving 6 High Potential Injuries per day which equates to 42 per week and 2184/annum.

4.14 Industry Response to Long Work Hours and Fatigue

Having investigated the long work hours and fatigue in the mining industry it is now appropriate to examine the industry response to long work hours and the impact of fatigue management. In order to understand the problems associated with mineworkers working these long hours some examples of fatigue management plans will also be evaluated.

4.14.1 Fitness for Work in the Mining Industry

Health promotion programmes can help prevent work related illness or injury and the industry is attempting to implement accepted strategies to maintain and enhance the fitness levels of miners. Traditionally, fitness for duty has been described as the "detection of medical problems that may compromise personal co-worker, and/or public safety"

(Kales et al. 1998). The mining industry has responded to legislation and increased awareness of risks by testing employees for drug and alcohol intoxication, and in some instances, excessive fatigue. Therefore if a worker is found not to have either medical problems or impairments related to drugs, alcohol or fatigue, he or she is considered 'fit for work'-implicitly extending the concept of fitness for work beyond the absence of illness or injury (Parker & Worringham 2004).

It is important to recognise that Fitness for Work is included in the Queensland Coal Mine Safety and Health Act 1999 and in the NSW Work health and Safety Act 2011. Codes of practice in WA are issued by the Department of Mines and Petroleum. An approved code of practice is a practical guide to achieving the standards of health, safety and welfare required under the appropriate act and regulation. A code of practice applies to anyone who has a duty of care in the circumstances described in the code. In most cases, following an approved code of practice would achieve compliance with the health and safety duties in the WHS Act, in relation to the subject matter of the code. Like regulations, codes of practice deal with particular issues and do not cover all hazards or risks that may arise. The health and safety duties require duty holders to consider all risks associated with work, not only those for which regulations and codes of practice exist.

The Queensland Department of Natural Resources Guidance Notes for Fatigue Risk Management (2013) stipulates Fitness for Work in mines safety and health management system to provide for controlling risks at work associated with:

- Excessive consumption of alcohol
- Other physical or psychological impairment such as stress
- The improper use of drugs and
- Personal fatigue

A cross section of the workforce must be involved in developing a programme for fatigue with fitness provisions agreed by the majority of the work force that will be affected by it. The programme must provide for the following criteria:

1. An employee assistance programme
2. An education programme

3. The maximum hours for a working shift
4. The maximum number of hours to be worked in a week or roster cycle and
5. The number of rest breaks in a shift.

It is necessary for operations to design a fatigue management plan, which will enable all stakeholders to work towards minimising risks of fatigue. The management of fatigue requires the following issues to be implemented:

- A policy which outlines the approach, commitment and accountability for all stakeholders which must be audited on a regular basis
- A training programme so that workers can identify the signs and symptoms of fatigue
- A suitable programme for tracking incidents and near misses and
- A medical and well-being support that includes diagnosis of sleep disorders.

Incidents and crashes on the way to and from work have been discussed in some detail, including the impact that they are having on mine workers, it is therefore now appropriate to look at the counter measures that are put in place to try and minimise these incidents and crashes which include the following:

- ➢ A working party was established to investigate and initiate a feasibility study based on the recommendations from the reports in NSW and Queensland
- ➢ All mines should implement the means to ensure that all staff can adequately manage the current rosters designs that are in place
- ➢ All mines to undertake fatigue management training of all staff and management
- ➢ A health programme should be put in place, either through the mining companies or the NSW and Queensland governments.
- ➢ Where possible mines should investigate the opportunities for utilising buses as an alternative means of transport. If this is not practicable, car-pooling should be encouraged.

4.14.2 Industry Response to Fatigue Issues

Although the industry is still coming to terms with the complexity of fatigue and shift arrangements throughout the industry, all mining companies in NSW, WA and Queensland have now implemented fatigue management plans. The larger companies are managing these issues better than the smaller companies. However one of the biggest issues that they all face is that of consistency across the industry. The outcome of the Queensland Coronial Inquiry, mentioned earlier in this chapter with regard to fatigue, has clearly focused the industry's attention on the issue.

In response to the issues associated with fatigue, the Queensland Resource Council members have supported the formation of a Road Accident Group in collaboration with emergency service providers and community representatives to promote road safety in the Bowen Basin in Central Queensland.

4.14.3 Road Safety Alliance Programme

The road safety programme has been developed in conjunction with the Queensland Resource Council Members, Queensland Police, Department of Main Roads and Queensland Transport. This programme is called the Mining Industry Road Safety Alliance (MIRSA), which develops and coordinates road safety initiatives and delivers agreed safety outcomes. The main objective of the MIRSA is to be involved in all road safety activities to address the 'fatal four' namely:

1. Drink driving
2. Speeding
3. Failure to wear seat belts and
4. Driving while tired with particular focus on the Peak Downs Highway and adjacent corridors.

Through the MIRSA a broad range of issues have been initiated to raise awareness of the consequences of risk taking behaviours on regional highways which include the following:

- Fatigue education for all mine employees
- Infrastructure projects
- Wide loads

- Rental vehicles
- Roadside billboards
- Young drivers
- Safety campaigns and
- A MIRSA website.

4.14.4 Fatigue Management Standard

The fatigue management standard provides a framework for managing and understanding and minimising and controlling the risks associated with fatigue in the workplace and in the mining industry referred to as Fatigue Management Plans. In order to gain an appreciation of these plans some examples in NSW and Queensland will be evaluated.

The first example is at Coal and Allied in NSW (2007) where the aim of the fatigue management plan is to ensure that:

- Individuals are fit for work
- Companies must meet their obligations to employees, contractors and the community by carrying out its operations in a safe manner
- A safe work environment requires that hazards and risks associated with fatigue must be minimised
- Informed and appropriate decisions are to be made in relation to hours of work and shift roster systems
- Ongoing assessment and monitoring of fatigue risks and
- A range of preventative initiatives such as education and training to help manage fatigue is provided.

This chapter has clearly shown that work hours in the mining industry are high when compared to Australian and international standards, which have ensured that fatigue management standards stipulate the hours of work. Rules for hours of work across the industry are typically illustrated in the Coal and Allied example in Table 4.6.

Table 4.6 Work Hours

Work Hours (24 Hours)	Rules
Up to 14 hours	▪ Individual assesses fitness for work
14-16 hours	▪ Formal risk assessment to be completed by individual and leader. ▪ Leader to approve any extension of working beyond 14 hours. ▪ Prior to going home fitness must be re-assessed and transportation may be provided.
More than 16 hours	▪ No individual is permitted to work more than 16 hours in a 24 hour period.
Total hours of work	▪ Total hours should not exceed an average of sixty hours per week over a four week period. ▪ Controls must be in place to ensure that individuals are not working excessive hours in any seven day period. ▪ Appropriate fatigue controls must be in place for any roster that employees work.
Break between consecutive shifts	▪ A minimum break of 10 Hours between consecutive shifts worked. ▪ Formal risk assessment is required if the individual is required to return to work after a 10 hour break.
Call back	▪ No more than one call back in a 24 hour period

4.14.5 Management Fatigue Policy

Throughout the mining industry, the management of fatigue policy generally consists of the following steps:

1. Employees must manage their own fatigue
2. They must take the first steps if they consider that they have a problem
3. If a worker considers he has a problem they must discuss with their leader and if necessary allowed to have a fatigue break or be allocated to other duties
4. The leaders are responsible for ensuring that fatigue is appropriately managed in their particular work group taking into account fatigue breaks and
5. If an employee is constantly suffering from fatigue and unable to fulfil the requirements of their role then counselling or discipline is appropriate.

In order to ensure that employees and supervisors can make decisions about roster design and work arrangements they must undergo appropriate education and training. They must be able to understand the factors, which contribute to fatigue, their responsibilities in relation to fatigue management and consequently be able to develop strategies for managing operational and personal fatigue. All employees must be provided with information on fatigue management education on the commencement of employment. Risk assessments must be carried out when:

- When planning a task or carrying out work
- Prior to making changes to existing rosters or implementing a new shift roster and
- Prior to approval of any extension to working above 14 hours.

When assessing risk factors which effect a person the following issues which need to be considered are length of shifts, commuting times, sufficient time off, rest breaks, personal factors, heavy physical work, and recent shift history.

When assessing risk factors which effect the work the following issues need to be considered are the type of work being carried out, is the work physically or mentally, demanding, fatigue environmental factors, the level of supervision required and the shift involved day or night shift. The fatigue management plan must be reviewed on a regular basis and audited on an annual basis.

The majority of shift rosters in the mining industry are based on the following criteria see Table 4.7

Table 4.7 Shift Roster Criteria

Health and Safety Considerations	
Business Needs	**Employee Needs and Preferences**

The industry general guidelines when designing working arrangements related to fatigue management are the use of simple rosters which include the following, start times, direction of shift rotation, blocks of shifts, appropriate breaks, rostered hours, travel time, night work and sleep opportunities.

4.14.6 Management of Fatigue at Billiton Mitsubishi Alliance (BMA) Mines

The second example of how fatigue is managed is at BMA mines in Central Queensland. According to the BMA fatigue policy, in order to manage shiftwork and reduce the effects of fatigue the responsibility lies with both the employee and the employer. Fatigue is managed in a similar manner to the one described at Coal and Allied, however in order to try and counter these effects of fatigue, two sleep pods have been trialled at Gregory Crinum mine to allow employees to take short naps during a shift to reduce fatigue and increase alertness. The philosophy behind this is that if employees become fatigued on the job then a power nap can really help (Anderson 2007). A self-assessment procedure is used to determine if a controlled nap is required. When employees finish a shift if they feel sleepy they are encouraged not to drive home, but to get someone else to drive them home, despite the fact that in reality it may be very difficult to find someone. However according to Strahan (2009) who conducted a survey regarding reducing fatigue risk within mining operations found that;

- Depression is a significant issue and linked to fatigue risk
- Excessive alcohol consumption is linked to increased fatigue risk; and
- Napping is symptomatic of poor and inadequate sleep and poor coping rather than an effective or sustainable fatigue management strategy. Another example is illustrated below in NSW.

The third example of fatigue management evaluation is as follows:

4.14.7 Fatigue Management Evaluation Manual

In (2013) the NSW Mine Safety Advisory Council published a fatigue management evaluation manual in order to help the resources industry better manage fatigue and enable them to evaluate their performance with the adoption of the following steps:

1. Plan the fatigue management process by asking employees to complete a questionnaire on their perception of how fatigue is being managed on their site
2. Conduct an evaluation process with members of the workforce and ask them to make an assessment of the way fatigue is managed on site
3. Review the evaluation results and prepare a report based upon how the results of the survey compare with the management plan and
4. Develop an action plan by communicating the findings of the evaluation process to all stakeholders in order to progress improvements to the management of fatigue on site.

4.15 Discussion

This chapter has reviewed the literature regarding fatigue management, shift rosters and work hours in order to understand the implications of these issues for safety improvement in the mining industry. It has been demonstrated that that these issues are amongst the most important safety concerns facing the mining industry today. As previously stated fatigue and awareness issues are having a major impact on safety at work, which is particularly evident when people are working 12-hour shifts. The rapid expansion of the industry has required the growing use of contractors which in turn has produced a more inexperienced workforce, According to the Queensland Mines Inspectorate "Consultation Regulatory Impact Statement 2013". The effective management of contractors is a continuing cause of concern of the Queensland Inspectorate. The increasing use of contractors and their overrepresentation (based on their proportion of the workforce) in fatalities indicates the importance that contractors be effectively managed especially with regard to fatigue and awareness issues. Research has shown that shift arrangements and rosters have significant consequences for the health and safety of mineworkers. These working time arrangements increase the risk of fatigue related errors and awareness issues when compared to working day-time hours. One of the most significant reasons for miners suffering the effects of fatigue and awareness issues is the move away from the traditional eight-hour to the 12-hour shift and four day and seven day rosters. It has been outlined in this chapter how the industrial relations laws of the Howard Government have encouraged companies to move to these longer working hours for productivity reasons. Mineworkers initially rejected these longer working hours but have now overwhelmingly accepted them because of life style considerations. These roster arrangements have allowed mining families to live in coastal and major centre communities. According to the CFMEU these longer working hours and the self-regulation of work hours has been the approach in mining since 1996.

The increasing use of contractors, of 12-hour shifts, of compressed rosters and the use of 'fatigue management policies' are major contributors (CFMEU 2004).

This approach has been at the expense of safety fatigue considerations throughout the mining industry. It has demonstrated that mining is still a hazardous industry and we still expect miners to undertake their tasks suffering the effects of fatigue. The Australian Coal and Energy Survey (2012) highlights many aspects of mining and energy work that are subject to change, including work hours and unpredictable shift patterns. It is now very clear that jobs in the mining industry are characterised by something with significant physical and psychological health implications and lack of control. Changes in the mining and energy sector have been underpinned and reinforced by shifts in power from labour to capital. Most employees have very little say over their hours and shift arrangements and half have no say at all. Approximately half of the mining and energy workers in the industry would prefer to be working less hours than they are working, even after taking into account of the impact on their income, leisure and domestic activities.

This lack of control, combined with tiredness, is not simply making mining and energy workers feel unsafe: it is having negative health consequences, including affecting psychological health. This lack of say over basic work-life decisions is having a flow on effect on partners of mining and energy workers, who often confirm that their spouses are indeed too emotionally drained to function properly in the household, which in turn has other adverse effects on partners.

The comments made by the participants of the survey indicate that 12 hour rotating shifts, fatigue and the effects of working FIFO are major safety issues in the mining industry.

It has been demonstrated that shift work reduces the opportunity for sleep and that reduced sleep quality is generally considered to be a major risk factor associated with shiftwork related incidents and accidents. Given that the effects of fatigue are similar to the effects of moderate alcohol consumption it is difficult to understand why fatigue performance impairment has not been subject to similar levels of intervention.

Although the miners admit to fatigue working these long shifts, because of life style considerations that these rosters provide for their families they would be very reluctant to move away from these shift arrangements. Recent mine expansions have led to miners working in areas where accommodation is limited which has led to more traffic on the roads and with a 12 hour shift it means that most of these mine workers are on the roads at peak morning and afternoon periods. With hot seat change-overs this means that some rosters have shift lengths of 12.5 to 13 hours.
According to Brown and Fitzpatrick (2010) in February 2010 BMA implemented new fatigue management guidelines which increased the maximum shift length from 12 to 14 hours. The CFMEU responded by issuing a directive to stop work at all BMA sites in Queensland, claiming the company’s fatigue management standard represented an unacceptable level of risk to workers.

The transportation of heavy mine equipment, fuel and oils to mining areas is not only a hazard in its own right but it is a hazard to persons travelling to and from work especially at shift change times. This traffic congestion is proving to be a major safety concern.

This chapter has highlighted the fact that the weekly work hours in the NSW mining industry are high when compared to the Australian mining industry as a whole, according to the Digging Deeper Report (Wran 2007). The following gives some comparative data:

- NSW 50 Hours per week
- USA 47.3 “
- Austria 44.3 “

The International Labour Organisation Report, Working Time around The World (2007), gives some comparative statistics in twenty countries from 2000-2005. These statistics have been analysed and it was found that Peru had the highest percentage of employees working long hours with 51% of employees working more than 48 hours per week. The NSW mining industry is well in excess of that figure with 53% of employees working more than 48hours per week. Based on the current information available it can be assumed that the situation in Queensland would be similar to that of NSW if not worse.

These long working hours were reinforced by interviewees from staff groups during the survey who reported that they were fatigued as a result of their long work hours and shift arrangements.

These long working hours between 54 and 51 hours per week are most probably understated due to the fact that overtime is not tracked and therefore not reported. These long working hours are of concern for the safe working of mine operations and will almost have negative consequences for safety performance.

A detailed analysis of 32 vehicle related incidents has been undertaken from the departmental web sites of Queensland, NSW and WA which is shown in Table 4.4. The incidents have been divided into the following causes:

- Primary Cause – collision or rollover
- Secondary Cause – Fatigue, Safe work procedures, Risk assessments, Design, Communication, Inadequate safety barriers and Inappropriate traffic plans.

It can be concluded from the analysis of the 32 incidents that have been investigated that 78% are related to collisions and 22% to rollovers and all related incidents are attributable to fatigue and lack of safe work procedures. Lack of communication resulted in 44% of the incidents followed by inadequate safety barriers on 18%, inappropriate design 12%, Inappropriate traffic plans 9% and lack of risk assessments 6%.

These incidents would increase considerably if all incidents regarding vehicle collisions and loss of control if all incidents were reported. Very few operators will admit to fatigue unless there is a witness or there is damage to the vehicle concerned, since these mainly dump truck operations particularly in open cut mining are repetitive and consequently can cause the operator to suffer weariness, boredom and fatigue particularly so when working 12 hour shifts.

A key underpinning of effective risk management of fatigue is accurate and reliable information about fatigue related incidents. If individuals have a concern that they will experience negative consequences as a result of reporting fatigue, it will be impossible for the industry to satisfactorily address fatigue on mine sites. A no-blame approach to incident reporting and investigations must also extend to fatigue issue management.

Employers are now encouraging employees to have a power nap if they become fatigued on the job. According to the DDR employees are able to have a short sleep provided that they carry out a defined procedure using self-assessment with the supervisor involved. Taking a nap has the ability to be abused – *'I don't need to get a good sleep at home because I can sleep at work'* (coal OHS manager). Some supervisors reported that they actively discouraged napping and considered that it was abusing the system. A fatigue related incident at one NSW mine site resulted in the dismissal of the individual for failure to control non-work related risk factors. As a consequence this issue resulted in the employees at the site in question saying that they would be less likely to report fatigue issues in the future.

The use of rotation of tasks as a fatigue control has proved to be reasonably effective in some cases, however due to the rapid expansion of the industry this has become increasingly difficult to implement. According to (Dalliston 2008):

Rotation of tasks has been recently raised as a fatigue control when used in regard to extended shifts, but with current skill shortages this is becoming increasingly difficult to implement.

All industry stakeholders now accept that fatigue is a major cause for concern regarding the safety and health of mineworkers and as a consequence all companies have implemented fatigue management plans. Most fatigue management plans rely on the individual response to fatigue, however most individuals have diverse response to fatigue issues. Therefore it is important to focus on the work related causes rather than just focusing on the individual causes. It has been shown that in order to effectively address fatigue management it is most important to complete appropriate risk assessments that concentrate on work hours and sleep opportunity. This chapter has demonstrated that these 12 hour shifts being worked in the industry have created major safety fatigue issues. One way to effectively remove the issues with fatigue is for the industry to go back to the 8-10 hour shift and in doing so dramatically improve mine safety throughout the mining industry. The discussion has substantiated the authors hypothesis that the safety performance in the Australian mining industry has not improved despite all the rhetoric and may even be deteriorating.

The next chapter will consider the issues which are associated with current prosecution policies and their impact on safety performance in the mining industry.

CHAPTER 5

5. PROSECUTIONS IN THE AUSTRALIAN MINING INDUSTRY

5.1 The Gretley and Moura No 2 Inquiries

It has been demonstrated in the earlier discussions on the analysis of the Gretley and Moura No2 disasters that they have similar management failings. Since the outcomes of these inquiries have had a profound impact on safety and prosecutions in the coal mining industry both in New South Wales and Queensland it is first of all appropriate for this thesis to investigate the different types of inquiry used for both of these disasters. Following the Gretley mining disaster the Department of Primary industries developed a new found enthusiasm for prosecution, particularly following a fatality.

5.2 The Gretley Inquiry Process

In NSW the incident or accident is investigated by a court process, which is held before a Judge. According to the Coal Mine Regulation Act s95 the Court process was as follows:

- The Minister may direct a court to hold an investigation for ascertaining the causes and circumstances of an accident or determining the effects of a practice.
- The Report to the Minister must state the causes and circumstances; or the findings relative to practice; and add any observations, which the court thinks right to make.
- Where show cause actions or appeals are involved Assessors must be appointed to assist the Judge.
- In other actions they must be determined by the rules of the court.
- The Assessors have the power to advise but not to adjudicate, they are not required to make findings or recommendations.

5.3 The Moura No 2 Inquiry Process

It is appropriate to first consider how the Moura No 2 disaster inquiry was undertaken. The investigation into the Moura No 2 disaster was conducted by a Warden's Court of Inquiry. In conjunction with the Mining Inquiry, a Coronial Inquiry was conducted by the Mining Warden in his capacity of Coroner. This Wardens inquiry was governed by the following legislation, (Coal Mine Act 1925) S74:

1. Unless otherwise determined by the Minister, in every case of accident causing death or serious bodily injury, an inquiry into the **nature and cause** of such an accident shall be held before the **warden and four persons** having practical knowledge and skill in the mining industry selected by the warden and having no connection with the coal mine where the accident occurred.
2. In every case of an accident causing death or serious bodily injury, the warden shall at least 4 days before such an inquiry is held, send notice of time and place of holding the inquiry to all appropriate parties.
3. The warden shall forward to the Attorney- General the notes of evidence taken at such inquiry and in the opinion of the persons having practical knowledge and skill in the mining industry (who shall record **their findings** as to the **nature and cause** of the accident, and make such **recommendations** as appear to **them** necessary for the **prevention of similar accidents**), and the **warden's report as to the nature and cause** of such accident, and shall forward a copy of same to the Minister. The warden shall announce the findings at the conclusion of the inquiry.
4. The evidence taken at the inquiry held under this section may, if the Minister thinks fit, be submitted to a Board of Examiners; and if it appears to such a Board from such evidence that the accident was caused directly or indirectly by the non- observance by the holder of any certificate, licence, or permit under this Act of any of the provisions of this Act, or by reason of the holder's negligence, such Board may require the holder to show cause why his or her certificate, licence, or permit should not be suspended, cancelled, or otherwise dealt with.
5. Every person so required to show cause shall, when called upon, appear before the warden, who shall hold a further inquiry into the conduct of such person.

6. If such a person fails to appear, or such Board finds after such further inquiry that the person has been guilty of any offence against this Act or of any negligence or misconduct, such Board may disqualify the person by cancelling or suspending the person's certificate, licence, or permit, or, if such certificate or licence was granted by an authority outside the state, by cancelling or suspending the approval thereof for such period as such board thinks fit; and during the period of disqualification the person so disqualified shall be deemed not to hold a certificate, licence, or permit. For all the purposes of an inquiry under this Act, the warden shall have the power of a warden's court.

An inquiry into the nature and cause of the accident was convened at Gladstone in Queensland in October 1996 before the Mining Warden and four persons having practical knowledge and skills in the mining industry who were not connected with Moura No 2 coal mine where the accident occurred. The inquiry sat for thirteen weeks and heard evidence from sixty-six witnesses who were cross examined as indicated in the following inquiry structure. The transcript from the evidence comprised 5200 pages and a total of three hundred exhibits which included plans; reports, graphs and letters were tended.

The structure of the Warden's Court is as follows:

- The structure is similar to Coronial Proceedings,
- The process is inquisitorial as opposed to adversarial. All witnesses were asked detailed and searching questions,
- Appearances
    - Council Assisting,
    - Council for the Parties,
- The questions asked by the council assisting were of an investigative nature. Whereas the questions asked by the Council for the respective parties was of a protective nature.
- Each witness was examined under oath,
- Expert witnesses gave evidence at the inquiry,
- Evidence in Chief,

    - Was determined by the questions asked by the Council Assisting,
    - Statements made in court during the proceedings and the report compiled by the four panel members.

- Cross examination by all the parties,
- Examination by the panel members,
- Examination arising from questions from the above mentioned people.

It is therefore necessary to understand the procedural differences between the Gretley mine and the Moura No2 mines in the way the two inquiries were conducted.

5.4 Procedural Differences between the Gretley and Moura No2 Inquiries

The essential procedure differences between the Moura and Gretley Inquires is shown in Table 5.1. The main difference between the two inquiries is that in the case of the Moura Inquiry **the purpose was to determine the "nature and cause" of the accident and for the panel to make findings and recommendations**. **Prosecutions were not sought, which allowed a free flow of information between all the parties which enabled the Warden to complete the findings and produce a report that contained recommendations.** The Gretley Inquiry adopted a completely different approach which involved the prosecution of the companies and managers involved in the disaster.

These recommendations have dramatically changed the way safety is managed both in New South Wales and Queensland. The Moura panel assisting the warden consisted of individuals with extensive experience in the coal mining industry, who after examining all the evidence and the witnesses were able to make sound recommendations based on their findings. One and a half years after the disaster the findings and recommendations were produced which enabled all the interested parties to make a start on implementation Table 5.2.

Table 5.1 The Major Differences between the Gretley and Moura Inquires

Moura	Gretley
Unless the Minister otherwise determines	If Minister Directs
Before a Magistrate (Warden)	Before a District Court Judge
Panel required to make findings and recommendations	Panel advisory only
Possible for subsequent proceedings before a Board of Examiners (BOE)	No subsequent proceedings except appeal to a higher court
Constrained jurisdiction	Broad jurisdiction

The Gretley Inquiry adopted a totally different approach which involved prosecutions and took over eight years to finalise Table 5.2. The total length of time to complete this inquiry was seven years longer than the Moura Inquiry. The reason for this significant length of time as previously stated was due to the prosecution of companies, managers and other duty holders. This process also encourages all parties to use legal privilege and thus prevent vital information that would help to prevent accidents from being made available.

One of the main reasons for this is that it is a judicial process where a Judge hears evidence and where the prospect of a prosecution can limit the free flow of information due to legal privilege. The Judge can have individuals with experience in the mining industry to assist him; however those individuals are not allowed to make recommendations, that is the responsibility of the court. This process takes far too long to get the final outcome of an investigation and legal privilege is the main reason. This aspect will be discussed in more detail and demonstrate how the Queensland Warden Court system is much more efficient in dealing with the outcomes of investigations and making recommendations than the judicial system.

Table 5.2 Time Taken to Complete the Gretley and Moura Inquires

Accident	Date of Accident	Date of Findings	Time to Complete Investigation
Moura	August 1994	January 1996	1.5 years
Gretley	November 1996	August 2004	7.75 years
	November 1996	Final Decision May 2005	8.5 years

Having established the time differences between the two inquiries, this thesis will now investigate the following outcomes in order to make comparisons in terms of time taken to complete them. The main reason for this approach is the quicker the lessons are learned from an accident or incident then the quicker these lessons can be implemented in order to prevent a recurrence of these accidents or incidents.

- Outcomes from the Wardens Court in Queensland from 1997-2001
- NSW Prosecutions from 1995-2007 and
- Findings of the Coroners Court in Queensland from 2002-2007.

5.5 Outcomes of the Queensland Wardens Court from 1997 to 2001

The outcomes of the Wardens Court will be examined between November 1997 and the last case in March 2001. The purpose of the Wardens Court was to determine the nature and cause of the accident without the fear of prosecution. It may be observed from Table 5.3 that it took between 5 to 14 months to complete an investigation and the average time taken to complete the twenty one investigations was seven months. Therefore the lessons learned and the recommendations were available for all parties in the industry some seven months compared to eight and a half years at the Gretley Inquiry.

Table 5.3 Outcomes of the Queensland Wardens Court from 1997 to 2001

Date of Accident	Injury Type	Location of Accident	Date of Findings	Time Taken Months
22 Mar-2000	Serious Injury	Goonyella Riverside Mine	8 March 2001	12
26 Aug-2000	Serious Injury	Lorena Mine	9 Feb-2001	5
30 Aug-2000	Fatal	Cook Colliery	1 March 2001	6
14 Jul-2000	Fatal	MT Isa Mines	7 Dec 2000	5
26 May-2000	Fatal	Oaky No 1 mine	9 Nov. 2000	5
15 Mar-2000	Fatal	Jellinbah mine	24 August 2000	5
20 Dec-1999	Fatal	MT Isa Mines	16 June-1999	5
27 Jun-1999	Fatal	Cannington M	30 Mar-2000	9
22 May-1999	Serious Injury	Laleham U/G	24 Feb. 2000	11
20 Jan-1999	Serious Injury	Oaky No 1 Mine	29 Oct. 1999	8
23 Nov-1998	Fatal	Enterprise	27 May-1999	6
14 Dec-1997	Fatal	Cannington	26 Feb 1999	14
4 June-1997	Fatal	MT Isa Mines	2 Feb-1998	8
4 May-1997	Fatal	Blackwater O/C	3 Dec. 1997	6
19 Jun-1997	Fatal	MT Isa Mines	20 Nov-1997	5
25 March-1997	Fatal	Newhill Mine	29 Oct-1997	7
5 Nov-1996	Fatal	Laleham U/G	3 Sept. 1997	10
23 Nov-1996	Fatal	Selwyn Mine	14 Aug-1997	9
10 Dec-1996	Fatal	MT Elliott	14 Aug-1997	8
6 Oct-1996	Fatal	MT Isa Mines	18 Jun-1997	9
19 Sep-1996	Fatal	Oaky No 1 Mine	27 March 1997	6
Average Time Taken				**7.00 months**

5.6 Prosecutions Findings in NSW from 1996 to 2008

In response to the Mine Safety Review in 1997 and the Gretley Inquiry the New South Wales Government established the NSW Department of Primary Industries Investigation Unit in order to improve mine safety and promote changes to safety culture in the mining industry. This investigation unit will be discussed later in this chapter.

According to Freeman (2012) the Investigation Unit since 1999 has had 39 successful prosecutions and are currently involved in 18 investigations. The organisational failures were as follows;

- Contractors 20%
- Risk Management 23%
- Systems of work 10%
- Training 10%
- Supervision 3%
- Other Failures 34%

These case study observations have found that there is a “disconnect” between the systems of work in place and what is being done by supervisors and employees. Some supervisors are not competent to monitor the tasks being undertaken. Risk management systems are being plagued by time consuming procedures that inadvertently create token-compliance. Contractors are strongly represented in incidents and the management of contractors has been found to be deficient and failure to enforce, maintain and audit safety standards of the contractor’s safety management plans. The effects of fatigue not being identified and work hours have also contributed to the issues concerning contractor management. Figure 5.1 illustrates the major organisational failures. Contractor Management, Risk Management, Training, Supervision and Systems of Work all contribute to active and latent failures with the consequent result of an accident or incident.

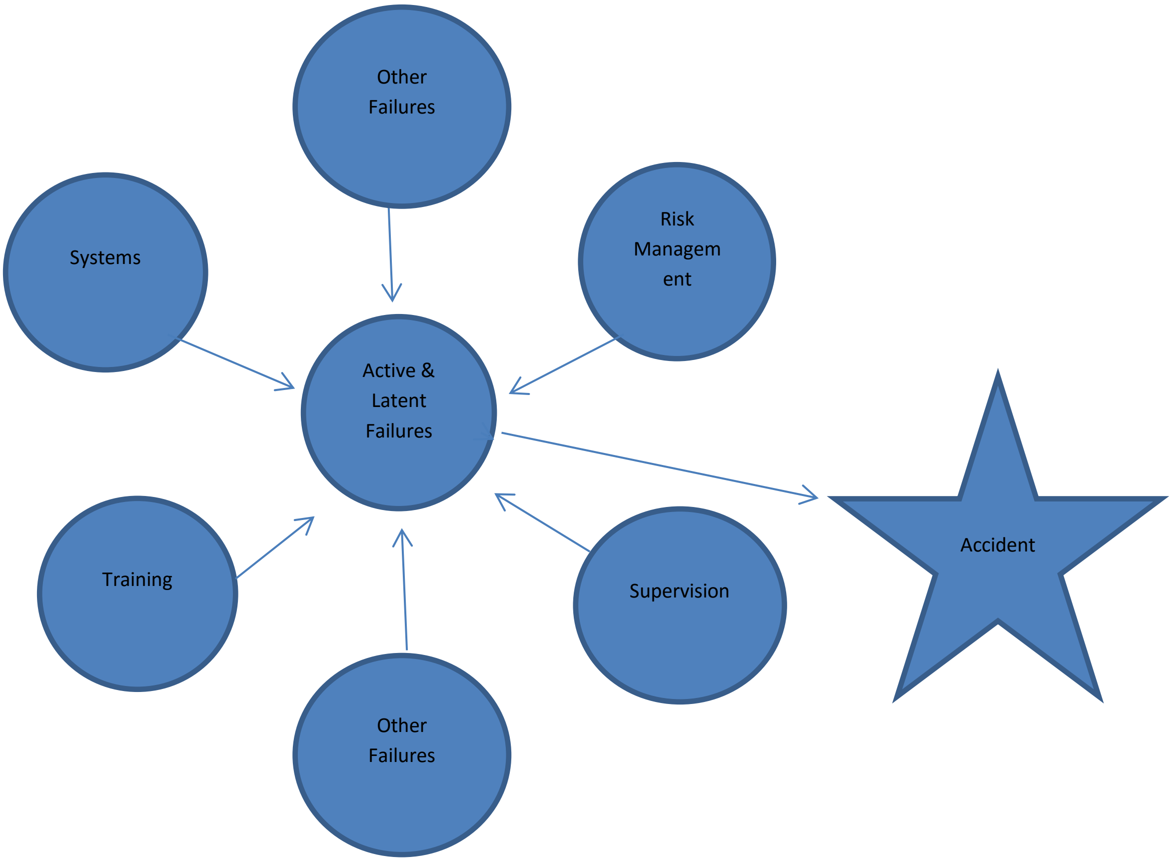


Figure 5.1 Major Organisational Failures

The time taken to complete an investigation under the Queensland Wardens Court system as mentioned earlier was on average 7 months. It can be observed from Table 5.4 regarding prosecutions in NSW mines for fatal and serious injuries that from 1996 to 2010 there were a total of 39 successful prosecutions (namely 26 fatalities and 13 serious injuries) and these prosecutions took between 3 and 9 years and the average time to conduct each investigation was over 4 years.

Table 5.4 Prosecutions in NSW Mines for Fatal and Serious Injuries 1996 to 2008

Date of Accident	Injury Type	Location of Accident	Date of Findings	Time Taken In Years
Jan-1996	Serious Injury	Coal Cliff	Aug-1999	3.5
Apr-1996	Fatal	Berrima	Jan- 2001	4.8
Nov-1996	Fatal x 4	Gretley	Mar-2005	8.3
Nov-1997	Fatal	United Colliery	Nov-2003	6.0
July-1988	Fatal	Wallerah Coll.	Oct-2005	7.3
Jan-1997	Fatal	Dartbrook	Nov-2003	6.8
July-1998	Fatal	Awaba Colliery	Nov-2004	6.3
Mar-1999	Fatal	Elura Cobar	Nov-2005	6.7
July-1999	Fatal	Cooranbong	Nov-2003	4.3
July-1999	Serious Injury	United Colliery	Mar-2005	5.6
July-1999	Fatal	Tahmoor	Sep-2003	3.1
Aug-1999	Fatal	Cumnock No 1	Jun-2004	4.8
Nov-1999	Fatal x 4	Northparkes	Apr-2003	3.4
Feb-2000	Fatal	Hillgrove	Jun-2003	3.3
Feb-2000	Fatal	Cressfield	May-2003	3.3
May-2000	Fatal	Ridgeway	Dec-2004	4.6
Jun-2000	Serious injury	Emu Plains	July-2003	3.0
Dec-2000	Fatal	Bellambi West	Nov-2009	9.0
Mar-2001	Fatal	Wambo	Jul-2004	3.3
Sept-2001	Fatal	Baal Bone	Apr-2008	6.9
Nov-2002	Fatal	Perilya Mine	Jun-2007	4.9
Nov-2002	Fatal	Broken Hill	Jun-2007	4.6
Dec-2003	Fatal	Dartbrook	Feb-2007	3.2
May-2004	Fatal	Mount Thorley	Apr-2007	3.0
May-2004	Fatal	Dartbrook	Sept-2007	3.4
May-2004	Fatal	Warkworth	Apr-2007	3.0
May-2004	Serious Injury	Metropolitan	Feb-2008	4.0
July-2004	Serious Injury	Clarence	Nov-2007	3.3
Jun-2005	Serious Injury	Dartbrook	Oct-2008	3.3
Jun-2005	Fatal	Hunter Quarry.	Oct-2009	3.3
Mar-2006	Serious Injury	Bulga O/C	Mar-2009	3.0
July-2006	Fatal	Angus Place	Feb-2010	3.3
Nov-2006	Serious Injury	Cobar Mine	Sep-2011	4.2
Jan-2007	Fatal	Perilya U/G	May-2010	3.4
Nov. 2007	Serious Injury	Perilya U/G	Mar-2011	3.3
Nov-2007	Serious Injury	Liddell C/P	Apr-2011	3.3
Mar-2008	Serious Injury	Austar Mine	Aug-2011	3.3
Sep-2008	Serious Injury	Gujarat NRE	May-2011	2.6
Apr-2009	Fatal	Integra U/G	Nov-2015	6.6
Aug- 2009	Fatal	Narrabri U/G	Sep-20-13	4.1
Apr-2010	Serious Injury	Beltana U/G	Feb-2015	4.8
Average Time				**4.4 years**

It can be observed in Figure 5.2 that of the 41 prosecutions investigated 68% were fatalities and 32% were serious injuries.

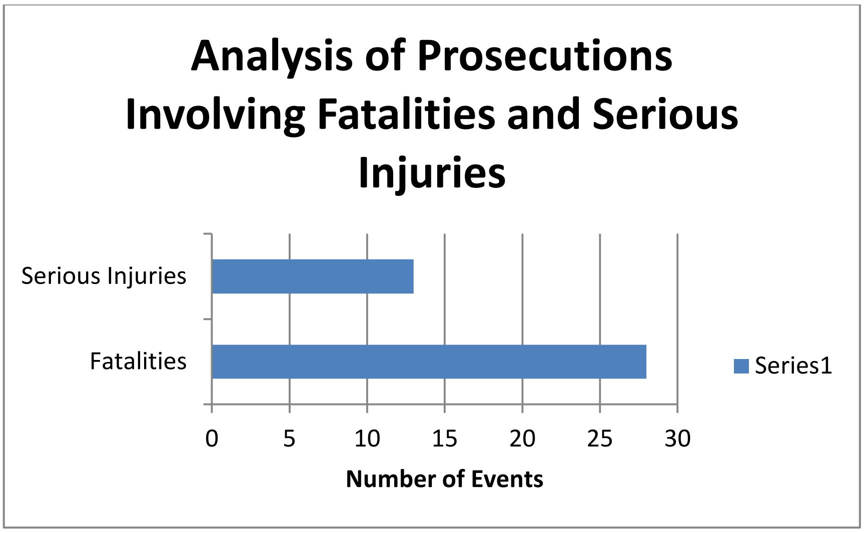


Figure 5.2 Analysis of Prosecutions Involving Fatalities and Serious Injuries

The analysis of prosecutions by industry sector is illustrated in Figure 5.3 and shows that underground coal scored the highest prosecutions at 61% followed by underground metalliferous on 22%, open cut coal on 10% and extractives on 7%.

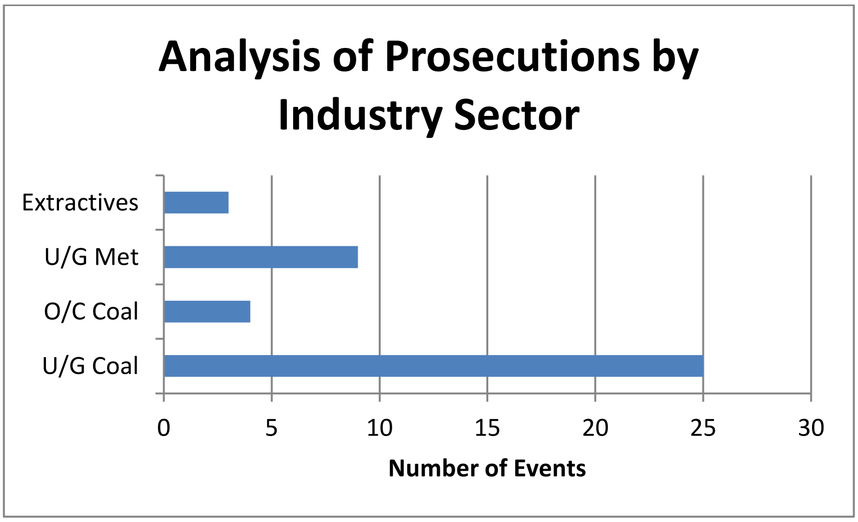


Figure 5.3 Analysis of Prosecutions by Industry Sector

Since it takes over four years to complete a successful prosecution the lessons learned are too late to prevent a recurrence of the accident or incident. A good example of this problem is the May 2004 explosion at BHP Billitons Boodarie Hot Briquette Plant at Port Headland Western Australia, killing the shutdown coordinator and seriously injuring two other employees (Moore 2006).

1. Two years after the accident at the BHP Billiton (BHPB) Boodarie Plant, no lessons to the public forum have emerged on how safety can be improved.
2. This delay is due to the dual effects of legal privilege and legal process.
3. The results of the public inquiries into the 1988 Piper Alpha disaster in the North Sea and the 1998 Longford disaster in Victoria have had a major effect of improving safety practice and management.

During discussions with industry personnel it has been stated that some law companies are advising their clients to use lawyers to undertake incident investigations and therefore use "legal privilege" in order to protect any information gleaned. In June 2006 BHPB pleaded guilty for failing to provide a safe work place and was fined $200,000 and also had to pay a $58,000 in associated costs. The May 2004 Boodarie explosion findings gleaned from investigations never made it to the open court and therefore did not become public knowledge because BHP pleaded guilty to the charges.

The Safety Institute of Australia President Gavin Waugh made the following comment *"he suggested that the Boodarie incident highlighted a lack of investigation transparency in Western Australia"* (Moore 2006).

Other comments along the same lines was made by Janine Freeman of the Unions of WA who suggested that companies should not be allowed to hide behind the law to avoid their occupational safety and health responsibilities (Moore 2006).

5.7 Findings of the Coroners Court in Queensland from December 2002-May 2009

The Queensland Government replaced the Wardens Court with the Coroners Court in March 2001. This change was opposed by all the mining unions in Queensland and many stakeholders since the Wardens Court had been operating successfully for many years. It is reasonable to assume that the Queensland Government wanted to follow the NSW prosecution policies and in order to achieve that objective it was necessary to abandon a well-tested and efficient Wardens Court.

In order to make a comparison between the Wardens Court and the Coroners Court in terms of time taken to complete an investigation it is necessary to examine Table 5.5. The table shows the findings of the Coroners Court from December 2002 to May 2009. It may be observed from Table 5.5 that the length of time taken to finalise investigations ranges from between one and three years compared to the Wardens Court of seven months. This time difference of over two years is a consequence of legal process, legal privilege and prosecution activities. This means that the lessons learned in order to prevent a recurrence cannot be implemented until two years after the accident or incident which is a major impediment to improving safety on mine sites.

Table 5.5 Findings of the Coroners Court in Queensland from December 2002 to May 2009

Date of Accident	Injury Type	Location of Accident	Date of Findings	Time Taken In Years
May-2009	Fatal	Mt Isa Mine	Nov-2013	4.7
Jan-2008	Fatal	Cannington	Aug-2013	5.6
Mar-2007	Fatal	Moranbah North Mine	Sep-2009	2.5
Feb-2007	Fatal	Dysart-Middlemount	Feb-2011	4.0
Feb-2006	Serious Injury	Broadmeadow Mine	February 2008	2.0
Dec-2006	Fatal	Cannington Mine	Nov-2009	2.9
Oct-2005	Fatal x 2	Rockhampton-Yeppoon H/W	Feb-2011	5.3
Aug-2005	Fatal	Foxleigh	Mar-2007	1.6
Jul-2005	Fatal	Mackay	Oct-2009	4.2
February 2004	Fatal	Century Mine	May 2006	2.3
July 2004	Serious Injury	Goonyella Riverside Mine	January 2008	3.5
August 2004	Fatal	Highway Reward Mine	July 2005	1.0
October 2004	Fatal	Mayne River Mine	February 2007	2.3
November 2004	Fatal	Mount Norma Mine	December 2006	2.0
August 2005	Fatal	Foxleigh	March 2007	1.7
September 2005	Fatal	Dawson Mine	December 2007	2.2
October 2005	Fatal	Rockhampton/ Yeppoon H/W	November 2008	3
December 2002	Fatal	Highway Reward Mine	November 2004	2
Average Time				3.0 years

It can be observed from Figure 5.4 that it takes the Queensland Coroners Court 36% and the NSW Prosecution Investigations 56% more time to conduct investigations than the Queensland Wardens Court. This illustrates the fact that under the Wardens Court system all the facts relating to an investigation are available in a much quicker time frame which allows the lessons learned to be put into practice in order to prevent a recurrence of accidents and incidents much quicker with a consequent benefit for safety improvement.

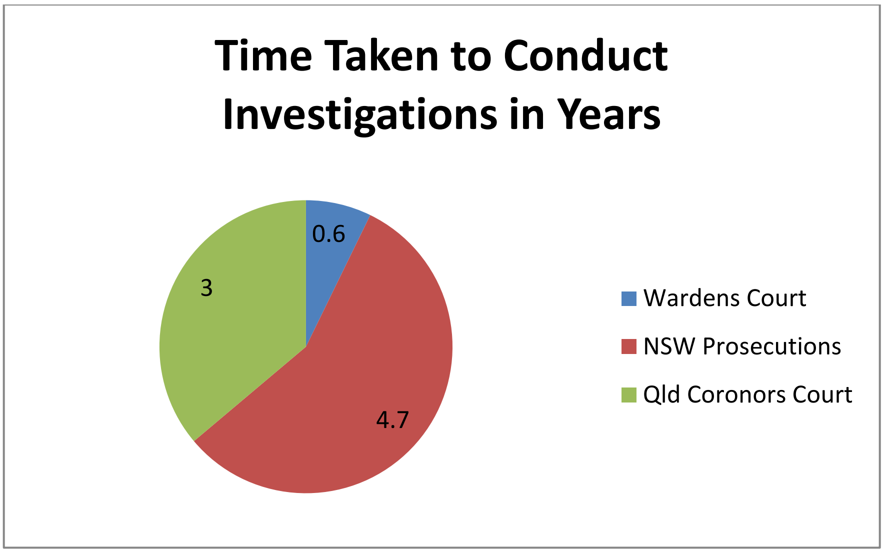


Figure 5.4 Time Taken to Conduct Investigations in the Wardens Court, NSW Prosecutions and the Qld Coroners Court.

In summary one would have to conclude from the above analysis that the Wardens Court is not only more efficient in its process, but because there is no fear of prosecutions, it is able to find out what happened, why it happened and what needs to be done to prevent a recurrence without the fear of the legal process and legal privilege. The Warden's Court outcomes allows for free flow of information where lessons can be learned and trust between all parties can be restored, instead of information being locked up which is unavailable to prevent a recurrence.

Contrary to this approach in British pits it was found by Braithwaite (2002) that companies "not only thoroughly involve everyone concerned after a serious accident to reach consensual agreement on what must be done to prevent reoccurrences but also did this after 'near miss accidents' as well as discussing safety audits results with workers even when there was no near miss accident. Braithwaite concluded that:

"After mine disasters, so long as there has been an open and public dialogue amongst all those affected, the families of the miners cared for, and a credible plan to prevent recurrence put in place, criminal punishment served little purpose. The process of the public inquiry and helping the families of the miners for whom they were responsible seemed such a potent

general deterrent that a criminal trial could be a gratuitous and might corrupt the restorative justice process that I found in so many of the thirty-nine disaster investigations I studied". (Braithwaite 2002).

5.8 United Kingdom Health and Safety Enforcement Policy

The United Kingdom Health and Safety Executive (HSE 2002) Enforcement Policy is carried out as follows. The Health and Safety Executive's aims are to protect the health, safety and welfare of people at work, and to safeguard others, mainly members of the public, who may be exposed to risks from the way work is carried out. The purpose of enforcement is to:

- Ensure that duty holders take action to deal immediately with serious risks
- Promote and achieve sustained compliance with the law
- Ensure that duty holders who breach health and safety requirements and directors or managers who fail in carrying out their responsibilities may be held to account.

This focus on risk enables substantial consideration to be given to prosecutions which target the failure to deal with crucial issues such as management systems and risk control, and which are geared to promote the proactive "system based" aspects of OHS management (Gunningham 2007).

Where, in the words of the United Kingdom Health and Safety Commission (2002) "*there have been repeated breaches which give rise to significant risk, or persistent and significant poor compliance"* or failures to comply with improvements and prohibition notice or their equivalent, or *"a breach which gives rise to significant risk has continued despite relevant warnings from employees or their representatives, or from others affected by a work activity",* then this should weigh substantially in the decision to prosecute.

5.9 Prosecutions for Occupational Health and Safety (OHS) Offences in the Australian Mining Industry

The role of prosecution in achieving compliance with OHS mining legislation in Australia is a highly contentious issue. Nowhere is this more so than in New South Wales, where, following the Gretley mining disaster the Department of Primary Industries developed a new found enthusiasm for prosecution, particularly following a fatality. The Department's prosecution policy and the approach of the independent Investigations Unit charged with investigating fatalities, has precipitated a seething dispute between the New South Wales Minerals Council and major mining companies on the one hand and the mine safety regulator and the trade unions on the other. (Gunningham 2007).

The following statement emphasizes the futility of the current prosecution policy being pursued by the New South Wales inspectorate following a fatality:

"*It is fundamental that the criminal law must be administered in an appropriate fashion. The legislature has chosen to emphasise the importance of occupational health and safety matters by creating absolute offences. If the prosecution of offences is undertaken in an arbitrary, capricious and irresponsible fashion, the laws themselves are brought into disrepute for reasons that are obvious. This is especially so in the area of occupational health and safety prosecutions where is the custom of the prosecutor to seek a moiety of the penalty, that is payment of one and a half of any amount imposed by way of penalty." Newcastle Wallsend Coal Company Pty Ltd v Inspector McMartin (2006) NSWIRComm 339, per Marks J.* (Gunningham 2007).

It would appear that there are two sides of disagreement regarding the highly contentious New South Wales policy. One on side is the New South Wales Mineral Council which represents the mining companies, and on the other side are mining unions and the inspectorate.

The mining companies believe that prosecution is counter-productive and inhibits appropriate safety investigation, moves away from a no blame culture, encourages a defensive rather than a proactive approach to OHS and drives away potential mine managers at a time of critical shortage of appropriately qualified and experienced people.

J Galvin of the University of New South Wales made the following comment:

"One of the most effective means of achieving sustained improvement in health and safety culture is to inculcate health and safety values and attitudes in future leaders and managers when they are in their youth. Unfortunately, one negative effect of the current 'automatic' prosecution policy of Work Cover / Minerals Resources is to discourage the young from entering mine management. Increasing numbers of future mining industry professionals are electing whilst they are still at university not to enter into mine management" (Galvin 2005).

The enactment of the Occupational Health and Safety Amendment (Workplace Deaths) Act 2005 (NSW), introducing a higher penalty regime for workplace fatalities involving recklessness or intent, has added fuel to the fire. The trade unions have welcomed these developments as providing effective deterrence to corporate law-breaking and have strenuously urged regulators to expand their use of prosecution to a far wider set of circumstances. The unions believe that the Department of Primary Industries has not been effectively applying the compliance policy and therefore welcome the push for more prosecutions. The union view is articulated by Hawkins (2002) who argues:

"Prosecution is a ceremonial restatement of norms by which people and individuals order social life. Its use sustains the moral world which the regulatory organisation inhabits. One way it does this is through the satisfaction given to the prosecution of a blameworthy defendant that moral boundaries are being maintained and reinforced … In making public those standards of behaviour deemed proper, decent and desirable, prosecution can be cathartic, since it can sometimes satisfy a demand, whether from the victim, the victim's family, the media or people generally, for a public statement of the worth of the victim and the culpability of the defendant".

5.10 Prosecution Practice in New South Wales, Queensland & Western Australia

5.10.1 Prosecution Policy in NSW

The prosecution policy in NSW according to the Director General Alan Coutts (1999) stated that the purpose of this document is to support an open and consistent approach by the Department to the enforcement of health and safety standards in mines through assessment of mining operations, investigation of accidents and incidents, and, where appropriate, prosecution. This policy according to personnel communication with Freeman (2016) is still valid.

Prosecution will be considered in all instances where a significant breach of legislation is discovered by the NSW Department of Mineral Resources. Significant breaches of legislation will include, but may not be limited to breaches which:

- cause, or are likely to cause, death, or serious injury or ill health; or
- continue to occur after other representations or interventions by the Department; or
- interfere with the proper investigation of causes and circumstances surrounding an event.

Where there is a significant breach, and a prima facie case, together with a reasonable prospect of conviction, then the public interest expects that a prosecution will result.
With the Occupational Health and Safety Act as the principal health and safety legislation, charges and defendants under that Act will be considered first. This means that actions will most likely be against corporations (as the employer) but that individuals, whether management, contractors or employees who commit significant breaches may also be proceeded against.

The Department intends to effectively use prosecution as an integral part of its overall Enforcement Strategy. To do this the Department will:

- *"prepare, publish and implement prosecution guidelines and keep them under review;*
- *train and support investigating officers required to prepare and conduct prosecutions including the gathering, assessment and presentation of evidence and relevant law relating to offences, investigation and evidence;*
- *consider prosecution as a matter of course, and in a fair, consistent and timely manner, where a significant breach of legislation has occurred*
- *keep a record of all decisions whether or not to prosecute and of the reasons for such decisions; and*
- *publish information on prosecutions undertaken, appropriate to the stage that the prosecution has reached at the time of publication while keeping in mind the importance of timely and relevant information being made available to industry for preventative purposes".*

5.10.2 The NSW Mine Safety Investigation Unit

The NSW Trade and Investigation Unit was established in 1998 by the NSW Government to improve mine safety in the state Millington (2012). It investigates the nature, cause and circumstances of major accidents and incidents in the NSW mining and extractive industry for coroner's reports and legal proceedings. The Investigation Unit is an autonomous unit that reports to the Director-General. The Unit has the power to investigate accidents and incidents in any part of the NSW industry and can investigate matters off-site including equipment suppliers, manufactures and other people relevant to the accident and it can recommend prosecution if appropriate. The Inspectorate report the occurrence of serious accidents and incidents to the Investigations Unit. The Unit aims to contribute to a better understanding and management of the safety hazards and risks in mining operations. It provides industry with information on the lessons learnt from past accidents and incidents to increase safety awareness.

According to Millington (2012) the unit's team of investigators improves safety by:

- conducting major investigations into significant mine events

- participates in inquests and legal proceedings
- liaises with incident victims, families and a range of stake holders
- provides information and feed-back to industry
- proposes new standards for safety protocols, procedures and
- provides specialist training to department staff.

5.10.3 Prosecution Policy in Queensland & Western Australia

Queensland and Western Australia have been, and remain substantially less prosecutorial in orientation than New South Wales, although the current trend in both states is very much towards more prosecutions.

In Queensland and Western Australia there is still a strong philosophical commitment to the “advise and persuade” approach and the prosecution policies are not as strictly enforced as they are in NSW. However signs are emerging that this policy is changing and as a consequence, many companies are watching anxiously, fearing that the new found enthusiasm for prosecution in NSW will infect their own states. As previously stated the mining unions are pushing for prosecutions as hard as they can (Gunningham 2007).

It would seem that there are two sides of disagreement regarding the highly contentious New South Wales prosecution approach. On one side is the NSW Mineral Council, which represents the mining companies, and on the other side are the inspectorate and the mining unions.

5.11 View of the NSW Mineral Council on Prosecution

The NSW Mineral Council argues very strongly that the prosecution policy is counter-productive, inhibits thorough safety investigation, which in turn stimulates a defensive attitude towards a proactive safety culture and in so doing creates a problem for continuous safety improvement.

"The automatic prosecution policies are impacting negatively on the objective of reaching zero harm" (Galvin 2006).

The reasons for the above statement are as follows:

- The lessons from serious accidents and incidents are not being used to prevent a recurrence of the accident or the incident until many years after they have occurred, because of legal privilege and other considerations related to the pending charges. It creates a climate of distrust between the parties, which is in complete opposition to finding out:
    1. **what happened,**
    2. **why did it happen and**
    3. **what can be done to prevent a recurrence".**
- The policy does not encourage near miss reporting simply because the findings could be used against the company in future prosecutions.
- It moves away from the no blame culture, which is absolutely necessary if the mining industry is to continually improve its safety performance and
- The recent prosecutions have not only targeted the companies concerned but individual duty holders, it also has become a major disincentive for young people to consider a management role in the mining industry.

In the NSWMC (2005) submission to the review of the OHS Act 2000 it was stated that

"*The application of OHS legislation should encourage and foster a relationship of honest and open communication regarding safety*".

They support the notion that reckless behaviour which endangers others will not be tolerated, prosecution of employees and companies should be a remedy of last resort and the introduction of alternate means of prosecution and conviction should be pursued.

These automatic prosecution policies are promoting a defensive safety culture where the respective parties are encouraged to seek client legal privilege to the detriment of finding out the facts as soon as possible.

5.12 Client Legal Privilege

In order to understand what "Client Legal Privilege means in terms of finding out the facts regarding an accident or incident the following statement by a lawyer in Brisbane in 2001 which is still valid today explains the legal ramifications:

"*Documents produced for the purpose of obtaining legal advice or in the anticipation of possible prosecution may be subject to client legal privilege. This means there is a basis to say those documents do not need to be produced to the inspector or to a court or to a tribunal"* (Humphreys, 2001).

In the event of a serious incident or accident mining companies are advised by the legal profession to be very careful about generating reports about the incident or accident. Employees are encouraged not to write written reports in relation to the incidents and accidents without prior approval of the manager, because they may be damaging the company's legal position and the legal position of its employees, managers and directors. Very often, the first person on the site of an accident or incident these days is the company lawyer who then effectively takes charge of the investigation.

This is the reason why the NSWMC says that these prosecution policies are counter-productive and inhibit thorough safety investigation. How is it possible to investigate a serious incident or accident if not all the all the facts are made available to the participants of the investigation in order to carry out the task of finding out what happened, why did it happen and what is to be done in order to avoid a recurrence.

Indeed, when inappropriately used, prosecution can have a negative impact on OHS outcomes. For example there is evidence that a confrontational style of enforcement may diminish the willingness of some companies to cooperate and learn from past experience, as well as make them reluctant to share information and unwilling to consult regulators for fear that their disclosures will be used against them (Bardach & Kagan 1992; Kagan 2001; Scholz 1984; Hopkins 2005a).

The prosecuting authority must prove its case beyond reasonable doubt. It is the inspectorate's responsibility to carry out the investigation and prove its case against any company or individual. It is not for any company or individual facing prosecution to help prove the case against them. However one Chief Executive of a large mining company made the comment to the author that it would seem that under the current prosecution policies in the mining industry a mine manager is guilty and has to prove his innocence, compared to the standard philosophy that under the law of the land you are innocent until proven guilty.

Currently after an accident or incident some companies will volunteer all the relevant information and in so doing will provide the inspectorate with all the information the company has in its possession. Some companies may not wish to cooperate at all, hiding behind client legal privilege. Most mining companies take steps to protect the company's legal position of its employees, managers and directors at the same time ensuring proper communication and cooperation with the inspectorate.

5.13 View of the Mining Unions on Prosecutions

As indicated previously the mining unions agree with the current prosecution policies because they believe that they act as a deterrent to company law breaking and as a consequence are actively encouraging the inspectorate to further expand the use of prosecutions to a much greater set of circumstances. In order to improve occupational health and safety in the industry the mining unions believe that the current prosecution policies are an essential way forward. There are now definite moves in Queensland to travel down the same path as NSW, with pressure being put on the inspectorate to enforce prosecutions where possible.

According to a CFMEU Safety Alert Briefing Note (2007) the statistics concerning NSW mining industry prosecutions reveals two important points which substantiates their position on prosecutions:

1. The mining industry has historically been under-represented in the number of prosecutions undertaken relative to the incidence level of injuries and death; and
2. Since the NSW Government safety regulator commenced a more rigorous policy of prosecution there has been a significant improvement in the recorded level of death and serious injury in the mining industry.

When the prosecution polices were first enacted these policies affected the relationship between the mine operators, industry associations and the mines inspectorate.

5.14 Relationship between Mine Management and the Mines Inspectorate

Mine operators and industry associations widely report that the trust between themselves and the mining inspectorate is at an all-time low (Wran & McClellan 2005). Obviously, Mine Managers in NSW have the most contact with the inspectorate and have indicated that prior to the prosecution policy being implemented the relationship between management and the inspectorate was very constructive and helpful. It is now quite the opposite and is strained, difficult and cautious. Previously, both parties worked together to achieve a common goal of zero harm which has brought about this change which is entirely due to the prosecution policy. Instead of working together to achieve a common goal the parties are working against each other since the relationship has broken down and the mistrust between the parties has destroyed the constructive interactions regarding compliance and indeed improving compliance outcomes. Another way of putting this conflict is as follows:

"We have a greater chance of efficient and effective regulation if we have a regulatory culture where regulators and regulated actually listen to each other and respect the concerns of the other; we have a lesser chance of cost-effective regulation if these two constituencies see their mission as to destroy the other, taking it in turn to win battles without either side winning the war" (Braithwaite 1993)

The mining industry needs to encourage open reporting and in doing so develop a proactive safety culture that is just, in order to achieve continuous safety improvement. Reason's

"just culture" emphasises that

"*valid feedback on the local and organisational factors promoting errors and incidents is far more important to safety than assigning blame to individuals"* (Reason 1998).

Reason also argues that a small proportion of unsafe acts are egregious, and warrant sanctions, so what is needed is not a blanket amnesty on all unsafe acts but a just culture which generates "an atmosphere of trust in which people are rewarded, for providing

essential information, but are also clear about where the line must be drawn between acceptable and unacceptable behaviour "(Reason 1997).
This advice may prove useful in a regulatory context where it can be argued that the line should be drawn at a point that will encourage reporting and avoid the sorts of defensive individual and corporate behaviour documented earlier, while making clear that behaviour which departed substantially from reasonable expectations, would not be countenanced. This has been the approach of a number of high reliability organisations which are distinguished by their exemplary OHS performance. For example, British Airways Flight Crew Order 608 suggests that disciplinary action should only be taken against an employee where they have taken action or risks, which, in the company's opinion, no reasonably prudent employee with his/her training and experience would have taken (Reason 1997).

As recently discussed in New South Wales, political pressure for increased levels of prosecution and higher penalties has resulted since the Gretley decision which has resulted in substantial penalties being imposed on both the operators, owners and on an individual mine manager.

5.15 Prosecutions Resulting from the Gretley Mine Disaster

The Gretley Mine disaster was discussed in some detail in Chapter 2. The following is a brief account of what happened. In November 1996 at Gretley Mine a team of eight men were in the process of developing a roadway with a continuous miner which inadvertently broke through into flooded workings of an old abandoned mine and four miners died in the inrush of water.

After two years of the judicial inquiry into the 1996 Gretley disaster the New South Wales Government started the process of prosecuting the Newcastle Wallsend Coal Company, and its parent company Oakbridge Pty Ltd and several of its managerial staff.

An inquiry into the incident by former Justice James Staunton made recommendations concerning prosecution and charges were subsequently brought in the New South Wales Industrial Commission, both against the two former operating companies and against a number of individuals. In 2004 Commissioner Justice Patricia Staunton stated that the corporate defendants had failed to ensure the health, safety and welfare of their employees, and two former mine managers and a mine surveyor were “deemed to have committed the same offences as the corporations, having failed to satisfy the onus placed upon them” to exercise due diligence to protect workers (McMartin v Newcastle Wallsend Coal Company Pty Ltd (2004) NSWIComm 202 at (979).

Although the defendants argued that they were entitled to rely on old plans of the workings supplied by the relevant government agency, Justice Staunton found that “this does not excuse the defendants from their independent statutory obligation… to ensure a safe system of work. Nor does it relieve the defendants of their obligation to satisfy themselves by way of their own research as to the accuracy of the Department of Mineral Resources plans which were seriously deficient in purporting to depict old workings” (2004) NSWIComm 202 at (806).

This decision to prosecute senior officers of the company was not only a departure from previous practice in the mining industry but amounted to a new direction of prosecutions under the Occupational Health and Safety Act 1983. The ability to prosecute company officers has been present for a number of years and had mostly been used for officers of small companies who were directly involved in safety and health breaches. The Gretley proceedings represented a new direction regarding prosecuting those involved in the overall management of a large company (Foster 2008).

Justice Staunton rejected the company’s defences, finding that while the companies were entitled to rely on the Department of Mineral Resources (DMR) information as being accurate, this did not excuse them from their obligations to ensure a safe system of work. She went on to say that two of the plans provided by the DMR were seriously deficient in purporting to depict old workings in a way that one should be confident of their accuracy, and moreover companies should have taken the step of ascertaining their accuracy. Justice Staunton also rejected the defence of the two surveyors, finding that they were concerned in the management of the corporation as well as mine managers. She also found that they had not established that they were not in a position to influence the conduct of the companies and they had not used due diligence to prevent the companies contravention of the act (Smith 2005).

The outcome of the Gretley Inquiry was that mining convictions were imposed on the company and managerial staff, which is the first time in Australia where a company and managerial staff have been convicted for safety mis-management. Penalties were imposed on the operating company, owning company, first mine manager, second mine manager and the mine surveyor (Hopkins 2005). The penalties imposed on the various defendants were as depicted in Table 5.6:

Table 5.6 Penalties Imposed on Companies and Management

Companies & Management	**Penalties**
Operation Company	$730,000
Owning Company	$730,000
First Mine Manager	$30,000
Second Mine Manager	$42,000
Mine Surveyor	$30,000

It is interesting to note that penalties were not imposed on the Department of Mineral Resources (DME). However Paul Hall (2004) the QC representing the dead miners families believed that both the mining company and the DME could have been convicted for being the *"direct causes of the disaster".* The formal investigation had found that the DMR had approved maps, which indicated that the abandoned mine was 100 metres from where the miners broke through into the old workings, and ultimately perished. Therefore the question which must be asked is if the companies and management are to be prosecuted then why not the DMR.

This was shown to be the case when Justice Staunton recommended that the evidence of the inquiry be referred to the Crown Solicitor to determine whether the Newcastle Wallsend

Coal Company should be prosecuted for offences under the Occupational Health and Safety Act.

The second tribunal mentioned earlier was not completed until August 2004 nearly eight years after the disaster and over six years after the first tribunal was completed. The CFMEU (2004) criticized the government for not prosecuting the DMR and have stated that there is a lack of regulatory protection for the growing number of contract workers within the mining industry since industry studies indicate a connection between a lack of safety in coalmines and the growth of contract employees in the mining industry. The CFMEU also stated that contractors are favoured by mining companies over full time mine employees because they are cheaper and many contract workers are non-union orientated. Since contractors receive much less training and induction for safe operating their safety standards were much lower than permanent full time employees.

The president of the CFMEU Tony Marr (2004) made the following comment:

" It's the first time in the 200 year history of the NSW coal industry that anyone has been convicted for the loss of life despite more than 3000 miners being killed in the States coal mines".

Xstrata, the new owner of Gretley Mine is a Swiss conglomerate mining company who was responsible for paying the $1.6 million fine and who subsequently challenged the validity of the Health and Safety Laws that provided for the Gretley criminal convictions. This action was seen to be a very provocative approach by the mining unions. The families of the deceased men asked the company to drop its challenge to the validity of the Health and Safety laws that provided for the Gretley criminal convictions. This challenge provoked enormous resentment amongst the rank and file mineworkers which led the Miners Union General president to make the following comment:

"Our members demand the right to the full protection of the law when they go to work. Mining companies have to accept that if their negligence results in death or injury to workers then they will be held to account. Our members cannot be expected to work in the most dangerous industry in the world without the full protection of the law" (Maher 2005).

A Full Bench of the NSW Industrial Relations Commission overturned the previous conviction by a single Judge, Justice James Staunton, that the surveyor at the Gretley mine was *“concerned in the management of the corporation”* and therefore guilty of an offence under the Occupational Health and Safety Act 1983. This decision re-affirmed the guilt of the two mine managers and the two companies concerned in the management of the mine (Foster 2008).

Interestingly the penalty imposed on the mine manager who had been actively involved in the company at the time of the disaster was effectively overturned and the court applied the provision of the law not to enter a criminal conviction against that mine manager. The main reason for this was the *“justifiable sense of grievance experienced”* where one of those parties responsible for the incident (NSW-DMR who had provided inaccurate maps) had not been prosecuted. However Justice Marks disagreed with the other members of the full bench regarding the sentences that should have been imposed. According to Foster (2008) He went on to make some very critical comments regarding the prosecution process which were subsequently widely reported in the media *“more than prosecution…amounting to persecution”.*

5.16 Prosecutions at the Boodarie Plant Explosion in Western Australia

This accident was discussed in some detail earlier in this chapter regarding the fact that BHPB pleaded guilty in failing to provide a safe workplace.
Further comments were made by Janine Freeman of the Unions of WA who suggested that companies should not be allowed to hide behind the law to avoid their occupational safety and health responsibilities

- the notion of hiding behind legal privilege when being prosecuted is dishonest and shows contempt for occupational health and safety laws and
- legal privilege should only be allowed where it is legitimate advice between lawyer and client and not for restricting access to accident an incident reports.

- Accident and incident reports should be publically available so that lessons can be learnt and that action to conceal information always leads to a lack of trust between the parties.

The Boodarie fatality was one of three, which occurred at BHPB facilities within weeks of each other. The WA government responded by setting up an independent inquiry headed by Mark Ritter who issued BHPB with 21 recommendations in order to improve occupational health and safety.

The author of the Lessons from Longford Gas Explosion Andrew Hopkins was asked by BHPB to conduct an investigation into the Boodarie incident. When BHPB were contacted regarding the findings of this investigation and the consequent impact on the lessons learned they made the comment that the Hopkins Report was produced under legal privilege and as a consequence was unavailable to other stakeholders or the general public.

5.17 Other Problems Regarding Prosecution Policies

Throughout the mining industry in Australia up until the Gretley prosecutions there was a free flow of information between all parties and accident and incident information was shared. That situation of trust between the parties has now changed because of legal process and privilege (Gunningham 2007). A very good example of this deterioration is clearly demonstrated in the following situation:

At the Kayuga Mine NSW in November 2003 a contractor was fatally crushed by a fall of equipment. As a consequence the operating company was prosecuted for failing to ensure that employees of Muswellbrook Crane Services working at the site were provided with or maintained a safe system of work, and also for not carrying a proper evaluation of the risks associated with the task. Some two hundred fifty contractors and only two company employees were on site at the time of the accident. There was a failure to conduct a proper risk assessment for the task in hand and some other company systems for managing contractors were not in operation at the time of the accident. For failing to identify and assess the risks involved Muswellbrook Crane Service was also prosecuted.

A senior person connected with the accident expressed concern at how the company investigation was carried out and has requested anonymity. The following organisations were represented at the investigation:

1. Kayuga Management
2. Contracting Company
3. Mines Inspectorate
4. Mines Investigation Unit and
5. Mining Unions and Employees.

Each of the above mentioned parties were represented by legal people. This resulted in the fact that no one at the investigation would talk to each other because of legal privilege. The objective of:

- Finding out what happened
- Why did it happen and
- What can be done to prevent a recurrence of the accident

was a non-event. The company concerned did not share their findings with anyone which included the inspectorate or the investigation unit. The aforementioned senior safety person connected with the incident was extremely frustrated by the whole process which turned out to be a complete waste of time by all concerned.

A report was produced by the company after completing its own investigation, however it was not made available to company employees for them to learn the lessons from the accident and as a consequence help to prevent a recurrence. The report was locked away and no one was allowed to discuss the accident. The reason given for this approach was that it needed to be done in order to protect the company. The real reason was that of “legal privilege” because the company lawyers needed to protect the company.

The NSW inspectorate through the Investigations Unit (IU) have the authority to investigate High Potential Incidents (HPI) as well has serious injuries and fatalities which has caused the mining companies to investigate their own HPIs in order to learn the lessons learned. However as previously indicated once the IU gets involved, information is locked away by the companies because of the issues with legal process and privilege.

The three basic things mining companies do to learn the lessons from an accident or incident is to consider the following:

- Inspection
- Audit which is subject to legal privilege and
- Investigation which again is subject to legal privilege.

It is appropriate to ask the question when conducting audits and investigations involving "legal privilege" how is it possible to gain the root causes of accidents and incidents when companies are advised by their legal representatives to withhold information that would allow lessons to be learned. The whole essence of any investigation is to find out what happened, why it happened and what can be done to prevent a recurrence. This approach is being jeopardised due to legal privilege and is clearly demonstrated in the following example.

A contractor was killed underground at a BHP Billiton Mine in January 2008; the mine is situated south east of Mt Isa. The Minister for Mines in Queensland Geoff Wilson made the following comment:

"*My Department has advised me that mines investigators were prevented from accessing the scene of the fatal incident and speaking to witnesses and other employees for a full 24 hours after the incident occurred"*

(*Minister demands answers on investigation delay,* 2008)

The Minister went on to say that after a meeting with BHP Billiton he still remained concerned about the unacceptable delay in vital information being provided to the mines inspectorate. He went on to say that it is the mining company's responsibility to ensure that investigators have appropriate information to do their work, finding out what happened, why did it happen and how similar accidents can be avoided in the future. In this case that did not happen. The Minister made the following final comment:

"There is no excuse when those in control of a mine site fail to provide the basic particulars of a fatal incident at the mine for more than 24 hours".

5.18 Discussion

The Moura and Gretley Inquiries outcomes have been discussed in some detail, which has highlighted the impact that these outcomes have had on the mining industry. The Moura Inquiry was completed and the Wardens Report published in one and a half years after the accident compared to the Gretley Inquiry which took eight and a half years to complete and as a consequence changed the Australian mining industry safety culture.

It has been shown that under the Wardens Court system all the facts relating to an investigation are available in a much quicker time frame, which allows the lessons learned to be put into practice in order to prevent a recurrence of accidents and incidents much quicker with a consequent benefit for safety improvement.

This research has demonstrated that the mining industry in Australia has made some significant improvements in safety performance outcomes and this has been achieved by companies, inspectorate and unions working together to achieve a common goal of safety improvement. However, since the Gretley prosecutions this working harmonious relationship and trust between the parties has deteriorated to the detriment of safety improvement in the mining industry throughout Australia. The lessons from accidents and incidents are not being learned because the companies fear being prosecuted which has created distrust between the parties. According to Gunningham (2007) The department's prosecution policy and the approach of the independent Investigations Unit charged with investigating fatalities, has precipitated a seething dispute between the NSW Mineral Council and major mining companies on the one hand and the safety regulator and trade unions on the other.

The mining companies are being encouraged to seek client "legal privilege" in order to protect the company and its directors because the findings could be used against the companies in future prosecutions. Near miss reporting, audits and high potential incidents are also subject to prosecutions which means that vital information is withheld and as a consequence not available in order to prevent a recurrence of the accident or incident. More importantly it moves away from the no blame culture which is the most important part of any safety improvement programme and instead promotes a defensive culture.

According to Gunningham (2007), achieving a balanced approach to prosecution is not easy. On one side the evidence suggests the extreme 'advise and persuade' policy that Queensland and Western Australia inspectorates have favoured will possibly fail to send appropriate signals to the recalcitrant. On the other side the tough prosecution policy that New South Wales has applied to fatalities will also fail in preventative terms. The Gretley decision demonstrating the vengeful prosecution against those who neither intended harm nor were reckless in their behaviour is considered unjust, and this has caused the law to lose its legitimacy in the eyes of duty holders.

The conviction of companies and managers sends a strong message that where the lives of many workers are at high risk from known hazards, companies need to be very careful in planning and executing work, and be very mindful of the consequences if they do not.

In this regard the NSW Mineral Council made the following comments in its submission to the review of the OHS Act 2000 (Williams 2005) regarding the prosecution of the mine manager who had recently been found guilty by the Full bench of the Industrial relations Court despite the Court finding that:

1. He took up his position just months before the collapse of the roof of a mine he was managing;
2. He had limited opportunity to become completely familiar with the mine and its operations;
3. He carried out underground assessments and did not notice anything untoward in respect of the state of the roof;
4. He attended conscientiously and diligently to all his safety responsibilities in the period before the incident;
5. He found nothing in the reporting system that alerted him to a risk arising from the instability of the roof; and
6. He was not involved in the critical planning stages where decisions were made about assessment procedures.

The mine manager would be subjected to the possibility of a term of up to two years imprisonment if he had had a prior conviction. Mine managers are now simply unwilling to place themselves 'in the firing line' where prosecutions can occur for acts or omissions outside their control and in spite of their best efforts. This issue was discussed in the introduction to this Chapter (Galvin 2005).

The NSW Government have been criticised by the CFMEU for not prosecuting the DMR in the Gretley inquiry and stated there is a lack of regulatory protection for the growing number of contractors in the mining industry. They also expressed concern that the safety standards for contractors were lower than full time employees since they receive much less training and induction for safe operating. This is a major problem facing the industry since contractors now make up a large percentage of the workforce.

Queensland and Western Australia remain less prosecutorial in orientation than New South Wales, although the current trend in both states is very much towards more prosecutions.

In 2006 the Prime Minister John Howard called on State Premiers to support him in reforming occupational health and safety laws that apply to the mining industry. The Prime Minister declared that the existing laws are imbalanced and unfairly target mine managers. State laws are inhibiting productivity by effectively scaring off prospective senior staff and that the laws need to be overhauled to reflect a "sharing of the burden" (Howard 2006).

In regard to offences involving recklessness being treated as a criminal offence it is interesting to note the following comment contained in the Robens Report:

"*We recommend that criminal proceedings should, as a matter of policy, be instituted only for infringement of a type where the imposition of exemplary punishment would be generally expected and supported by the public. We mean by this, offences of flagrant, wilful or reckless nature which either have or could have resulted in serious injury"* (Robens 1972).

In January 2008 one of the largest mining companies in the world BHP Billiton (BHPB), prevented mine investigators from accessing the scene of a fatal accident and speaking to witnesses and other employees for a full 24 hours after the incident occurred. The Minister for Mines in Queensland had to call a meeting with BHPB in order for them to cooperate. He said after the meeting, that he remained concerned that there was an unacceptable delay in vital information being provided to the mines inspectorate. This is a classic example of "Disconnect" between what corporate management want and what is achieved at the mine site.

In the event of fatal accident on a mine site the Chief Executive Officer or his immediate subordinate is one of first persons to know about a fatality. One can only assume that the company acted in this way to protect the company due to the fear of litigation. This kind of behaviour has no known precedent in Australia. One month after this incident the company in February 2008 settled out of court to the tune of $300,000 after two workers were seriously injured at the Goonyella Riverside mine. The company had been charged with neglecting its duty of care obligations under Queensland's Coal Mine Health and Safety Act 1999. BHP incurred two fatalities in WA and one in Qld in 2008. One way of trying to prevent these fatalities is for a free flow of information between the parties concerned with an open and honest dialogue instead of protecting the company's interests through legal privilege.

In summary, if the current prosecution philosophy continues valuable information which could help prevent accidents and incidents will be lost to the detriment of improving the safety performance in the Australian mining industry and attracting mining engineers into mine management positions. One way of preventing this happening would be for the mining industry to move away from the automatic prosecution policies and adopt a no blame culture with the aid of a system similar to the Wardens Court in Queensland where there was no fear of automatic prosecution which encouraged a free flow of information. The finding and recommendations are completed in a much quicker time frame which means that the lessons learned are available in a much shorter time span than the current outcomes in Queensland, New South Wales and Western Australia with a consequent positive outcome for safety improvement in the mining industry. The following paragraph supports this argument;

In discussion with CEO's and mine management in Queensland regarding prosecutions after the Gretley decision, it is the overwhelming view that management personnel are guilty until they can prove their innocence. They want the legislation to change such that in the event of a prosecution, management personnel are innocent until proven guilty, as is the case with civil prosecutions.

Regarding the need for prosecutions it would make eminent good sense to adopt the "Robens Report" recommendations which essentially state that those who act "wilfully and recklessly" should be prosecuted.

The next chapter will discuss the design and implementation of a field study in order to seek mineworker's opinion in the following areas:

- General Safety questions
- Risk Assessments
- Safety Health Management systems
- Fatigue & Awareness Issues
- Prosecution Policies and
- Fly in Fly out (FIFO).

CHAPTER 6

DESIGN AND IMPLEMENTATION OF A FIELD SURVEY TO ASSESS MINEWORKERS OPINION TO A SERIES OF SAFETY QUESTIONS.

6.1 Introduction

The first part of this chapter describes recent surveys that investigated the opinions of the mining workforce both in Australia and in the USA on a range of safety topics. The results of these safety climate surveys have provided a very good foundation for the development of the survey which is described in the second half of this chapter.

Mine site safety culture which was discussed at some length in Chapter 3 will be shown to be the basis of the safety culture surveys and questionnaires which have been carried out by researchers in order to improve safety performance in the minerals industry.

Studies on the links between safety performance and production safety performance are many and varied, but generally conclude that a productive work environment is also a safer work environment. The most comprehensive review of these links was carried out by Randolph (1989) of the US Bureau of Mines. Evidence from a sample of 22 high-productivity mines show how they achieved better than average safety records. They were characterised as fostering a positive management labour climate where responsibility for both safety and productivity was felt throughout all levels of the organisation. This study showed strong links between production efficiency and safety performance in coal mines in the USA. This statement was substantiated by Wheelahan (1994) when he said:

"Safety requires hard work by line management, but with safety improvements we get greater efficiency, improved productivity, better industrial relations and higher morale. These are the attributes of a successful organisation".

Other major studies include the research work of Kotter and Heskett (1992). They found that in 202 companies in the USA the strength of the work culture correlated positively with economic performance measures. Collins and Porras (1994) came to similar conclusions after studying several companies over their entire histories.

Safety climate surveys have been carried out by a number of researchers in Australia (Coyle et al 1995; Williamson et al, 1997; Brown and Holmes, 1986) who investigated attitudes and perceptions in different occupations. The following are some recent examples of Australian culture surveys.

6.2 Safety Culture Survey Report Australian Minerals Industry

In 1998, the Minerals Council of Australia initiated a safety culture survey of the Australian minerals industry (Pitzer 1999) to assess the attitudes and values of the mining workforce. This was by far the most comprehensive survey which has been undertaken in the mining industry to date. The data from the survey was used to identify and prioritise strategies aimed at improving a range of outcomes which included; job satisfaction, productivity, communications and safety.

The objectives of the Safety Culture Survey were to:

- Identify the strategic strengths and limitations of the minerals industry's safety culture
- Measure, against a baseline of industry employees, supervisors and managers, the trends in perceptions and attitudes of employees in different sectors of the minerals industry
- Measure the changes in perception and attitude trends against each participating company's own baseline and
- Provide recommendations to industry leaders on specific actions, initiatives or system based on the results of the survey

Some 6700 employees from 42 participating mines from coal and metalliferous, open cut and underground mining sectors, plants and refineries completed the survey making it the largest survey of its kind in Australia (Table 6.1).

Table 6.1 Profile of Participants in the Safety Culture Survey (1999)

Employee Group	N	% of Total N	Sample	% of Total S
Senior Management	212	1.8	161	2.3
Middle Management	380	3.2	279	4.1
Staff/Specialists	1733	14.8	1030	15.3
Supervisors	700	5.9	476	7.1
Operators	6647	56.6	3837	57.1
Contractors	2074	17.7	935	13.9
Total	11746	100	6718	100

The survey measured “safety culture” which is a set of shared values, beliefs and assumptions which guide and influence actions and behaviours which in turn influence safety performance.

Participants were asked to agree or disagree with 41 statements on aspects of safety culture which included their perceptions of the following:

- Organisational - of the companies attitude and commitment to safety
- Management – attitude and commitment of senior managers to safety
- Supervision – attitude and commitment of their direct supervisor to safety
- Management Processes – effectiveness of management processes that affect safety such as consultation and feedback
- Safety systems – effectiveness of safety standards, systems and training
- Job factors – are my tools and equipment safe and well maintained
- Team factors – do people around me comply with safety rules
- Individual factors – their personal attitudes to safety at work.

An electronic method was used which allowed respondents to participate regardless of their literacy skills and ensured confidentiality. A safety SWAT profile, strengths, weaknesses, opportunities and threats was developed from the survey findings outlined below:

- Employees are getting the safety message
- The value of “care about employees“ is lacking in the industry
- Widespread job insecurity will hamper safety improvement

- Lack of management credibility
- Safety management systems are deficient, particularly regarding training
- Management groups are reducing the effectiveness of safety committees
- No recognition for safety and safe work performance by operators
- Operators are taking risks and fatalism is alive and well at operator level
- There is a large gap in the positive responses of senior managers and other groups, particularly operators
- Managers indicated high stress levels of job stress and work pressure but overall are positive on safety
- Supervisory group were relatively positive but show areas of concern especially regarding job security and job stress
- The operator group show disturbing trends especially regarding fatalism and risk taking and
- Contractors were very positive compared with operators.

6.3 Safety Behaviour Survey of the Western Australian Mining Industry in 2002

A Safety Behaviour Survey was conducted by the Mines Occupational Safety and Health Advisory Board (MOSHAB) in 2002 to collect information from employees regarding their views on key safety issues, which included perceptions of issues that might lead to risk taking behaviour on mine sites.

The survey was conducted by a tripartite Safety Behaviour Working Party as a follow up from the initial 1998 “Risk-Taking Behaviour Survey” of underground mines but was expanded to include all major industry sectors and surface operations. MOSHAB has adopted a goal of achieving a step change reduction in mining related fatalities and serious injuries within three years. The goal is to be achieved through the implementation of a programme of activities within three priority areas, namely:

1. Risk Management
2. Communicating Risk Information and
3. Specific Targeted Initiatives.

The results of the survey will be used by MOSHAP to develop strategies for implementation by its members to improve safety performance across the industry.

All major industry sectors were involved, including alumina, coal, gold, iron ore, mineral sands and nickel. Approximately 4700 employees were surveyed, representing about 14% of Western Australian Mining Industry employees and 22% of the total employees at the visited sites. A total of 60 mines across the State were visited, which included 21 underground mines, 24 surface mines, 13 processing operations and 2 port/rail operations.

The survey took the form of a confidential questionnaire which included 40 questions

Major findings of the survey are as follows:

- There appears to be a high level of hazard, accident, incident reporting but timely follow up action in order to address these hazards and feedback on the results needs to be improved.
- Some risk taking behaviour still exists within the industry and appears to be driven by production pressures and management acceptability of such behaviour.
- Managers and supervisors can have a significant impact on employee behaviour by communicating the expected standards for ‘safe production’, setting the example by leading from the front, and actively encouraging and promoting safe behaviour.
- It was found that there were significant differences in perceptions of what is expected across job groups. These could be addressed through more effective communication at all levels, manager supervisor, supervisor employee and managers/supervisors allocating more time to discuss safety with employees
- In order to ensure that managers and supervisors have the skills in effective communication, people management and able to encourage and promote safe behaviour, they need better training in order to be able to achieve these goals.
- Safe work procedures are generally being developed by involving employees, however they must be more readily available and accessible to all employees such that they are an integral part of all training programms. Also systems need to be put in place that readily capture the changes that improved work practices provide, such that procedures can be updated, documented and communicated to all employees.

The Working Party made eight recommendations that cover a wide range of issues with responsibility for direct action by mine management. The first recommendation requires mine management to address the major findings of the survey in consultation with employees. The remaining recommendations call for action by MOSHAB or its member organisations. Examples of these are:

- The development of industry wide standards and training programmes for managers and supervisors
- Programmes to improve the involvement and commitment of Executive Management
- Develop an industry wide approach to injury reporting
- Promoting the development of fatigue management plans and
- Programmes to improve the effectiveness of safety and health representatives.

Mine management should ensure that copies of the report are made available to all employees.

6.4 The Findings of the Digging Deeper Report

The Digging Deeper Project was commissioned by the New South Wales Mine Safety Advisory Council (NSWMSAC) in 2007 to address a number of Wran Mine Safety Review recommendations on fatigue, consultation, Work Health and Safety (WHS) management systems and safety incentive schemes which have been reported as having negative WHS impacts in the NSW mining industry.

An independent consulting consortium led by Shaw et al (2007) Idea Pty Ltd was engaged to undertake the project. Some 53 sites were visited, 580 people were interviewed and 1,667 individuals completed questionnaires. This is the first time that so much more detailed and credible information has been obtained from all sections of the NSW mining industry. The extensive knowledge gained from this process has provided a clear picture of how work is structured and systems implemented.

The project gives an accurate idea of the state of the systems which are operating in the NSW mining industry with respect to the following areas:

1. Production bonus and safety incentive schemes;
2. Hours of work and fatigue management and
3. OHS management systems disconnect and consultation.

It was established that production bonus and safety incentive schemes that involve payment in exchange for achieving particular outcome targets have proved not to improve safety outcomes. The number two and three items mentioned above have been discussed in some detail in Chapter 4.

The findings across the three research groups have identified an underlying theme that it is very important to get the basics of OHS right in the first instant.

From the analysis of the qualitative data the sites were able to be divided into three categories, namely;

1. Proactive – these sites had appropriate risk management systems and effective consultative processes. This included six coal, seven extractive and three metalliferous sites;
2. Transitional – these sites ranged between the proactive and reactive categories, patchy risk management, poor systems and variable consultative processes. This included eight coal, thirteen extractive and two metalliferous sites;
3. Reactive – nothing in place, systems practically non-existent and poor consultation. This included three coal, six extractive and three metalliferous sites.

The spread of organisational categories across all three sectors is shown in Figure 6.1 below. Approximately 30% of mines are working towards best practice, a further 43% of sites are in a transitional stage and 27% are in the reactive phase. This means that the majority of mines (70%) have a lot of work to complete in order to achieve best practice.

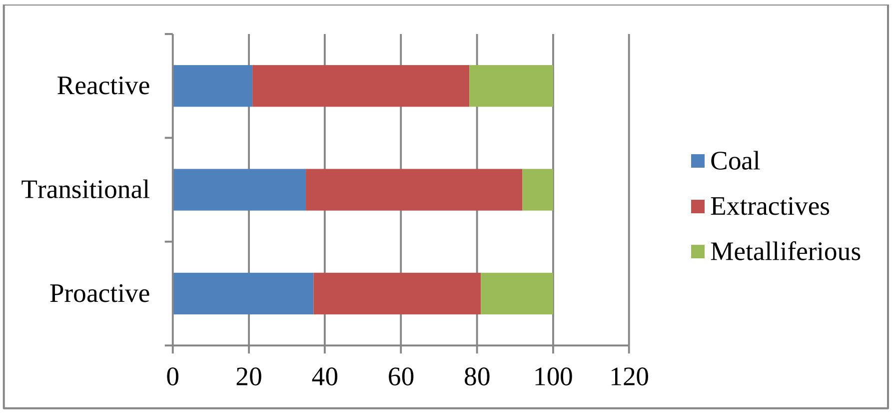


Figure 6.1 Organisational Categories by Sector

The study group have developed rules for the fundamental steps the industry should adopt in order to more effectively manage OHS.

1. Remember you are working with people – treat them with dignity and respect;
2. Listen to and talk with your people – be inclusive, value and develop people skills particularly in managers and supervisors;
3. Don't let issues fester and keep people informed on progress;
4. Make sure paperwork is current and make sure that it is meaningful;
5. Improve management competence in OHS;
6. Encourage people to give you bad news;
7. Fix your workplace first;
8. Measure and monitor risks that people are exposed to – fix things before incidents happen and control risks at their source;
9. Keep checking that what you are doing is working and
10. Ensure that adequate resources in time and money are available.

The report made some 25 recommendations which discuss how improvements can be made and the NSWMSAC has developed an action plan to address them.

In summary the NSWMSAC first priority was to oversee the development and implementation of an industry wide fatigue risk management education and improvement plan that is supported by the DPI, employer groups and the unions. High priority be given to developing a consultation, education and improvement plan that encompasses all sectors of the NSW mining industry and then overseeing its subsequent implementation. In a similar way MSAC will oversee the implementation of an OHS management system education programme that is agreed by all stakeholders. Progress on all these issues be reported back to the NSWMSAC at regular intervals.

6.5 Addressing the Cultural Complexity of OHS in the Australian Mining Industry

A survey involving the findings of site assessments of ten pilot mine sites involved in a project entitled, Addressing the cultural complexity of OHS in the Australian Mining Industry C Aickin, A Shaw, V Blewett, L Stiller, S Cox (2012).

This research was undertaken for the New South Wales Mine Safety Advisory Council which was established in 1998 and aims to increase the emphasis on safety and health within the mining industry by reviewing and analysing safety performance, setting strategic directions, providing advice and developing policy recommendations. The project aimed to deliver a self - sustaining method for achieving and monitoring continuous improvement in OHS culture and practice to the NSW mining industry. The pilot sites involved in the project tested a set of self-assessment tools to enable mines to assess and improve their own OHS culture and performance on key elements of an OHS management system. The tools not only allowed the examination of the current OHS culture but allowed them through a participative process to develop an improvement plan. This enabled the summary data to be produced without identifying individual sites.

Ten sites across the mining industry volunteered to participate in the site assessments. These sites included the following;

- One open cut coal mine
- Two underground coal mines
- Two metalliferous mines and
- Two extractive clusters of mines (five in total).

At these ten sites quantitative data was collected from 650 people via questionnaire, qualitative data from approximately 250 people via individual and focus group interviews and results from participative systems assessment.

6.5.1 Methodology

The methodology is based on the methods which were successfully used in the Digging Deeper report which has been discussed previously in this chapter.

The investigating team included skilled interviewers and reviewers of organisations who were capable of collecting the data, skilled data analysts and experts in the areas under research in the mining and other industries in Australia and internationally. In order to successfully undertake this project the collaboration of these individuals was essential.

The data collection tools included a site OHS systems and a practice self-assessment tool. In order to carry out this data collection programme a method of how to apply the data collection tools to produce an assessment of health and safety culture and systems was developed and piloted at the ten volunteer sites. Assistance to the ten sites to use the findings of the assessments to develop and implement action plans in order to address the opportunities identified in the assessments.

6.5.2 Results

A baseline assessment was developed at each site using the data collected against the following seven features of organisational culture:

- Mindfulness: International research into organisations that create reliable, safe workplaces suggests that such organisations create organisational “mindfulness”, reflecting awareness of potential errors whereby lessons can be learned in order to minimise future risk. Mindfulness is thus a state of organisational readiness; being culturally and systematically ready to cope with the unexpected (Weick, Sutcliffe 2007).

- Workgroup cohesion: describes the organisational capacity for peers to work together, give safety and health a priority, rely on each other, ask for help and finally to work safely without cutting corners even if under pressure to get the task completed.
- Trust in management: this represents a set of beliefs held by employees and others about the commitment to safety and health by management. It is demonstrated by management's attitude to the management of OHS and its decision making, the provision of adequate equipment and procedures to ensure good OHS practice and managerial competence regarding OHS.
- Organisational justice: emphasizes diversity, elimination of discrimination and recognises the societal impact of occupational health and safety, it also refers to a sense of fairness that exists at the workplace and the level of respect that is displayed for others.
- Supervisor support: this concerns information and help which is provided by the supervisor or manager to their subordinates. In order to ensure that communication channels do not become blocked or ineffective, it is necessary to have appropriate supervisor support when addressing OHS issues.
- Role clarity: means being given appropriate information needed to do the job, knowing what is expected of one in one's job and being informed well in advance concerning changes or decisions affecting the task being carried out.
- Work life balance: means having sufficient time for family, friends and social life outside working hours.

Each of the cultural features was scored on a scale of 1-5, where

1. Corresponds to strongly disagree and
2. Corresponds to strongly agree.

The average score for each feature is shown in Figure 6.2

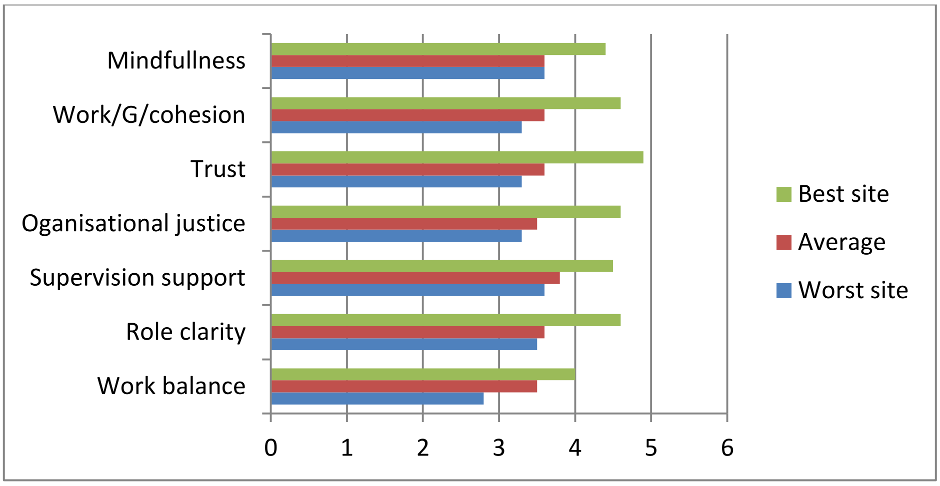


Figure 6.2 Overall Culture Scores from Questionnaire

It may be observed from Figure 6.2 that almost all pilot sites reported positively on all factors, with the most positive score on average being for supervisor support. One site scored below 3 for work life balance. There was a significant difference between the highest and lowest score at each site. The size of the sites was found to be a key variable which impacted the different scores.

The above quantitative data was reinforced by qualitative data which was collected from the sites. From the interview comments it was found that the same variation between and within the sites was evident.

6.5.3 Systems

The following six OHS management system elements were defined for the project to act as a framework for providing an assessment of OHS managements systems:

- Role clarity and commitment
- Consultation
- Risk management
- Training and competence
- Supervision
- Evaluation and review

The scoring system which was used to self-assess these elements was as follows:

1. Negative
2. Reactive- inadequate
3. Meets the law
4. Good practice
5. Best practice

The average score for the sites for each management system element is shown in Table 6.2

Table 6.2 Average Score for System Elements

System Elements	Average Score
Role clarity and commitment	3.3
Consultation	3.2
Risk management	3.2
Training and competence	2.7
Supervision	3.1
Evaluation and review	3.0

In general participants on the pilot sites reported that the overall process was useful, leading to strategies that may not have been identified otherwise and some of them wanted to continue using the tools to monitor and review their progress. They were also interested in participating in networking activities in order to share lessons and successes.

The difficulty of balancing OHS and production effectively in the face of significant production pressures and flat management structures were common issues identified during the study. Because of the work load on some sites middle managers found it hard to participate in proactive OHS activities which included planning.

As the results of the questionnaire suggest, work life balance continues to challenge sites and is becoming a more overt issue which relates both to shift work and workload more generally for middle and senior managers.

6.6 International Mining Surveys

One of the earliest safety surveys which was carried out in the USA was the “Safety Culture Survey” which was developed by Geller and his associates at Virginia Technical University to assess employees perceptions of safety and health issues in corporate environments which included automotive, chemical, energy and other high risk industries. The survey included the Persons Factor Scale, Actively Caring Scale, Safety Perception Scale and the Safety Management System Scale. According to Geller, the survey can help determine if behaviour change leads to subsequent attitude change, which is necessary for the long term continuous improvement in industry.

A National Institute of Occupational Safety and Health (NIOSH) - sponsored research investigation (Geller et al, 2000a) was carried out at five mines, which included two quarries, an underground coal mine and a coal preparation plant. Only 126 employees responded.

The authors found that;

- Management did not participate in the survey at any of the mines
- Eighty three percent of employees were willing to follow safety procedures
- Other positive responses included:
  - Rules and regulations
  - Hazard identification and correction
  - Safety communication
  - Safety suggestions
  - Training
  - Employee involvement and
  - Rewards and reinforcement

The above responses indicate that industry is performing well on the above mentioned measures; however there was an overwhelming majority of employees who believed that production was more important than safety where management was concerned. This situation may be due to the lack of effective communication by management, since effective communication systems will ensure that the actions taken by management to reduce accident and incidents are communicated to their employees.

The survey also indicated that pressure was being applied by management and their peers to cut corners in order to get the job done. There is also a need for miners to develop personal responsibility for their own and others safety, since 31 % believe that their workplace is a risky environment.

6.6.1 Good Jobs for Everyone

In 2010 the US Department of Labour (DOL) made “Good Jobs for Everyone” its strategic vision such that a good job is safe and secure and gives people a voice in the workplace. In order to measure this vision DOL developed a concept *“Worker’s Rights – Access, Assertion and Knowledge”* (WRAAK) DOL’s definition is: *“Workers ability to access information on their rights in the workplace, their understanding of those rights, and their ability to exercise those rights without fear of discrimination or retaliation”.* A project was developed to measure WRAAK in the coal mining industry since this industry requires a special approach due to factors which set workers in this industry apart from most others:

- Nature of mining work. *“Underground mining is among the most dangerous occupations in the United States”* This situation forges close bonds between miners which extends to the full community and involve complex interactions between the miners, the mine operators and regulators.
- Mine operations provide the best paid, albeit the most dangerous jobs. Miners rely on regulators to enforce safety standards; they also know that such enforcement can have personal economic consequences.
- Mining communities tend to be reluctant to communicate with outside organizations because such communication could result in new laws, policies or enforcement actions which create problems for their community.

In 2013 a pilot survey was implemented that represents the first step towards the ability to collect national representative data. The following data collection methods were used:

- Paper surveys distributed through state training sessions and
- Online survey with recruitment through newspaper advertisements.

The following Table 6.3 illustrates the miner’s willingness to act where miners are comfortable in exercising their rights

Table 6.3 Willingness to Act and Taking Action

Understanding – Awareness that they have the right to act	Strongly Agree	Strongly Disagree
Report a possible hazard	24	13
Choose a representative to participate in all aspects of mine inspection	18	8
Get an X-ray for signs of Black Lung, paid for by my employer	22	6
Ask to transfer to a less dusty job if I am diagnosed with Black Lung	22	4
Refuse to operate equipment I am not trained to use, and tell my supervisor	34	2
Refuse to work in conditions I believe are unsafe	30	7
Complain to MSHA if I have been retaliated against for exercising my rights under the Act	24	7

It can be observed from the above Table 6.3 that from this small sample, the majority of miners are aware of their responsibilities under the Mine Safety and Health Act 1977, however it is interesting to note that regarding reporting a possible hazard, 65% agreed whereas 35% disagreed which suggests that even from this pilot study the DOI have some work to do in terms of communicating worker's rights.

One of the major issues with conducting a survey was getting management to allow time for conducting the assessment. Management want to improve safety performance but they also have to meet production goals so time spent on surveys means lost production. Most surveys are carried out at meal breaks or during regular safety training meetings.

In order to improve safety in South African mines according to Sanchez (2014), Timetric a London based business information service conducted a technological survey of more than a 100 African mines in 16 countries including South Africa, Zambia, Zimbabwe, Nigeria and Ghana. The mining technology operations in South Africa were compared with the abovementioned African countries.

The survey polled mine managers, maintenance managers, senior procurement officials and other key decision makers, to determine what technologies are being implemented and to what extent. The survey identified the following key areas of mining technology to determine mine practices and technological priorities which included;

- Fatigue management
- Machine automation
- Mine design
- Planning software and environmental monitoring

Therefore in order to improve safety most mines planned to increase investments in technology and software that better manage fatigue, collision avoidance and proximity protection.

6.7 Summary

A number of field surveys have been analysed which have asked questions and opinions of mining personnel from 2000 to 2014 both in Australia and Internationally. Most of these surveys focused on cultural type issues and risk taking. From the concluding remarks of these surveys it has been established that a field survey is a useful tool in order to obtain attitudes and opinions of the workforce in regard to issues that affects them at their workplace. There was a low level of knowledge and understanding by the workforce and a lack of commitment by management to both the participation in the survey and safety effort according to at least one of the survey findings.

A lack of independence from the organisation or individuals or credibility affected some of the survey results and did not provide respondents with adequate time or opportunity to express an opinion. However, the following valuable information was gained in order to assist in the running of a field survey:

- The development of the structure of the surveys
- The style of questions to ask
- Knowledge gaps in the surveys to be addressed
- Ambiguous questions and
- Ensuring sufficient time for respondents to complete the survey

6.8 Design and Implementation of a Field Survey to Measure Mineworker Attitudes

This section describes the research methodology which was adopted for the major part of this thesis, a survey to investigate the Safety, Health and Culture in the Mining Industry, with a view to improving safety performance on mine sites. It contains the objectives, design and development of the survey. It concludes by discussing some of the issues and problems which were encountered whilst conducting the survey and how future surveys may be improved.

6.8.1 Aims and Objectives of the Survey Questionnaire

The survey questionnaire aims to seek the opinions of the coal mining workforce in Queensland and NSW on a range of safety issues which include the following;

- General Safety issues
- Risk assessments
- Safety and health management systems
- Fatigue and awareness issues
- Prosecution policies and
- Fly In Fly Out (FIFO) operations

Although these safety issues have been discussed at some depth in the previous chapters, it is appropriate to reiterate the reasons for the above selection in the survey questionnaire as shown in Table 6.4

Table 6.4 Reason for the Selection of the Survey Questions

Aims and Objectives	Reasons for the Selection
General Safety Issues	To investigate the culture on coal mine sites and determine the following; o A comparison between: 1. the attitudes of various levels including supervisors, statutory officials and mine workers

	2. individual mines 3. Queensland and NSW 4. Open cut and underground 5. Age of a mine worker 6. Experience of a mine worker 7. Company or contractor employee ○ Asking questions regarding the knowledge base which determine the culture on the mine sites which will inevitably change the attitudes and behaviour of the workforce ○ Determine whether safety performance is improving at your mine site ○ To what degree are accidents and incidents reported on your mine site ○ The level of awareness and understanding of safety performance reporting ○ The extent and commitment of communication with regard to safety issues ○ The level and awareness and understanding of unsafe acts, errors and procedural violations
Risk Assessments	○ The level and awareness of risk assessments being a part of safety management ○ The extent and awareness of management influences regarding risk assessments ○ The level and awareness regarding risk management and prescriptive regulations ○ The extent of compliance and commitment to rules and regulations ○ The level and awareness of training requirements in order to conduct appropriate risk assessments
Safety and Health Management Systems (SHMS)	○ The level and awareness of experienced people in the workforce ○ The extent of adequate training in SHMS in order to carry out work safely and understanding the role under the obligations required under the SHMS ○ The extent to which workers understand their role and knowledge of the SHMS ○ The extent of communication with both the permanent and contractor workers with regard to the SHMS ○ The level and awareness of safety inspections –

	what actions are taken to make the workplace safe
Fatigue and Awareness Issues	o Attitudes regarding workers being able to operate without suffering fatigue o Attitudes regarding the work roster and the ability to support a sustainable work life balance o The extent that 12 hour shifts have on workers and does it affect their concentration and result in poor judgement of their own performance o The extent to which 12 hour shifts affect decision making and do they effect awareness and communication skills o The extent to which travel times to work affect fatigue
Prosecution Policies	o The level and awareness of how prosecution policies work on a mine site o The awareness of company people versus legal people being involved in site accident investigations o The level of awareness of legal peoples effect on the open provision of facts concerning an accident o The level of understanding of individuals regarding the root cause of accidents and companies being prosecuted o To determine if an official inquiry would produce better outcome if there was no fear of prosecution

Fly in Fly Out	o The level of awareness and understanding of the consequences of working FIFO rosters in the following areas;
	    o regard to stress levels and poor health
	    o Contributing to poor quality family relationships
	    o Improves financial circumstances from higher wages and lower living costs.

The survey was designed to measure perceptions and or attitudes of the workforce. It was not intended to discriminate between these two constructs. Perception can be described as

a tangible behavioural pattern that is regularly observed by employees and regarded by them as an expected behaviour. Attitudes are peoples learned tendencies to act in a consistent way in particular situations (Pitzer, 2001b).

One of the main objectives of the survey was to get as many mine operators involved in the survey as possible since it is very important to obtain answers from the grass roots of the industry. The research aimed to answer many of the questions regarding safety culture in the mining industry in order to obtain the answers which would enable mine management and the regulators to be able to improve safety in the industry.

6.8.2 Survey Method

The steps that should be followed in developing the survey include:

1. Define the objectives
2. Identify the population to be studied
3. Select the survey sample
4. Construct the instrument
5. Write an appropriate covering letter and
6. Pre-test the questionnaire

During the administration of the survey it is essential to:

- Emphasise the importance of the study
- Ensure that instructions are as clear as possible and well communicated
- Ensure that confidentiality is assured
- Ensure where possible personal contact with potential respondents and
- Set a deadline for receipt of the responses.

The safety questionnaire survey was developed over several months with input and advice from persons which represented a number of organisations which included the following:

- Three CEO’s of major coal producers
- Several open cut and underground mine managers and SSE’s
- Several senior people in the Department of Natural Resources and Mines
- Several Company Safety Managers
- The National General Secretary of the CFMEU and a Senior Queensland Safety Representative and
- A Professor at the University of New South Wales.

With the exception of the latter all had experience working in mines and were asked to make comment from the perspective of mine worker. The final survey was developed and tested with the aid of the abovementioned personal.

The final survey questionnaire which was used in this research consisted of the following broad elements:

- Personal information
- General safety questions
- Risk assessments
- Safety and Health Management Systems
- Fatigue and awareness issues
- Prosecution policies and
- Fly in Fly out (FIFO) Bus in Bus out.

The reasons for selecting these elements were as follows:

1. Personal information. It was important to gain personal information in order to be able to identify trends in the data. The questionnaire sought to establish if age or experience has an influence on attitudes and perceptions and what effects it may have on safety performance.

2. General safety questions.
The questions were designed to test the respondent’s knowledge regarding accident and incident information, safety culture, human error and communication at their mine site.

3. Risk assessments.

This section aimed to gain knowledge, understanding and awareness of the risk management process and their involvement and training at their mine site.

4. Safety and Health Management Systems.

This section aimed to ascertain knowledge and understanding of the SHMS with regard to the following, adequate training, understanding their obligations, updated knowledge and adequate communication.

5. Fatigue and awareness issues.

The questions were designed to test respondent's knowledge regarding being able to work safely, concentration, communication and decision making skills. These issues are having an impact on safety at work, which is particularly evident when people are working 12 hour shift rosters especially on night shift in underground mines.

6. Prosecution policies.

This section aimed to gain knowledge, understanding and awareness of the prosecution policies on their mine site. The current approach to prosecution has resulted in the common use of legal privilege which inhibits safety investigations and causes a defensive rather than a proactive safety culture. This impedes the timely sharing of information within industry to help prevent the recurrence of incidents.

7. Fly in Fly out operations.

These questions were designed to test the respondent's knowledge of stress levels, poor health, family disruptions and divorce. A parliamentary committee has been told that FIFO is destroying towns in Central Queensland and that marriage breakdowns and struggling businesses in a once-thriving community features heavily in submissions to the Government.

The final survey questionnaire consisted of 56 questions 8 of which were designed to gain personal confidential information about the respondent. The following 48 questions were of the Likert-format which required the respondent to signify his/her agreement or disagreement which will be discussed later in this chapter.

- 8 questions on General safety

- 8 questions on Risk assessments
- 10 questions on Safety and Health Management Systems
- 8 questions on Fatigue and awareness issues
- 9 questions on Prosecution policies and
- 8 questions on FIFO operations.

The survey was designed to have both adequate and psychometric integrity (reliability and validity) and be able to comprehensively assess the important dimensions of the safety environment. It was also designed to elicit maximum response from the grass roots of the mining workforce and thus:

- It was designed to be completed in a typical safety meeting or toolbox talk or within a typical break for lunch (crib)
- It was very important to use plain language and to keep the questions as simple as possible since the literacy of some miners is limited
- Biased or emotive phrases were avoided and
- Closed questions were preferred however sufficient open questions were included for the workforce to have their say.

6.8.3 Survey Design

Surveys can be divided into two broad categories according to Trochim (2008) namely the questionnaire and the interview. The interview technique was discarded because of the logistics of contacting people on a mine site, expense and time it would take to complete the process. Therefore the field survey that was chosen was the Likert 5 Scale questionnaire because this was obviously the best fit for the mining industry. Likert (1932) developed the principle of measuring attitudes by asking people to respond to a series of statements about a topic, in terms of the extent to which they agree or disagree with and so tapping into the cognitive and affective components of attitudes. Respondents may be offered a choice of five or seven responses with the neutral point being neither agree nor disagree. The five point scale was used in this case because of its simplicity, since this technique presents a set of attitude statements were respondents are asked to agree or disagree as shown below .

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

The 7-point Likert scale was not used because it could possibly confuse the person completing the questionnaire and lengthen the time taken for its completion.

Advice was sought from the University of New South Wales and the University of Queensland regarding using the Likert technique specifically in constructing the questions. The big advantage of using the Likert technique is that the data can be analysed qualitatively and quantitatively using the mode and data range.

6.8.4 Background Information provided with the survey questionnaire

6.8.4.1 Information to the CEO

A meeting was held with all the participating CEO's in the first instance and subsequently an email was sent to each CEO explaining the benefits of participating in the survey as shown in Appendix 1. It was stressed that:

- The results will be totally confidential
- Each participating company will receive an analysis of its workforce's responses and a copy of the final report were their mines can be benchmarked against the industry.

6.8.4.2 Information to the Questionnaire Respondent

A letter of support was given from CEO to the survey respondents - Appendix 4.
The following information was included in a letter to the survey respondents - Appendix 2

- ➢ The School of Mining Engineering at the University of New South Wales is seeking your assistance and involvement in a new research project that aims to improve the safety performance on mine sites. We are confident that with your involvement, this research will result in a positive outcome for safety performance improvement.
- ➢ The first step in the project is to seek your opinion on the following:

- General safety
- Risk assessments
- Safety and Health Management Systems
- Fatigue and awareness issues
- Prosecution policies
- Fly In Fly Out (FIFO) operations

➢ We are confident that with your involvement, this research will result in a positive outcome for safety performance improvement in the mining industry.

6.8.4.3 Instructions to the Respondent

Guidelines for completing the Questionnaire were given to the participant as follows:

1. Your input is important so please answer all questions
2. Each question will seek your agreement or disagreement
3. Please mark with an X the answer that closely matches your opinion
4. There are no right or wrong answers
5. The survey should take no longer than 10 to 15 minutes to complete
6. When you have finished pass on to your supervisor who will put all the responses into an envelope and seal same in your presence, this will ensure confidentiality
7. You can be assured that your responses will remain anonymous with only aggregated results going back to mine management.

6.8.5 Survey Questions

6.8.5.1 Personal Information

The following questions were asked seeking personal information that would be beneficial to the interpretation of the data.

1. Name of the mine …………………………………..type of mine O/C or U/G

2. My main job at the mine is… statutory officer, supervisor, permanent employee, contractor, consultant or plant operator, other

3. Years of experience in this job ………..
4. Years of experience in the industry….. (0 - 5yrs) (5 – 10yrs) (10 – 20yrs) (20 – 30yrs) (30yrs plus)

5. Your age…….(under 30) (30 – 39) (40 – 49) (50 – 59) (60 plus)

6. Years at this mine ………(Less than 2) (2 – 4) (5 – 9) (10 – 19) (20 plus)

7. I am employed by company ……….Yes No

8. I am employed by contractor ………Yes No

6.8.5.2 Likert Technique Questionnaire

The following 48 questions have been divided into six groups which were:

- **General safety**
- **Risk assessments**
- **Safety and Health Management Systems**
- **Fatigue and awareness issues**
- **Prosecution policies**
- **Fly In Fly Out (FIFO) operations**

6.8.5.3 General Safety

These questions were asked to determine the information regarding the following issues:

- Asking questions regarding the knowledge base which determine the culture on the mine sites which will inevitably change the attitudes and behaviour of the workforce
- Determine whether safety performance is improving at your mine site
- To what degree are accidents and incidents reported on your mine site
- The level of awareness and understanding of safety performance reporting
- The extent and commitment of communication with regard to safety issues
- The level and awareness and understanding of unsafe acts, errors and procedural violations.

1. Is safety performance improving on your mine site

2. Are all accidents and incidents investigated and reported at your mine site

3. Is accident and incident information acted upon to make improvements
4. Accident and incident information is communicated satisfactorily to permanent and temporary employees

5. Human error is a major factor in causing accidents and incidents

6. Accidents and incidents can be eliminated

7. I am encouraged by my employers to have my say on safety matters

8. The main causes of accidents and incidents is a poor safety culture

6.8.5.4 Risk Management

These questions were asked to determine the information regarding the following issues:

- The level and awareness of risk assessments being a part of safety management
- The extent and awareness of management influences regarding risk assessments
- The level and awareness regarding risk management and prescriptive regulations
- The extent of compliance and commitment to rules and regulations
- The level and awareness of training requirements in order to conduct appropriate risk assessments

1. Risk assessments are a useful part of safety management at my site

2. People who conduct risk assessments have sufficient training

3. Too many risk assessments are conducted in my workplace

4. I get benefit from risk assessments concerned with my workplace

5. I am involved in risk assessments concerned with my workplace

6. Management influences affect the outcome of my risk assessments

7. There should be less risk management and more prescriptive regulations

8. Is it necessary to break the rules and regulations to get the job done

6.8.5.5 Safety & Health Management Systems

These questions were asked to determine the information regarding the following issues:

- The level and awareness of experienced people in the workforce
- The extent of adequate training in SHMS in order to carry out work safely and understanding the role under the obligations required under the SHMS
- The extent to which workers understand their role and knowledge of the SHMS
- The extent of communication with both the permanent and contractor workers with regard to the SHMS
- The level and awareness of safety inspections – what actions are taken to make the workplace safe.

1. A lack of experienced people is causing safety issues at my workplace

2. My training is adequate to carry out my role safely

3. I understand my obligations under the Safety and Health Management System (SHMS)

4. Adequate training is given for me to understand my obligations under the SHMS

5. The SHMS is too complex for me to understand

6. More time should be allowed for training in the SHMS

7. My knowledge of the SHMS is updated on a regular basis

8. Information concerning the SHMS is adequately communicated

9. The SHMS drives improved safety performance

10. Safety inspections are done by persons in whom I have confidence will take strong action to make the workplace safe.

6.8.5.6 Fatigue and Awareness Issues

These questions were asked to determine the information regarding the following issues:

- Attitudes regarding workers being able to operate without suffering fatigue
- Attitudes regarding the work roster and the ability to support a sustainable work life balance

- The extent that 12 hour shifts have on workers and does it affect their concentration and result in poor judgement of their own performance
- The extent to which 12 hour shifts affect decision making and do they effect awareness and communication skills
- The extent to which travel times to work affect fatigue

1. Fatigue is causing a problem regarding me being able to operate safely

2. My current roster allows sufficient quality time with family and friends to support a sustainable work life balance

3. My concentration is reduced when working 12 hour night shift rosters

4. My current roster results in poor judgement of my own performance

5. Working my current shift roster affects my ability to assess problems and determine solutions

6. When working 12 hour shift rosters my decision making is impaired

7. When working my current roster my awareness and communication skills are impaired

8. Travel times to work cause me fatigue and awareness issues.

6.8.5.7 Prosecution Policies

These questions were asked to determine the information regarding the following issues:

- The level and awareness of how prosecution policies work on a mine site
- The awareness of company people versus legal people being involved in site accident investigations
- The level of awareness of legal people's effect on the open of facts concerning an accident
- The level of understanding of individuals regarding the root cause of accidents and companies being prosecuted
- To determine if an official inquiry would produce better outcome if there was no fear of prosecution

1. There are practices that limit the quality of accident investigation at my site

2. Information regarding an accident is free flowing on my site

3. I believe that company legal people should be involved in site accident investigations

4. Accident investigation would be best conducted by mine management and the site safety and health representative and not legal people

5. I am concerned about the current inspectorate prosecution policies that are in place

6. Legal people's involvement affects the open provision of facts concerning an accident or incident

7. Prosecution policies should be used as a last resort when wilful and reckless disregard for safety is the case

8. The root causes of accidents and incidents are not being examined for fear of the company being prosecuted

9. An official inquiry would produce better outcomes if there was no fear of prosecution.

6.8.5.8 Fly In Fly Out (FIFO) includes drive in drive out and bus in bus out.

These questions were asked to determine the information regarding the following issues:

- The level of awareness and understanding of the consequences of working FIFO rosters in the following areas;
- regard to stress levels and poor health
- Contributing to poor quality family relationships and reduced social and community interaction
- Improves financial circumstances from higher wages and lower living costs.

1. Are you a FIFO worker………Yes No

If you answered (Yes) please complete the questionnaire
If you answered (No) you have now completed the questionnaire

2. FIFO working increases stress levels and poor health

3. FIFO operations are contributing to poor quality relationships and leading to increased break-ups and divorce.
4. FIFO operations cause family disruptions and stress

5. FIFO workers have reduced social and community interaction and feelings of loneliness and isolation

6. FIFO working improves financial circumstances from high wages and lower living costs

7. FIFO operations allow workers to make lifestyle choices for themselves and their families

8. FIFO operations allow uninterrupted blocks of time to enable workers to spend better quality time with their partners and families.

6.8.6 Questionnaire Development and Deadlines

The survey was first drafted in March 2012. It was sent to CEOs, district inspectors, the inspectorate hierarchy, company senior safety managers, senior union officials and the University of New South Wales for comments and improvements. This resulted in several drafts of the questionnaire including the letter which was sent inviting participants to complete the survey. The final draft of the survey was completed in August 2012.
Before the survey was allowed to be distributed it was necessary to gain approval from the University of New South Wales Human Ethics Advisory Committee (HEAC) see Appendix3, which required the following information:

6.8.6.1 Application form requirements

Below is a list of the requirements required by the HREA:

- Instructions for applicants
- Sample of questionnaire document
- Name and contact details of investigators
- Status of investigations
- Project title and description
- Potential harm to participants and /or investigators
- Selection and recruitment of participants
- Informed consent
- Privacy
- Observations and records
- Confidentiality, privacy and anonymity

  Voluntary participation requires that people will not be coerced into participating in the research. The questionnaire will be group administered where possible and participants will be able to complete the survey electronically or in hard copy. It is expected that most participants will be able to complete the survey during a safety meeting or a crib break in hard copy. The participant's confidentiality is assured because they will not be asked to give their name, only the mine at which they work and any other identifying information will not be made available to anyone who is not directly involved in the study. When participants have completed the questionnaire their responses will be placed in a sealed envelope in their presence which will ensure that the confidentiality, privacy and anonymity of all participants are maintained at all stages of the research project.

- Deception and debriefings
- Conflict of interest, including financial involvement
- Organisations other than the University of New South Wales
- Letters of support from the CEOs of the following organisations were obtained:
  - The Construction Forestry Mining Energy Union of Australia (CFMEU)
  - Peabody Energy Australia and
  - Jellinbah Group. (Appendix 4)

The approval process was very comprehensive and took practically 5 months from July 2013 to November 2013 to gain approval for the survey to be distributed. Also the HREA insisted as part of the approval process that each participant were able to have access to the "Participant Information Statement and Consent Form "which is attached to Appendix 5. This form dealt with the following information:

- Participant selection and purpose of study
- Description of study and risks
- Confidentiality and disclosure information
- Recompense to participants (not appropriate in this study)
- Feedback to participants
- Participants Consent

This delay created significant problems for the companies involved since they had to wait before they could send the survey questionnaire out to the participants for the distribution.

Communication with the CEO included the following documentation regarding the survey:

- Letter addressed to CEO
- Hard copy of the survey
- Electronic copy of the survey
- Letter of introduction to mineworkers and
- Participation information statement and consent form (Participants who agree to complete the survey automatically give their consent).

The following steps were suggested to the site management as follows:

1. Communicate with the mine site General Managers that you are ready to roll out the survey- Letters of Introduction
2. Send the hard copy of the survey to the mine sites which would be completed by the production workers during a safety information meeting or crib break
3. Send the electronic version which essentially would be completed by supervisory staff and other mine workers who have access to a computer and
4. Completed versions of the hard copy could either be sent back to the University of New South Wales or to the author's home address.

The survey was finally carried out from December 2013 to November 2014.

6.8.7 Types of Survey

Two types of survey were used as follows:

1. Manual survey was completed manually and it was expected that most participants would be able to complete the survey during a safety meeting or a crib break in hard copy and confidentiality was assured as described above.
2. The Electronic survey was completed by those participants that had access to a computer and as a consequence their answers were confidential.

6.8.8 Distribution of Surveys

After the meetings with the CEOs the surveys were emailed to them for them to distribute to their mine site General Managers. There was one exception to that situation in that after discussion with the CEO the author had contact with the mine General Manager regarding distribution of the surveys. It is worth noting here that Laurence (2001) made direct contact with mine managers regarding completing the questionnaires. In today's environment particularly in the coal industry, which is having a tough time due to the downturn in the industry, if permission for the survey process does not go through the CEO, it will not happen. This is a sad state of affairs, but never the less true since this is what the author experienced during the survey process. The surveys were sent to the following CEOs:

- Peabody Energy Pty Ltd
  During the distribution process to participants contact was made to several senior safety company personnel.
- Jellinbah Group Pty Ltd
  Contact with the mine General Manager regards the distribution process to participants was undertaken
- Queensland Mines Rescue
  Contact with the mine rescue CEO and his staff regarding the distribution process to participants
- New South Wales Mines Rescue
  Contact with the mine rescue CEO and his staff regarding the distribution process to participants.

It needs to be stressed that this research programme is not funded by the industry and as a consequence was limited to the above mentioned companies. The original survey was intended to be organised through the Queensland Resource Council and because of the downturn in the industry, it was obvious that the author would not be able to get them to run the survey through the coal industry in Queensland. The survey would have been too large and therefore expensive for the author to fund. The reason why the survey was limited to the organisations listed above was because the other companies which were approached did not respond.

After the CEO of the respective mines rescue organisations received the survey questionnaires, the majority of them were completed when the mines rescue trainees attended the station for training. Some of the questionnaires were posted to the trainees,

however all the respondent replies were posted to the author.
As previously discussed the existing survey has created a huge amount of work which is required for the analysis. The results have certainly supported the author's hypothesis that that safety in the coal mining industry in Queensland and New South Wales has not improved and if anything it is deteriorating.

6.8.9 Problems in Running the Survey

One of the major problems in running the survey was getting an organisation to run the survey at their mines. As previously stated making contact with the mine manager is a waste of time since he would have to gain permission from the CEO before he would be allowed to run the survey. Issues which have been raised in this regard include:

- The survey does not fit our modus operandi
- We are concentrating on other safety initiatives
- One mine manager said that his contractor stated that his workforce was currently in turmoil at the moment, coping with a new EBA and redundancies. He further stated that to undertake a survey with their mining workforce at the moment would be counter-productive and not be representative of the state of affairs and
- With all the activity on site at present time we are unable to complete your survey.

6.8.10 Recommendations for Future Surveys

The results from the following survey Chapter 7, have demonstrated that the survey needs to be completed by the whole mining industry, including the metalliferous mines.
Future surveys of this kind could be improved by:

- Getting the Mining Councils in the three big mining states Queensland, NSW and Western Australia on board in the first instance.
- A survey of this kind should be carried out by the Minerals Council of Australia and
- As one CEO stated to the author we might not like the answers from the survey but we need to know what our workers really think if we are going to improve safety in our industry.

CHAPTER 7

ANALYSIS AND DISCUSSION OF MINEWORKER RESPONSE TO THE SAFETY SURVEY

7.1 Overall Survey Response

A total of 37 coalmines were invited to participate in the survey which consisted of 25 mines in Queensland and 12 mines in New South Wales. Due to the economic downturn in the industry over the last few years many mines are losing money and as a consequence many miners have been made redundant. Most of the job losses have mainly affected contractors; obviously this climate has created a few problems regarding the conducting of the survey. The following two surveys which asked the same questions have been conducted at participating mines;

1. A Survey that was completed by manually filling out the questionnaire and
2. A Survey that was completed electronically via a computer.

The manual questionnaire was completed initially by approximately 1200 respondents, however over 80 manually completed questionnaires were lost in the process of transporting the questionnaires for analysis. Responses have been received from 993 manually and 119 electronic completed questionnaires making a total 1112 responses. The manual survey has generated a very large amount of data. For each mine, individual responses were coded and entered straight onto an excel spreadsheet. This resulted in 54,608 entries onto the spreadsheet which translated into over 70 man hours to complete the task.

A comparison will be made of the manual survey data and the electronic data in Chapter 8. A discussion of the manual responses will be presented in this chapter. Table 7.1 gives a summary of participating mines that completed the questionnaires manually.

Table 7.1 Summary of Participating Coal Mines that Completed Questionnaires Manually

Mine Name	Type of Mine	Location	Number of Responses
Appin	U/G	NSW	7
Bengalla	O/C	NSW	2
Broadmeadows	U/G	QLD	10
Copperbella	O/C	QLD	10
Dendrobium	U/G	NSW	8
Ensham	U/G	QLD	2
Helensburgh	U/G	NSW	10
Jellinbah	O/C	QLD	234
Metropolitan	U/G	NSW	32
Moranbah North	U/G	QLD	4
North Goonyella	U/G	QLD	148
North Wambo	U/G	NSW	15
Rolleston	O/C	QLD	2
Tahmoor	U/G	NSW	6
Wambo	O/C	NSW	332
Westcliff	U/G	NSW	4
Wilpinjong	O/C	NSW	159
Wongawilli	U/G	NSW	4
Yarrabee	O/C	QLD	1
Total	**19 Mines**		**993**

It can be observed in Table 7.1.1 that in the manual survey there were 86 respondents in NSW U/G, 166 in QLD and 493 respondents in NSW O/C and 248 in QLD O/C. In the electronic survey there were 5 respondents in NSW U/G, 29 in QLD U/G and 4 respondents in NSW O/C and 81 in QLD O/C. This resulted in there being a total of 588 respondents in NSW and 524 in QLD which equated to 74% respondents in the O/C and 26% in the U/G which represents a good cross section of the workforce in each state considering that the O/C sector is much larger than the U/G sector.

Table 7.1.1 Survey Respondents in NSW and QLD U/G and O/C Operations for the Manual and Electronic Surveys

Manual	NSW U/G	QLD U/G	NSW O/C	QLD O/C	Total
	86	166	493	248	993
Electronic	5	29	4	81	119
Total	91	195	497	329	1112

Table 7.2 gives a summary of participating mines for the electronic survey.

Table 7.2 Summary of Participating Coal Mines for the Electronic Survey

Mine Name/ Mines Rescue	Type of Mine	Location	Number of Responses
Blackwater	O/C Coal	QLD	2
Broadmeadows	U/G Coal	QLD	1
Burton	O/C Coal	QLD	9
Callide	O/C Coal	QLD	2
Carborough Downs	O/C Coal	QLD	5
Coppabella	O/C Coal	QLD	14
Cook	U/G Coal	QLD	2
Crinum	U/G Coal	QLD	2
Dawson	O/C Coal	QLD	3
Ensham	U/G Coal	QLD	3
Foxleigh	O/C Coal	QLD	1
Grosvenor	U/G Coal	QLD	2
Grasstree	U/G Coal	QLD	2
Jellinbah	O/C Coal	QLD	20
Kestrel	U/G Coal	QLD	4
Metropolitan	U/G Coal	NSW	2
Middlemount	O/C Coal	QLD	1
Millennium	O/C Coal	QLD	21
Moranbah North	U/G Coal	QLD	3
NSW Rescue Service	U/G Coal	NSW	3
Newlands	U/G Coal	QLD	2
North Goonyella	U/G Coal	QLD	2
Oaky North	U/G Coal	QLD	3
QLD Rescue Service	U/G Coal	QLD	3
Saraji	O/C Coal	QLD	3
Wambo	O/C Coal	QLD	1
Wilpinjong	O/C Coal	QLD	3
Total	**27 Mines**		**119**

7.2 Data Validity and Reliability

The targeted population for the investigation were the 37 coal mines operating in Queensland and New South Wales from April 2014 to January 2015. A summary of responses to the manual and electronic surveys is illustrated in Table 7.3. and shows a breakdown of the number of responses in Queensland and NSW underground and open cut mines.

Table 7.3 Summary of Mines responding to the Manual and Electronic Surveys

Participation	NSW U/G	NSW O/C	QLD U/G	QLD O/C	Grand Total
Manual	8	3	4	4	**19**
Electronic	2	2	13	10	**27**
Total	**10**	**5**	**17**	**14**	**46**

A summary of the working roles of survey respondents can be observed in Table 7.4 which indicates that 83% were mineworkers 7% supervisors, 7% statutory officials and 3% others.

Table 7.4 Working Roles of Survey Respondents

Roles	Manual	Electronic	Total	%
Permanent Mineworkers	596	57	653	68
Contractors Mineworkers	140	7	147	15
Statutory	50	15	65	7
Supervisor	45	22	67	7
Others	21	9	30	3
Total	**852**	**119**	**971**	
No Response	141	0		
Grand Total	**993**	**119**	**(1112)**	

The total coal mining workforce in Queensland and New South Wales in 2014 is estimated at 55,000 which comprises 30,000 in Queensland (Department of Natural Resources and Mines) and 25,000 in New South Wales (Department of Mineral Resources). Therefore the 1112 respondents from Queensland and New South Wales represent a sample of 2 per cent of the total workforce. However, it needs to be understood that the estimate of 55,000 people employed includes corporate, financial, marketing, environmental and administration personnel. It would be very difficult to obtain an estimate of the number of people involved in the actual mining operations, such as operating equipment, maintenance, contractors and site management; however it would be a much lower figure. The main objective of this survey was to ascertain the views on a range of safety issues from a cross section of mineworkers both working underground and open cut, with the emphasis being on operators which will ensure a representative sample of the workforce.

One of the main issues with a survey of this type is that the sample may not be representative of the population from which it was drawn. The questionnaire was designed to avoid sampling bias and at the same time minimising mistakes and errors (see Chapter 6). It was very important that the data was collated and entered into the spreadsheet through a painstakingly thorough process. Participation in the survey was completely voluntary by all participants and this was substantiated through the requirements of the University of New South Wales Ethics Committee. One of the main advantages of the electronic survey was that each respondent was able to complete the survey knowing that the response would be private and confidential and obviously voluntary.

It is known that some surveys can be made redundant though untruthful answers to questions. Although a risk in this survey, there was very little evidence of unreasonable answers. There is always a possibility in any survey that the responses did not reflect the view of the participant; however in this survey it is highly unlikely due to the nature of the questionnaire and the fact that their answers would only benefit safety on the mine site.

The number of responses in the manual survey varied considerably in that, of the 993 responses, 905 which equated to 91% came from 5 of the 19 mines surveyed. The reason for this was that the CEO at each of these companies had agreed to complete the survey. The number of responses to the electronic survey was such that of the 119 responses, 55 which equated to 46%, came from 3 of the 27 mines surveyed. Again the same reason applies as with the manual survey. It can be argued that under the economic circumstances that prevailed at the time a good reliable cross section of the coal industry participated in the survey such that the results should reflect a representative sample of the coal industry in Qld and NSW.

According to Weiner (2007) the reliability of a measure is the degree to which a measurement technique can be depended upon to secure consistent results upon repeated application. Measurement being the systematic, replicable process by which objects or events are quantified and or classified with respect to a particular dimension. The validity of a measure being the degree to which any measurement approach or instrument succeeds in describing or quantifying what is designed to measure. This aspect of the data will be further explored later in this chapter since it is considered that a survey is the most accurate method of measuring attitudes and perception as discussed in Chapter 6. The HREA Process assisted in the data validity and reliability process.

The following is a summary of the participating coal mines that completed the questionnaires manually.

7.3 Workforce Profile

The survey questionnaire consisted of 58 questions in the following categories;

Table 7.5 Number of Questions and the Category

Number of Questions	Category
7	Workforce Profile
8	General Safety
8	Risk Assessments
10	Safety and Health Management System
8	Fatigue
9	Prosecution
8	FIFO

7.3.1 Type of Mine

The first question the survey respondents were asked was what type of mine did they work at, underground or open cut. The responses shown in Figure 7.1 indicate that of the 993 responses 580 were in open cut operations 58% and 413 in underground operations 42%.

For the purposes of this survey this outcome should represent a reasonable sample of the coal mining industry in Queensland and NSW.

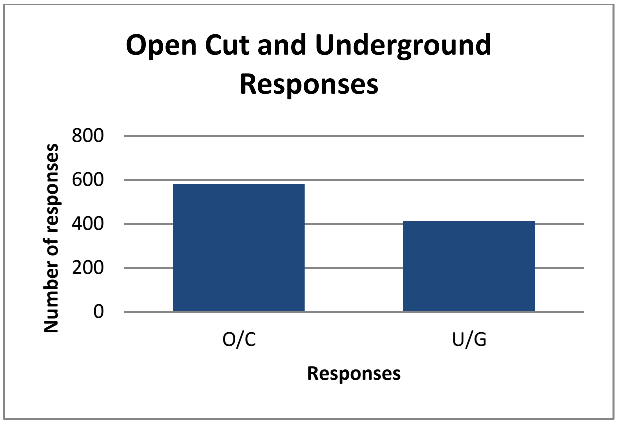


Figure 7.1 Open Cut and Underground Responses

7.3.2 Main Job at the Mine

The employee's main job at the mine were those of permanent employees, contractors, statutory official's, supervisors and others Figure 7.2. It can be observed that 60% of employees were permanently employed and were made up of operators and maintenance personnel. Contractors represented 14% of the respondents as did the 'no' response category. Supervisors and statutory officials recorded 5% of total respondents.

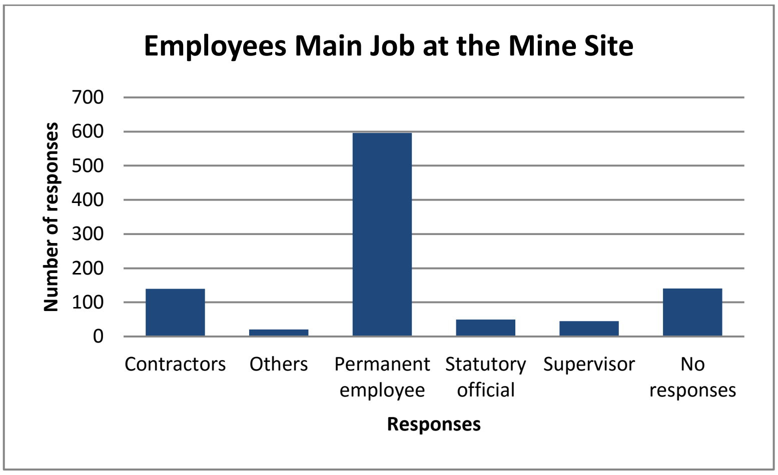


Figure 7.2 Employees Main Job at the Mine Site

7.3.3 Years of Experience in the Industry

The survey results reflect some of the inherent problems in the mining industry today and that there is a lack of experienced personnel. It may be observed in Figure 7.3 that 28% of the workforce have only 0-5 years' experience in the industry and 33% have 5-10 years which reflects a relatively young workforce and consequently one with little experience. Only 23% of the workforce has between 10 and 20 years' experience. It is the Department of Natural Resources and Mines (DNRM) (2013) contention;

"that safety standards are slowly eroding due to persons being appointed who do not adequately comprehend the task at hand. A process cannot be managed effectively without comprehending the process. This is being demonstrated, not only in the increasing number of concerning incidents, but also in the declining safety standards and reduced productivity being observed. People are being promoted to supervisor level and above who do not understand legislative requirements, hazard identification or the risk management process. The Queensland Mines Inspectorate, continually through investigations or audits, uncover a poor basic understanding of the processes these people are required to be managing or supervising.

According to DNRM (2013) the Queensland Mines Inspectorate has found and continues to find persons being appointed to positions who do not meet the competency standards required by the respective Acts, and further suggests that the standard of competency training and assessment provided by some registered training organisations is highly questionable.

If people with insufficient experience are being appointed to senior positions in the management structure on mine sites and are not able to meet the competency standards required, then this poses a serious problem which must be addressed with some urgency if the safety performance is to improve in the industry.

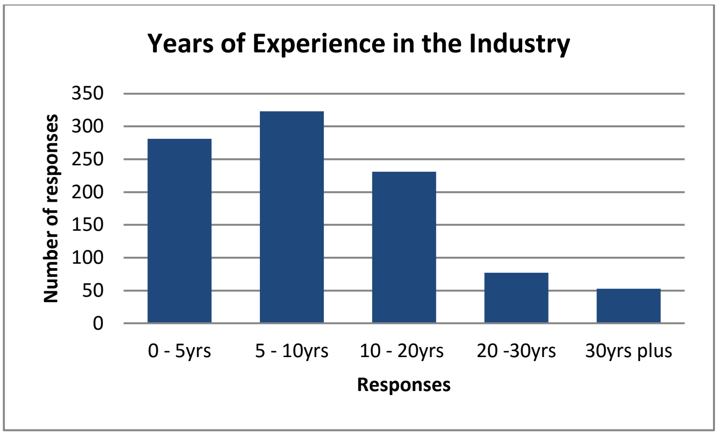


Figure 7.3 Years of Experience in the Industry

7.3.4 Respondents Age

The survey results in Figure 7.4 indicate that 21% of the workforce is under the age of 30 while a total of 79% of the workforce is under the age of 50. This fact again reflects a younger workforce with the inherent problems of inexperience. However one of the advantages of a younger workforce is that they are more likely to embrace change and new initiatives and are generally better educated and have higher levels of literacy than their older counterparts.

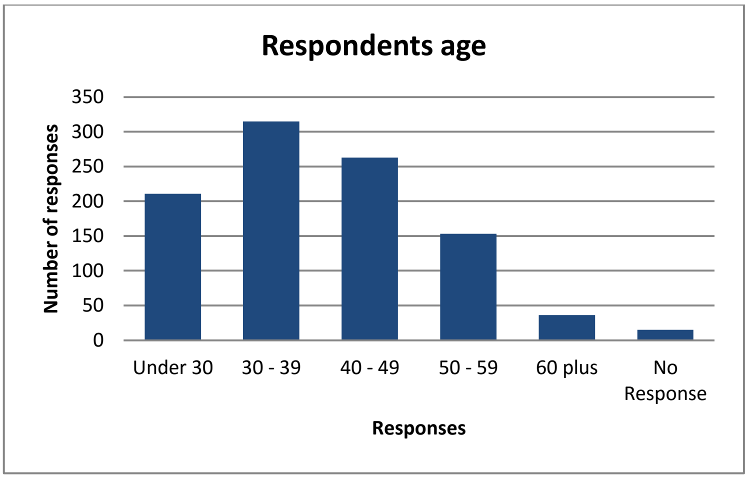


Figure 7.4 Respondents Age

7.3.5 Years of Experience in this Job

In Figure 7.5 it can be observed that 45% of the workforce had not been in the same job for more than 5 years and 30% had only been at the mine for between 5 and 10 years which again reiterates the problems associated with an inexperienced workforce according to the Queensland Mines Inspectorate "Consultation Regulatory Impact Statement 2013".

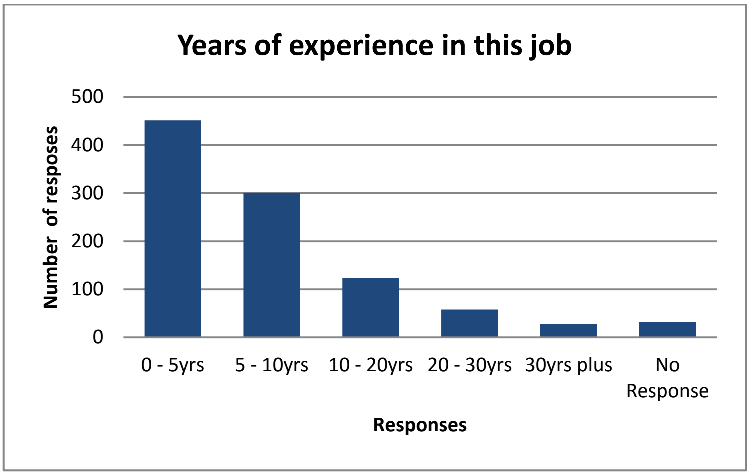


Figure 7.5 Years of Experience in this Job

7.3.6 Years at this Mine

It may be observed in Figure 7.6 that 22% of the workforce have worked at the mine for less than 2 years and 37% have worked at the mine for between 2 and 4 years. This inexperience again has significant consequences for safety especially since a good proportion of this workforce is contractors see Queensland Mines Inspectorate "Consultation Regulatory Impact Statement 2013".

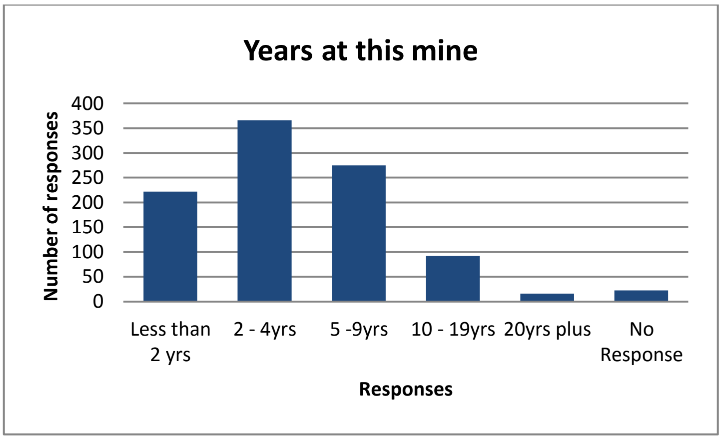


Figure 7.6 Years at this Mine

7.3.7 Employer

Figure 7.7 shows that 77% of the workforce is employed by company and 19% by contracting companies. This situation has arisen due to the recent downturn in the industry, as contractors are usually the first to be made redundant during downturn events. However the rapid expansion of the mining industry has required the growing use of contractors which has in addition created a more inexperienced workforce. According to the Queensland Mines Inspectorate “Consultation Regulatory Impact Statement 2013”

“The effective management of contractors is a continuing cause of concern of the Queensland Inspectorate. Alarming incidents and near misses involving contractors continue to occur. Coronial findings have emphasised the importance of there being only one safety and health management system at a mine and this needs to be followed by all workers whether employees or contractors. Eight of the nine deaths in Queensland coalmines and ten of the twenty deaths in Queensland metalliferous mines and quarries have been contractors since the current mining safety and health legislation came into force in 2001”.

On the whole, contractors tend to be less experienced in the mining industry than other workers. The increasing use of contractors and their overrepresentation (based on their proportion of the workforce) in fatalities indicates the importance that contractors be effectively managed on mine sites especially since mines employ contractors to perform physically intensive tasks such as installing rib wood chocks. This subject was discussed extensively in Chapter 4.

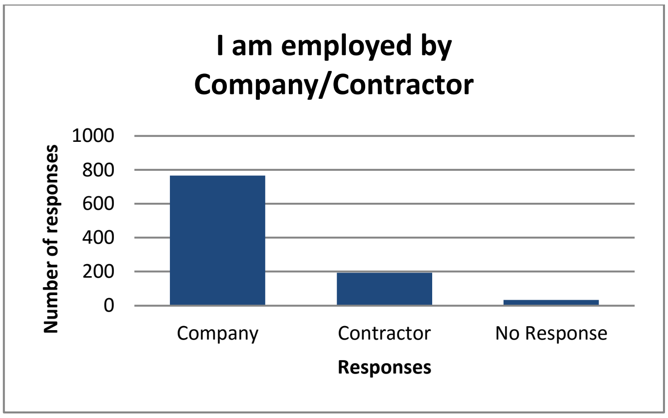


Figure 7.7 I am Employed by Company / Contractor

7.4 General Safety Questions

7.4.1 Is Safety Performance Improving on Your Mine Site

A total of 71% of respondents agreed or strongly agreed that safety performance was improving on their mine site, however 12% disagreed that safety was improving and 16% were not sure. The 12% that were not able to support the fact that safety was improving on their mine site may suggest that communication and training of permanent employees and contractors is a cause for safety concerns regarding safety performance improvement.

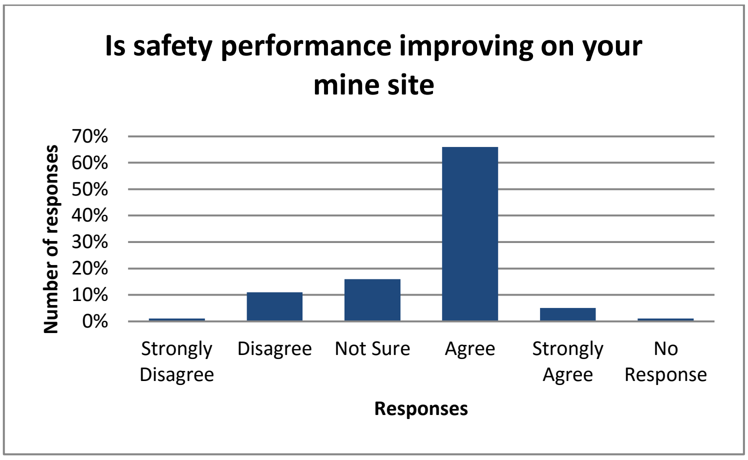


Figure 7.8 Is Safety Performance Improving on your Mine Site

7.4.2 Are all Accidents and Incidents Investigated and Reported at your Mine

Some 70% of respondents agreed or strongly agreed that all accidents and incidents are investigated and reported at their mine site, however 13% disagreed. It has been reported (see Chapter 2 – findings of a report published by Parker & Cliff) that some contractors and sub-contractors were not reporting all accidents and incidents that they were involved in, due to safety targets being a condition of their contract. It is interesting to note that the 13% that disagree correlates very closely with the 19% of contractors employed in the survey and certainly is a cause for some concern regarding safety reporting.

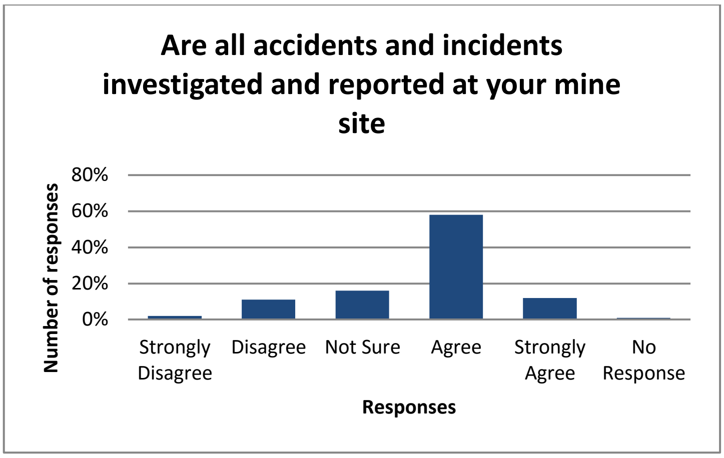


Figure 7.9 Are all Accidents and Incidents Investigated and Reported at Your Mine Site

7.4.3 Is Accident and Incident Information Acted upon to make Improvements

It can be observed in Figure 7.10 that 73% of the workforce agreed or strongly agreed that accident and incident information is acted upon to make improvements with 12% disagreeing and 15% not sure. The number of workers disagreeing and not sure is again a cause for concern since in a well-informed workforce one would expect that practically all workers should agree with the abovementioned statement.

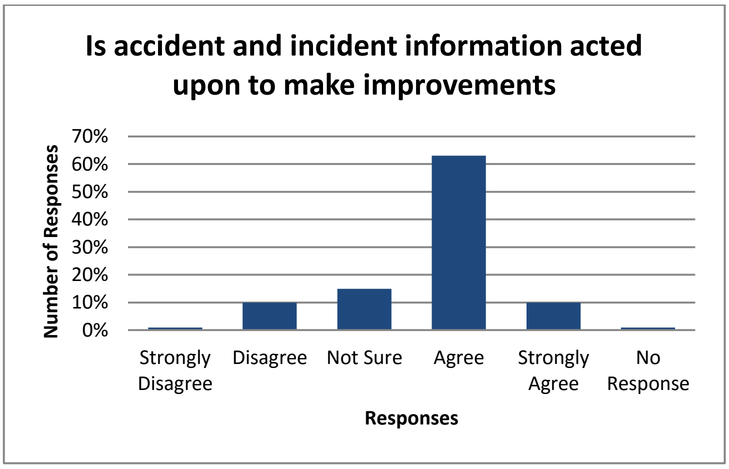


Figure 7.10 Is Accident and Incident Information Acted upon to make Improvements

7.4.4 Accident and Incident Information is Communicated Satisfactorily to Permanent and Temporary Employees

In Figure 7.11 it can be seen that 70% of employees agree or strongly agreed that accident and incident information is communicated satisfactorily to permanent and temporary employees. However 17% disagree, which again is a cause for concern since in a workforce with good communication and training one would expect a higher number of workers would agree with the above question especially regarding accident and incident information which is of paramount importance to all employees, especially if they are to learn the lessons from accidents and incidents.

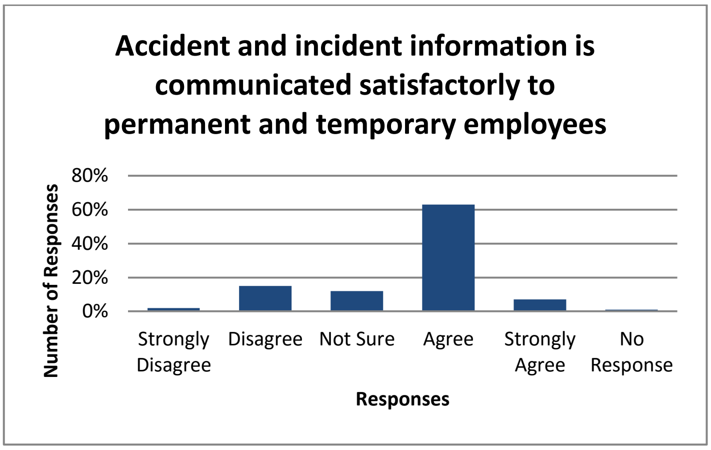


Figure7.11 Accident and Incident Information is Communicated Satisfactorily to Permanent and Temporary Employees

7.4.5 Human Error is a Major Factor in Causing Accidents and Incidents

It can be observed in Figure 7.12 that 73% of respondents agree that human error is a major factor in causing accidents and incidents. This is a real positive for the industry safety performance. However the remaining 27% (not sure and disagree) could be people that did not understand that human error violations are deviations from safe operating procedures and are frequently encountered which involve cutting corners to get the job done; this fact in itself is an issue for safety performance improvement especially since Reason (1990) stated, when describing the variability paradox, that error is implicated in 70-80% of all accidents. Hopkins (1995) reported that 95% of accidents occur because of acts of people.

They do something they are not supposed to do and are trained not to do, but do so anyway.

According to Reason (2000), the problem of human error can be viewed in two ways: the person approach and the system approach. Each has its model of error causation, and each model gives rise to different philosophies of error management. Understanding these differences has important practical implications for coping with the ever present risk of mishaps in the workplace.

Human error can best be defined as "the failure of planned actions to achieve their desired ends – without the intervention of some unforeseeable event." (Reason 1990).
Human error was discussed extensively in Chapter 3.

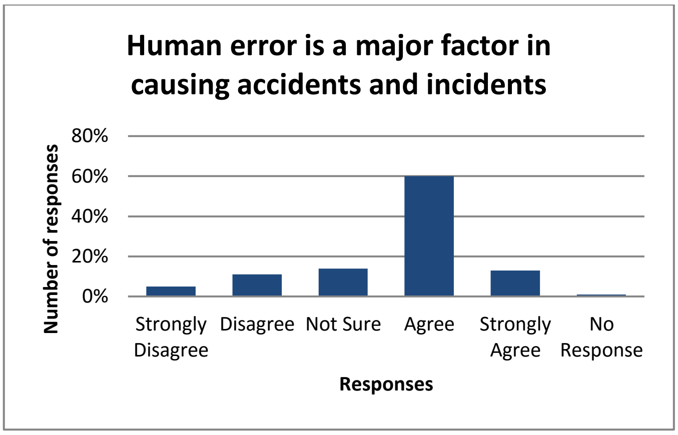


Figure 7.12 Human Error is a Major Factor in Causing Accidents and Incidents

7.4.6 Accidents and Incidents can be Eliminated

Only 56% of the survey respondents agreed or strongly agreed that accidents and incidents can be eliminated, however 28% disagreed and 15% were not sure. This indicates that nearly half of the survey respondents are not aware of unsafe acts, errors and procedural violations and deviations from safe operating procedures which would indicate a lack of safety training and education which is a detriment to a safe work place. The workforce need to be able to understand that most accidents are caused by unsafe behaviour, and certain people are more prone to behave unsafely than others. Therefore accidents can be prevented by changing the way people behave (Jonson 1997).

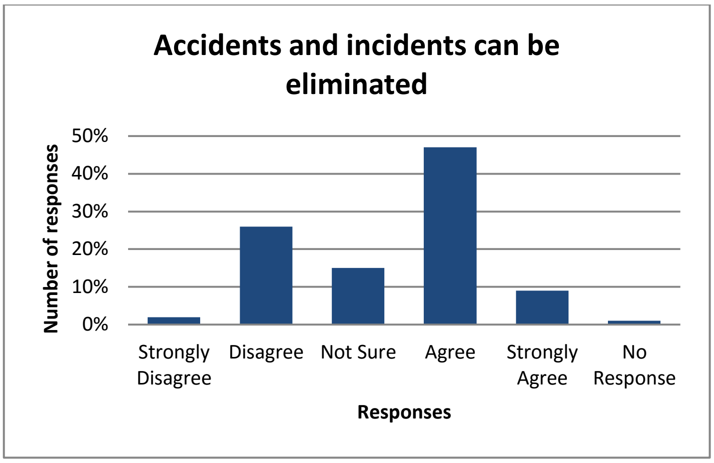


Figure 7.13 Accidents and Incidents can be Eliminated

7.4.7 I am Encouraged by my Employers to have my Say on Safety Matters

It can be observed from Figure 7.14 that 79% of the survey respondents agreed or strongly agreed that they were encouraged by their employers to have their say on safety matters which is a positive for safety improvement in the mining industry where employers are ensuring that employees are involved in all safety matters that affect them. However 12% did not agree and 8% were not sure which again suggests that communication and safety training is inadequate and needs attention if the mining industry safety performance is to improve.

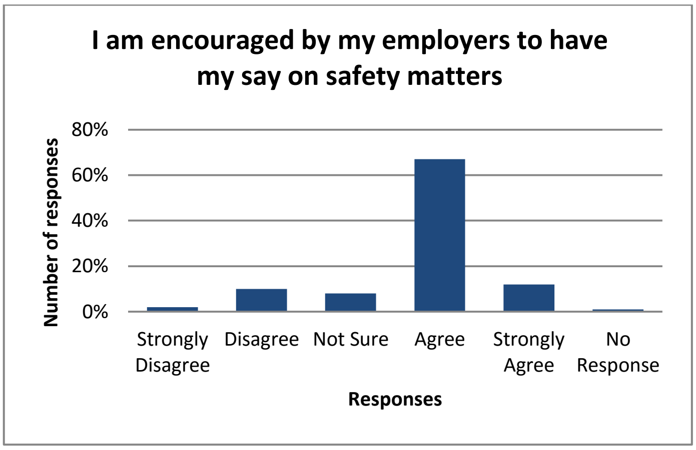


Figure7.14 I am Encouraged by my Employers to have my Say on Safety Matters

When discussing safety improvement it is appropriate to consider a very recent development in the coal mining industry. According to Colman (2016) in December 2015 the Queensland mines minister Anthony Lynham informed parliament of the first cases of black lung disease in three decades. A failure to quickly diagnose Black Lung disease and glaring inadequacies in coal mine regulation and monitoring has been revealed. He also stated that eight out of ten underground coal mines over the past 12 months had breached the legal coal dust limits.

There are fears more Queensland coal miners could be affected by Black Lung disease thought to have been eradicated in Australia 30 years ago. The Queensland government has confirmed six cases in two months, and is on notice that two more are imminent. This has resulted in a Senate Inquiry being established in March 2016 to investigate the return of Black Lung disease in Queensland.

The Queensland Coal Mine Workers Health Scheme has been in place since 1993 under state regulation. The critical elements of the scheme are the five-yearly chest x-rays for Queensland underground coal miners, and inspectors appointed by the department checking that mine coal dust levels comply with legal limits.

Professor Malcolm Sim of Monash University who is conducting the Queensland government review has stated to the senate inquiry that none of these cases had been detected within the existing coal miners workers health scheme and that the design and operation of the medical assessments performed under the Coal Mine Workers Health Scheme needs to be reviewed.

7.4.8 The Main Causes of Accidents and Incidents is a poor Safety Culture

It can be observed from Figure 7.15 that 48% of survey respondents disagreed or strongly disagreed that the main causes of accidents and incidents is a poor safety culture while 33% agreed and 17% were not sure. The industry has agreed that if safety performance is going to improve it needs to change the safety culture and implement programmes that achieve the objective of changing attitudes and behaviour of the workforce on mine sites.

Reason (1997) contends that 'commitment, competence and cognisance' fuel the safety engine.

"High levels of commitment are relatively rare and hard to sustain. This is why the organisation's safety culture is so important. Top management come and go. More organisational leaders are appointed to revive sagging commercial fortunes than to improve indifferent safety records. A good safety culture, on the other hand is something that endures beyond these palace revolutions and so provides the necessary driving force irrespective of the inclinations of the latest CEO".

It is therefore a poor reflection on industry if nearly half the workforce does not understand that workforce culture plays a very important part in accidents and incidents on mine sites especially since according to Research Solutions Survey (2011) 82% of Managers rated their industries performance to be a proactive, consultative safety culture. This subject was discussed in Chapter 3.

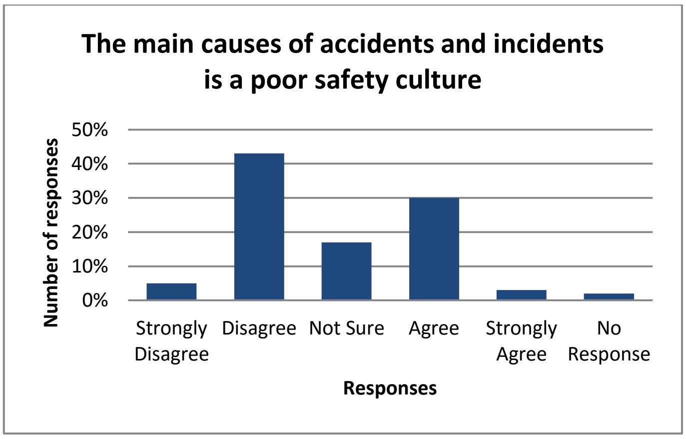


Figure 7.15 The Main Causes of Accidents and Incidents is a Poor Safety Culture

7.5 Risk Assessments

7.5.1 Risk Assessments are a Useful Part of Safety Management at my Site

Risk management techniques are now an integral part of the way the mining industry operates and as a consequence has been discussed at some length in Chapter 3. When considering risk assessments the following two comments need to be taken into consideration;

- Ross (2011) made the comment that that it is important to stay true to the intent of managing risk. We must make sure we do not get bogged down in processes and workshops which add little value, but instead think about why we want to perform a risk assessment in the first place.
- Roche (2013) stated that *"there has been too much focus in some areas on process and tick-a-box compliance which has steadily eroded innovation and risk –based management practices".*

It can be observed from Figure 7.16 that 86% of survey respondents agreed or strongly agreed that risk assessments are a useful part of safety management on their site while only 13% either disagreed or were not sure. This overall response suggests that the risk assessment philosophy is well communicated and enshrined in the mining industry. However in Queensland mining legislation the reintroduction of statutory certification for some existing safety positions is in response to the eroding safety standards in the Queensland mining industry.

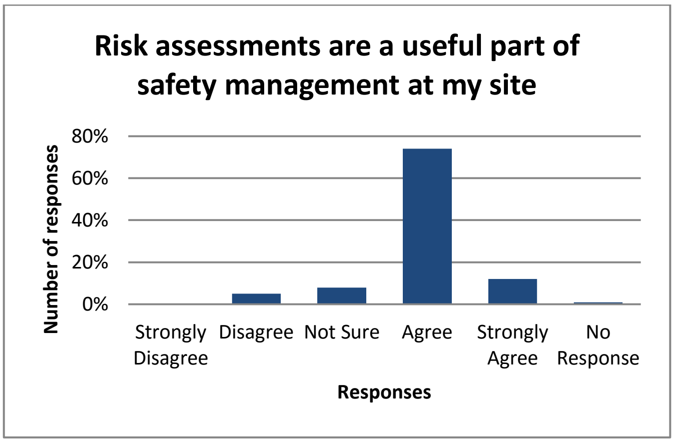


Figure 7.16 Risk Assessments are a Useful Part of Safety Management

7.5.2 People who Conduct Risk Assessments have Sufficient Training

The Figure 7.17 indicates that 67% of survey respondents agreed or strongly agreed that people who conduct risk assessments have sufficient training whilst 32% either disagreed or were not sure which would support the view of the CFMEU and safety practitioners in the industry that staff conducting risk assessments are not properly trained to perform the task, nor take into account the full nature of the risks. Again this was discussed extensively in Chapter 3.

Figure 7.17 People Who Conduct Risk Assessments have Sufficient Training

7.5.3 Too Many Risk Assessments are Conducted in my Workplace

It may be observed from Figure 7.18 that 56% of the surveyed workforce disagree or strongly disagree that there are too many risk assessments conducted in their workplace and 44% either agreed or were not sure. The fact that nearly a fifth of survey respondents agreed supports the unions view that says risk is not being assessed and managed adequately and that the necessary enforcement to ensure that it is, may be deficient and therefore wish to retain prescriptive legislation.

The CFMEU considers that "*staff conducting risk assessments at site level, are not properly trained to perform the task,* nor take into account the full nature of risks" (Wran 2005).

Many workers, managers and safety practitioners have expressed concern to the author that there are not only too many risk assessments but the risk assessment approach just allows management to do some 'window dressing'. The days when miners could use their own initiative or think for themselves to solve a problem have long since gone. The time taken for the risk management process may also have an effect on productivity, since that in 2000, the tonnes per man raw, was 20456 tonnes and in 2012 that had reduced to 6230 tonnes (sourced from data collected by the DNRM 2013). See Chapter 3. The author has been informed that these productivity figures could be plus or minus 20%; if that is the case the reduction in productivity would be significant.

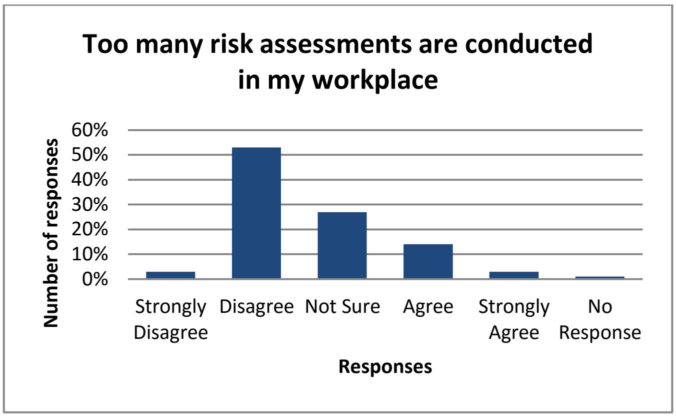


Figure 7.18 Too Many Risk Assessments are Conducted in my Workplace

7.5.4 I Get Benefit from Risk Assessments Concerned with my Workplace

The Figure 7.19 shows that 78% of the surveyed workforce agreed or strongly agreed that they get benefit from risk assessments concerned with their workplace whilst 21 % either disagreed or were not sure which again suggests that the risk philosophy is well communicated throughout the mining industry.

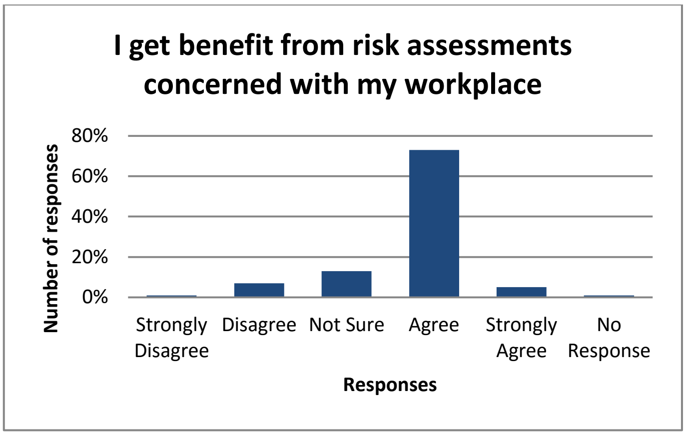


Figure 7.19 I Get Benefit from Risk Assessments Concerned with my Workplace

7.5.5 I am Involved in Risk Assessments Concerned with my Workplace

It is interesting to note in Figure 7.20 that 69% of survey respondents agreed or strongly agreed that they are involved in risk assessments concerned with their workplace whilst 30% either disagreed or were not sure, which would suggest that over a fifth of the survey respondents felt disengaged from risk assessments. This fact is of deep concern for safety in the mining industry since risk management is now an integral part of the way the mining industry operates and is part of QLD and NSW legislation. This obvious lack of education and communication regarding risk management adds to problems for safety in the industry.

Figure 7.20 I am Involved in Risk Assessments Concerned with my Workplace

7.5.6 Management Influences Affect the Outcome of my Risk Assessments

It may be observed in Figure 7.21 that of the surveyed workforce 53% agreed or strongly agreed that management influences affect the outcome of their risk assessments whilst 46% either disagreed or were not sure. If over half of the workforce which has been surveyed agrees that management influences affect the outcome of the risk assessment, which means that the risk assessment methodology is manipulated in order to achieve a desired result. This situation goes against the principle that risk assessments should be conducted where all parties involved contribute in an unbiased manner in order to achieve a result which is truly representative of the parties involved with the risk assessment. This is also one of the reasons why unions have expressed negative views regarding risk based legislation in favour of prescriptive legislation and also suggests that is one of the reasons for the reintroduction of statutory certification for some existing critical safety positions in Queensland mining legislation (DNRM 2013).

According to Pitzer (2009) "We create a myriad of rules and procedures that are supposed to defend us and create controls in the workplace and while it is largely successful, it eventually becomes a complexity of its own. Layer upon layer of risk controls actually create behavioural responses that expose the organisation in unpredictable ways".

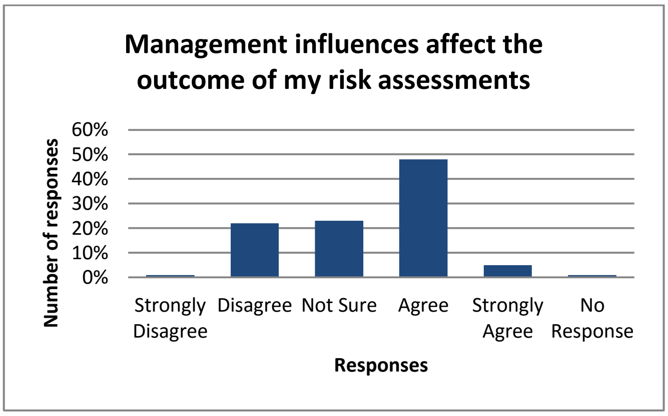


Figure 7.21 Management Influences Affect the Outcome of my Risk Assessments

7.5.7 There Should be Less Risk Management and More Prescriptive Legislation

In Figure 7.22 it can be seen that 42% of the surveyed respondents disagree or strongly disagreed that there should be less risk management whilst 57% either agreed or were not sure. It would therefore seem apparent that the union view towards more prescriptive legislation has had some effect on the surveyed workforce or that communication and education is lacking in both areas. If 33% of the workforce were unsure it is possible that they did not understand the question.

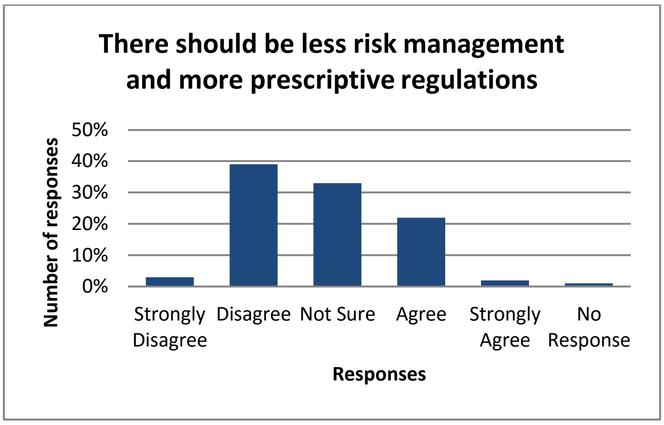


Figure 7.22 There Should be Less Risk Management and More Prescriptive Regulations

7.5.8 Is it Necessary to Break the Rules and Regulations to get the Job Done

It can be observed in Figure 7.23 that 79% of the survey respondents disagreed or strongly disagreed that it was necessary to break the rules and regulations to get the job done whilst 20% either agreed or were not sure. This result is good news for the industry’s safety improvement because the vast majority of the workforce is abiding by rules, regulations and safety procedures. The 20% that either agreed or were not sure indicate that taking risks to get the job done and communication, training and education needs to be improved if a consequent safety improvement is to be achieved.

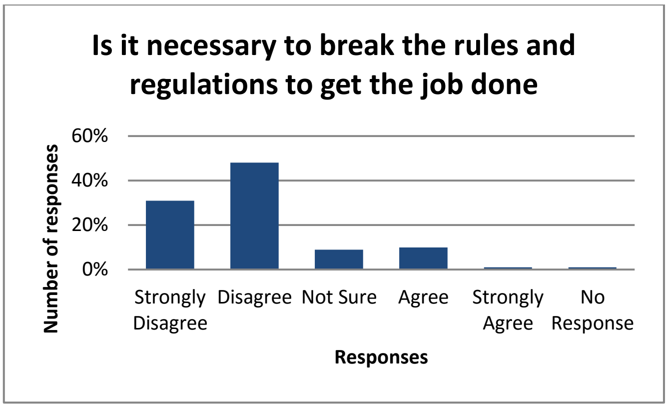


Figure 7.23 Is it Necessary to Break the Rules and Regulations to get the Job Done

7.6 Safety and Health Management Systems (SHMS)

7.6.1 A Lack of Experienced People is Causing Safety Issues at my Workplace

In Figure 7.24 it can be observed that 51% of the surveyed workforce disagreed or strongly disagreed that a lack of experienced people is causing safety issues at their workplace whilst 47% either agreed or were not sure. The fact that nearly half the workforce either agreed or were not sure, is due to inexperience since 22% of the workforce has worked at the mine for less than 2 years and 37% have worked at the mine for between 2 and 4 years.

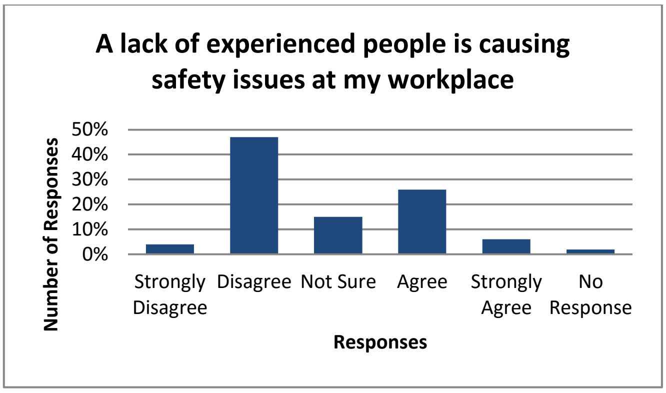


Figure 7.24 A Lack of Experienced People is Causing Safety Issues at my Workplace

7.6.2 My Training is Adequate to carry out my Role Safely

It can be observed from Figure 7.25 that 86% of the survey respondents agreed or strongly disagreed that their training is adequate to carry out their role safely. 12% either disagreed or were not sure

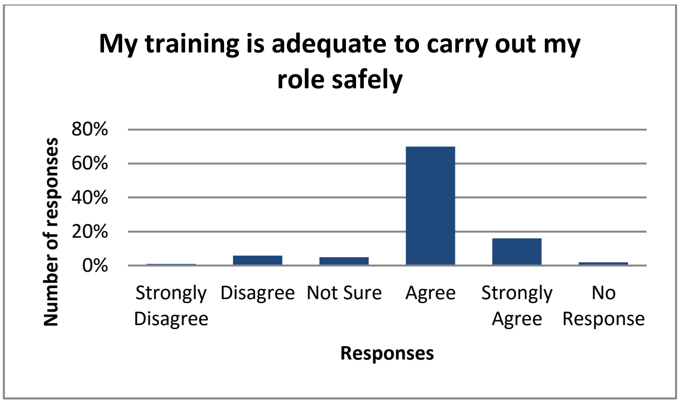


Figure 7.25 My Training is Adequate to carry out my Role Safely

7.6.3 I Understand my Obligations under the Safety and Health Management System (SHMS)

In Figure 7.26 it may be observed that 90% of survey respondents agreed or strongly agreed that they understand their obligations under the SHMS, whilst only 8% either disagreed or were not sure.

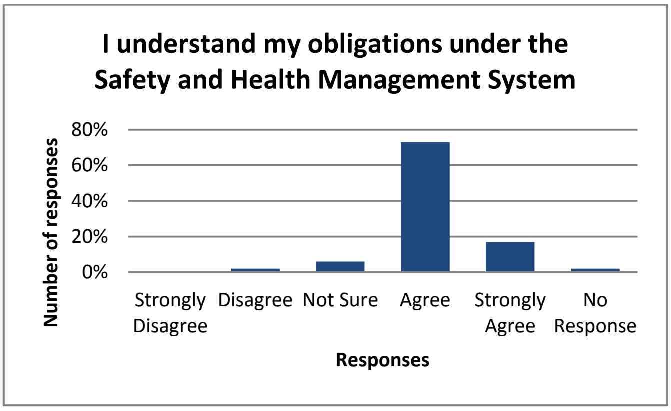


Figure 7.26 I Understand my Obligations under the SHMS

7.6.4 Adequate Training is given for me to understand my Obligations under the SHMS

It can be observed in Figure 7.27 that 70% of the survey respondents agreed or strongly agreed that they received adequate training for them to understand their obligations under the SHMS whilst 28% either disagreed or were not sure. This is understandable since a large percentage of the workforce is transient when compared to the workforce of several years ago when mines had long term employees who were relatively stable and experienced and is particularly relevant to contractors who move from site to site on a regular basis. This issue was discussed extensively in Chapter 3.

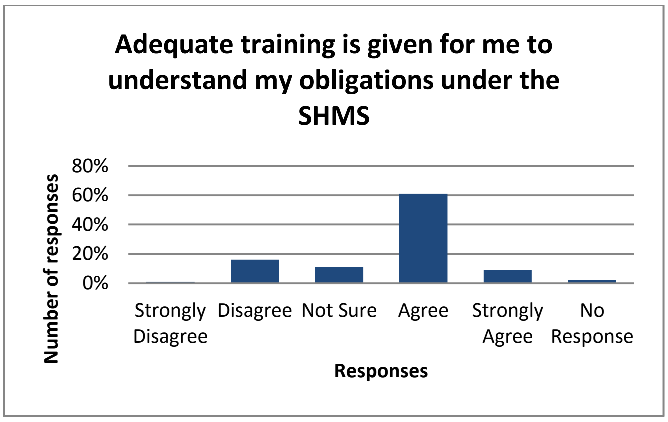


Figure 7.27 Adequate Training is given for me to Understand my Obligations under the SHMS

7.6.5 The SHMS is Too Complex for me to Understand

In Figure 7.27 it can be seen that 68% of the survey respondents disagreed or strongly disagreed that the SHMS is too complex. The 17% that agreed would support the fact that the SHMS are indeed complex documents because of the many elements involved in the system and because of this complexity can quickly become out of date, this subject again has been discussed in Chapter 3.

According to Forbes and Wilson (2005)

"We are required under the Coal Mine Health and Safety Act to make available for inspection by mine workers employed at a mine, a copy of the safety and health

management system. I suggest that this is also not achieved, as most mines are spread over a large area and the work area is some distance from the main office or training centre. So many employees would not actually have the ability to inspect or review the SHMS if seeking information. It is therefore just becomes another system that sits in the site library or Safety Managers office collecting dust. Even if it were readily available for employees, it is usually such a large document that anyone reading it would not have the time available to them during the shift. It is also generally written in such a manner that it is difficult for them to understand or locate the information they require".

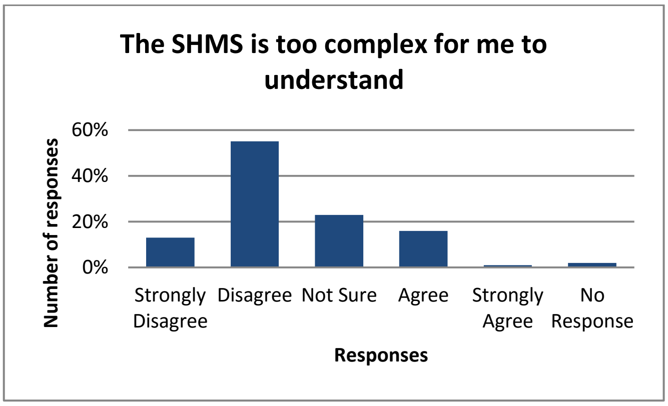


Figure 7.28 The SHMS is Too Complex for me to Understand

7.6.6 More Time should be allowed for Training in the SHMS

It can be observed from Figure 7.29 that 70% of survey respondents agreed or strongly agreed that more time should be allowed for training in the SHMS whilst 10% disagreed. Due to the complexity as previously stated the main challenge for any safety management system is how it is communicated and implemented for all to comprehend and comply with, especially those that move from site to site on a regular basis. This is another reason why the unions want more training and this fact has been substantiated by the results of this survey.

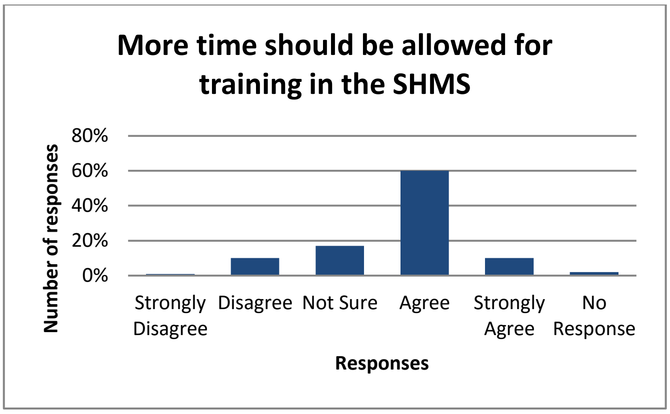


Figure 7.29 More Time should be allowed for Training in the SHMS

7.6.7 My Knowledge of the SHMS is updated on a Regular Basis

In Figure 7.30 it can be seen that of the survey respondents 41% disagreed or strongly disagreed that their knowledge of the SHMS is updated on a regular basis whilst 36% agreed and 21% were not sure. In order for any SHMS to be effective it must be updated on a regular basis. More respondents disagreed than greed which again is a concern for safety improvement and also goes against the current legislation. If over a fifth of the workforce is in the not sure category, education and communication with the workforce need to improve in order to achieve better safety standards with consequent safety benefits.

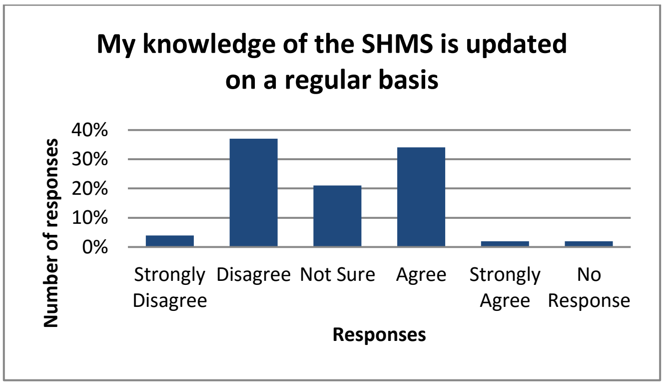


Figure 7.30 My Knowledge is updated on a Regular Basis

7.6.8 Information Concerning the SHMS is Adequately Communicated

It may be observed in Figure 7.31 that 46% of the survey respondents agree or strongly agreed that information concerning the SHMS is adequately communicated whilst 52% either disagreed or were not sure. It is again disturbing that 23% of respondents were in the not sure category which demonstrates not only a lack of communication but education about awareness of what is happening at the workplace.

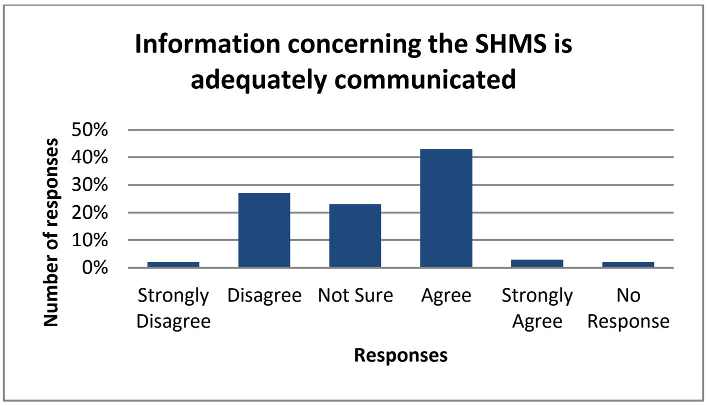


Figure 7.31 Information Concerning the SHMS is Adequately Communicated

7.6.9 The SHMS Drives Improved Safety Performance

It can be observed from Figure 7.32 that 59% of survey respondents agreed or strongly agreed that the SHMS drives improved safety performance whilst 40% including the not sure category disagreed. Again the 27% in the not sure category is a cause for concern which may be due to lack of effective communication and education in order to achieve better safety performance.

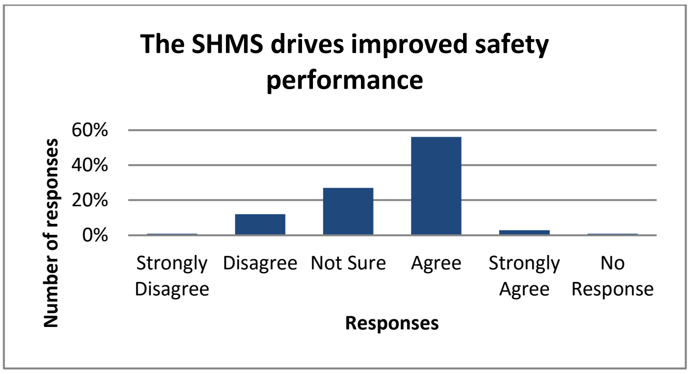


Figure 7.32 The SHMS Drives Improved Safety Performance

7.6.10 Safety Inspections are done by Persons in whom I have Confidence will take Action to make the Workplace Safe

In Figure 7.33 it can be observed that 71% of survey respondents agreed or strongly agreed that safety inspections are done by persons in whom they have confidence will take strong action to make the workplace safe whilst 27% either disagreed or were not sure. If over a fifth of the survey respondents disagreed or were not sure this could means a lack of confidence in management to make the workplace safe and better communication and education regarding management's philosophy regarding safety inspections.

Figure 7.33 Safety Inspections are done by Persons in Whom I have Confidence will take Strong action to make the Workplace Safe

7.7 Fatigue & Awareness Issues

7.7.1 Fatigue is Causing a Problem Regarding me being able to Operate Safely

In Figure 7.34 it can be observed that 67% of survey respondents disagreed or strongly disagreed that fatigue is causing a problem regarding them being able to operate safely whilst 22% agreed. If over one fifth of the workforce believes that fatigue is a problem regarding them being able to operate safely, especially when working a 12 hour night shift. This would suggest that fatigue management needs to be addressed with some urgency if safety performance is going to improve in the industry.

According to Muller (2008) from the School of Public Health and Tropical Medicine at James Cook University, miners working more than eight consecutive 12 hour day shifts were fatigued beyond the impairment expected from a blood alcohol concentration of 0.05%.

As previously stated fatigue and awareness issues are having a major impact on safety at work, which is particularly evident when people are working 12-hour shifts. The rapid expansion of the industry has required the growing use of contractors which in turn has produced a more inexperienced workforce.

According to David Logan (2013) fatigue is a serious issue in mining, particularly once mine workers get into a car to drive often long distances home after working long hours. Central Queensland Coroner Annette Hennessy recently made 24 recommendations for the industry following her investigation into the two separate fatal road accidents, one in Yeppoon in 2005 and the other in Dysart in 2007. She stated that driver fatigue was a potential factor in both incidents where coal miners were driving home following work.

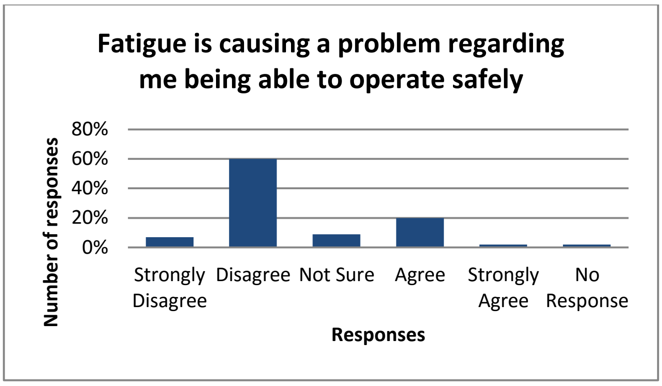


Figure 7.34 Fatigue is Causing a Problem Regarding me being able to Operate Safely

7.7.2 My Current Roster Allows Sufficient Quality Time with Family and Friends to support a Sustainable Work Life Balance

In Figure 7.35 it can be observed that 74% of survey respondents agreed or strongly agreed that their current roster allowed sufficient time with family and friends to support a sustainable work life balance whilst 24% either disagreed or were not sure.

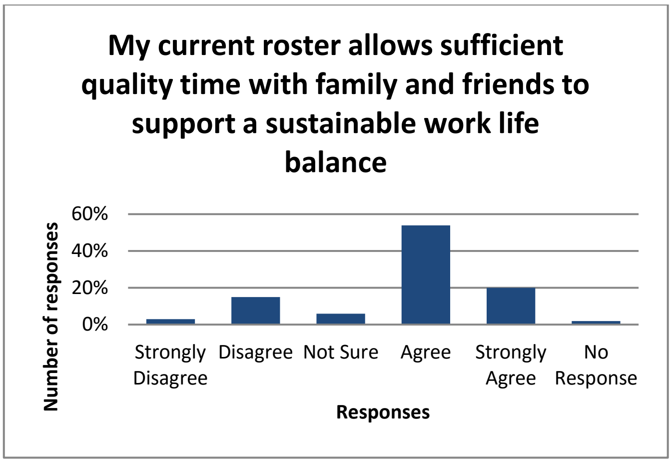


Figure 7.35 Roster allows Sufficient Time with Family and Friends to support a Work Life Balance

7.7.3 My Concentration is reduced when Working 12 Hour Night Shift Rosters

In Figure 7.36 it can be observed that 43% of survey respondents agreed or strongly agreed that their concentration is reduced when working 12 hour night shift rosters whilst 39% disagreed. If nearly half the workforce believes that 12 hour night shift rosters reduce concentration then this presents a substantial safety problem for the industry particularly in the underground sector and poses the question of how can workers operate machinery with reduced concentration especially on night shift. An example is illustrated below;

Of the 32 incidents analysed in Queensland, NSW and Western Australia mines (Chapter 4) it was found that the main causes of these incidents was found to be as follows:

- Collision 78%
- Rollover 22%
- Fatigue 100%
- Safe work Procedures 100%
- Communication 44%
- Inadequate safety barriers 18%

It was concluded from the above analysis of the 32 incidents that have been investigated that 78% are related to collisions, 22% to rollovers, 44% to communication, 18% to safety barriers and all related incidents are attributable to fatigue and lack of safe work procedures. This would suggest that concentration is reduced when working 12 hour night shift which is a concern for safety improvement.

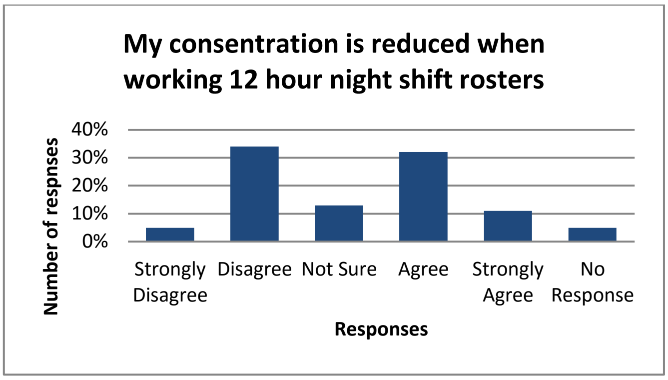


Figure 7.36 My Concentration is reduced when Working 12 Hour Shift Rosters

7.7.4 My Current Roster Results in Poor Judgement of my own Performance

In Figure 7.37 it can be observed that 75% of survey respondents disagreed or strongly disagreed that their current roster resulted in poor judgement of their own performance whilst 23% either agreed or were not sure.

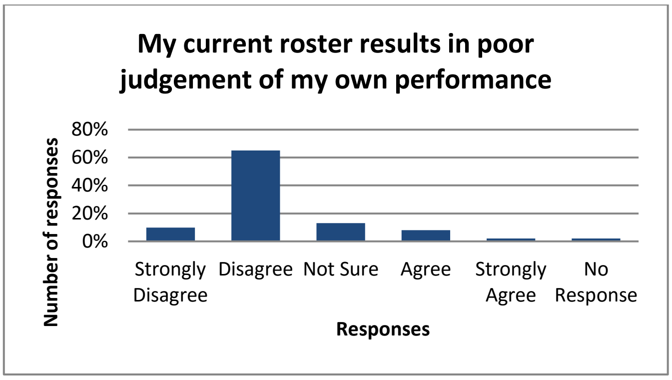


Figure 7.37 My Current Roster Results in Poor Judgement of my own Performance

7.7.5 Working my current Shift Roster Affects my Ability to Assess Problems and Determine Solutions

It can be observed in Figure 7.38 that 76% of survey respondents disagreed or strongly disagreed that working their current roster affected their ability to assess problems and determine solutions whilst 22% either agreed or were not sure. If 10% of survey respondents agreed, this could indicate that there is problem that will have a detrimental effect on safety performance.

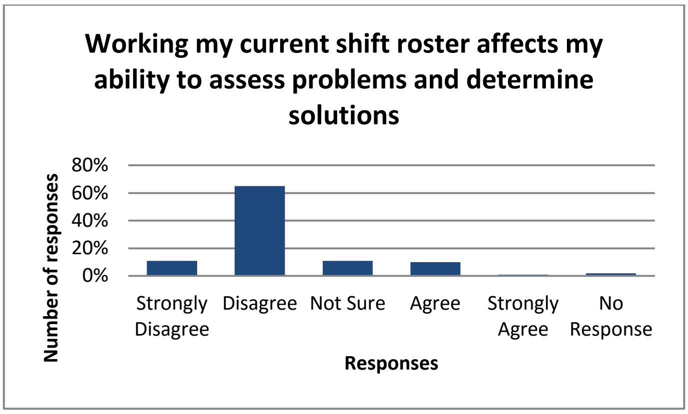


Figure 7.38 Working my current Shift Roster Affects my Ability to Assess Problems and Determine Solutions

7.7.6 When Working 12 Hour Shift Rosters my Decision making is Impaired

In Figure 7.39 it can be observed that 61% of the survey respondents disagreed or strongly disagreed that in working 12 hour shift rosters their decision making was not impaired and 21% agreed and 14% were not sure. If over a fifth of the workforce agrees that working 12 hour shift rosters impaired their decision making then again this could indicate that there is a problem that will have a detrimental effect on safety performance improvement. This result could question whether over a fifth of the workforce can operate machinery safely if their decision making is impaired especially on night shift.

It has been outlined in Chapter 4 how the industrial relations laws of the Howard Government have encouraged companies to move to these longer working hours for productivity reasons. Mineworkers initially rejected these longer working hours but have now overwhelmingly accepted them because of life style considerations. These roster arrangements have allowed mining families to live in coastal and major centre communities. According to the CFMEU these longer working hours and the self-regulation of work hours has been the approach in mining since 1996.

The increasing use of contractors, of 12-hour shifts, of compressed rosters and the use of 'fatigue management policies' are major contributors to incidents (CFMEU 2004).

This approach has been at the expense of safety fatigue considerations throughout the mining industry. It has demonstrated that mining is still a hazardous industry and we still expect miners to undertake their tasks suffering the effects of fatigue with consequent issues for safety performance improvement.

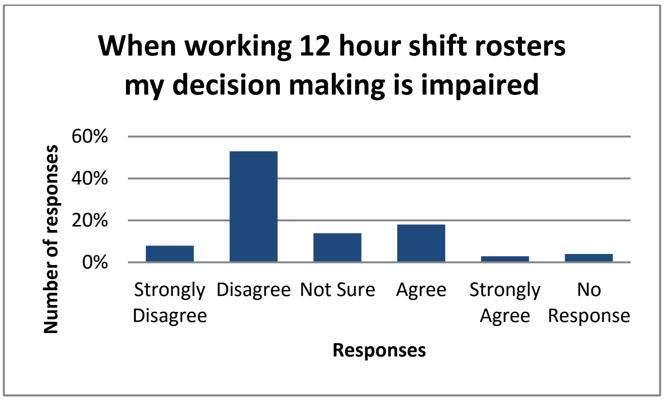


Figure 7.39 When Working 12 Hour Shifts Rosters my Decision making is Impaired

7.7.7 When Working my current Roster my Awareness and Communication Skills are Impaired

In Figure 7.40 it can be observed that 74% of survey respondents disagreed or strongly disagreed that when working their current roster that their awareness and communication skills are impaired whilst 23% either agreed or were not sure. The 12% that agreed is still a concern for safety performance in the industry. Especially when according to the Wran Report (2007) interviewees from staff groups reported that they were fatigued as a result of their long work hours and shift arrangements.

We work Twelve and a half hour night shifts – you only need bad concentration for a couple of seconds for something bad to happen. Fatigue is a really big problem. Twelve and a half *hour day shifts are not too bad, night shift is dreadful. I don't know how truck drivers manage it (coal employee).*

We have had lots of incidents; a truck ran off the road, lots of incidents falling asleep. Lots of people fall asleep and don't report it. You see marks, so you know what's happened. The consequences depend on who notices. If there is damage to the vehicle you have to report it, but otherwise people are too scared to speak up about it (coal operator).

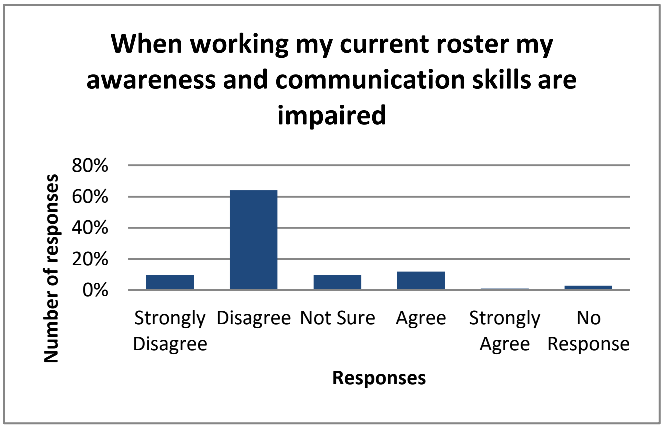


Figure 7.40 When Working my current Roster my Awareness and Communication Skills are Impaired

7.7.8 Travel Times to Work Cause Fatigue and Awareness Issues

In Figure 7.41 70% of the survey respondents disagreed or strongly disagreed that travel times to work causes them fatigue and awareness issues whilst 27% either agreed or were not sure, however a fifth of the respondents agreed which is a detriment to safety performance improvement in the industry particularly on night shift.

Recent mine expansions have led to miners working in areas where accommodation is limited which has led to more traffic on the roads and with a 12 hour shift it means that most of these mine workers are on the roads at peak morning and afternoon periods. With hot seat change-overs this means that some rosters have shift lengths of 12.5 to 13 hours. According to Brown and Fitzpatrick (2010) in February 2010 BMA implemented new fatigue management guidelines which increased the maximum shift length from 12 to 14 hours. The CFMEU responded by issuing a directive to stop work at all BMA sites in Queensland, claiming the company’s fatigue management standard represented an unacceptable level of risk to workers.

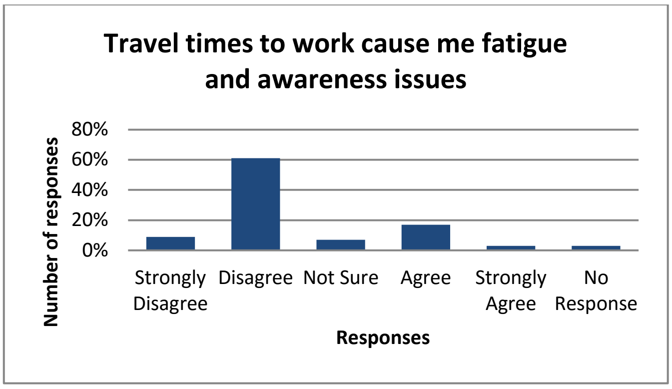


Figure 7.41 Travel Times to Work cause me Fatigue and Awareness Issues

7.8 Prosecution Policies

7.8.1 There are Practices that Limit the Quality of Accident Investigation at my Site

In Figure 7.42 it may be seen that 41% of survey respondents disagreed or strongly disagreed that there are practices that limit the quality of accident investigation at their site whilst 19% agreed and 37% were not sure, however if practically one fifth of survey respondents agree, then the quality of accident investigation needs to improve in order to achieve better safety outcomes.

Figure 7.42 There are Practices that Limit the Quality of Accident Investigation at my Site

7.8.2 Information Regarding an Accident is Free Flowing on my Site

In Figure 7.43 it can be observed that 52% of survey respondents agreed or strongly agreed that information regarding an accident is free flowing on their site whilst 27% disagreed and 18% were not sure, which would suggest that the 27% of survey respondents who disagreed have an issue with free flowing information on their site which is an obvious concern for safety improvement. If safety performance is to improve all the workforce must be aware of the outcomes of an accident in order to learn the lessions from the accident.

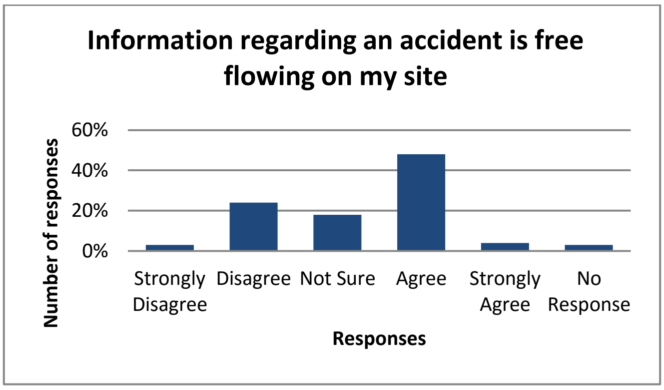


Figure 7.43 Information Regarding an Accident is Free Flowing on my Site

7.8.3 I Believe that Company Legal People should be Involved in Site Accident Investigations

It can be seen that in Figure 7.44 that the majority of survey respondents 45% disagreed or strongly disagreed that company legal people should be involved in site accident investigations and 22% agreed and 30% were not sure. This result supports the discussion in the thesis that company legal people should not be involved because of the issues of legal privilege which inhibit the sharing of accident information and the lesson's learned which has been discussed extensively in chapter 5.

The lessons from accidents and incidents are not being learned because the companies fear being prosecuted which has created distrust between the parties. According to Gunningham (2007) The NSW department's prosecution policy and the approach of the independent investigations Unit charged with investigating fatalities, has precipitated a seething dispute between NSW Mineral Council and major mining companies on the one hand and the safety regulator and trade unions on the other.

The mining companies are being encouraged to seek client “legal privilege” in order to protect the company and its directors because the findings could be used against the companies in future prosecutions. Near miss reporting, audits and high potential incidents are also subject to prosecutions which means that vital information is withheld and as a consequence not available in order to prevent a recurrence of the accident or incident. More importantly it moves away from the no blame culture which is the most important part of any safety improvement programme and instead promotes a defensive culture. This supports the authors hypothesis in that the mining industry needs to change the culture regarding prosecution policies so that legal privilege does not prevent the sharing of safety information and heeding the lession’s learned from accidents and incidents on mine sites.

Figure 7.44 I Believe that Company Legal People should be Involved in Site Accident Investigations

7.8.4 Accident Investigation would be best conducted by Mine Management and the Site Safety and Health Representative and not Legal People

In Figure 7.45 it can be seen that 66% of survey respondents agreed or strongly agreed that accident investigation would best be conducted by Mine Management and the Site Safety and Health representative and not legal people whilst only 11% disagreed. Again this supports the view that mine workers do not want legal people involved because of legal privilege and the issues of sharing and learning information from accidents as discussed in chapter 5. In order to understand what “Client Legal Privilege means in terms of finding out the facts regarding an accident or incident the following statement by a lawyer in Brisbane in 2001 which is still valid today explains the legal ramifications:

“*Documents produced for the purpose of obtaining legal advice or in the anticipation of possible prosecution may be subject to client legal privilege. This means there is a basis to say those documents do not need to be produced to the inspector or to a court or to a tribunal”* (Humphreys, 2001).

In the event of a serious incident or accident mining companies are advised by the legal profession to be very careful about generating reports about the incident or accident. Employees are encouraged not to write written reports in relation to the incidents and accidents without prior approval of the manager, because they may be damaging the company’s legal position and the legal position of its employees, managers and directors. Very often, the first person on the site of an accident or incident these days is the company lawyer who then effectively takes charge of the investigation.

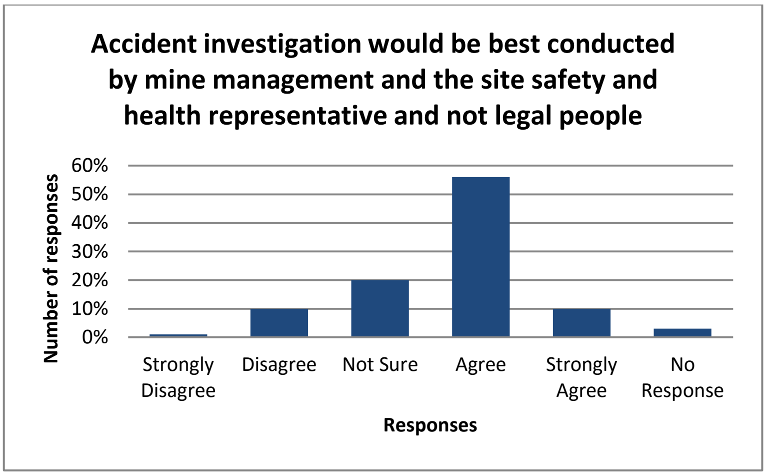


Figure 7.45 Accident Investigation would best be conducted by Mine Management and the Site Safety & Health Representative, not Legal People

7.8.5 I am concerned about the current Prosecution Policies that are in Place

In Figure 7.46 it can be observed that 27% of survey respondents were not concerned about the current inspectorate prosecution policies in place whilst 20% agreed that they were. A further 50% were not sure which may indicate a lack of knowledge regarding prosecution policies in the industry.

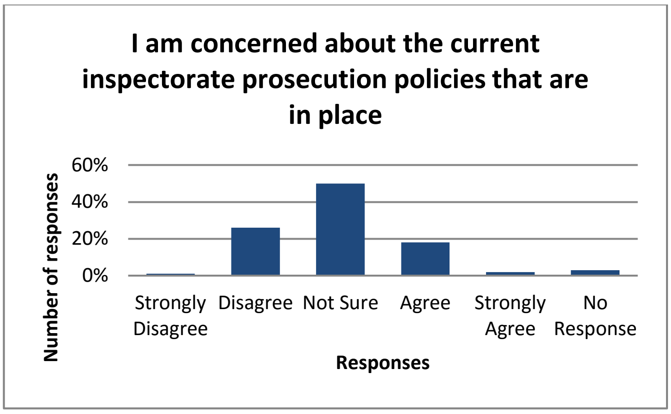


Figure 7.46 I am concerned about the current Prosecution Policies that are in Place

7.8.6 Legal People's Involvement Affects the open Provision of Facts concerning an Accident or Incident

In Figure 7.47 it can be seen that 39% of survey respondents agreed or strongly agreed that legal people's involvement affects the open provision of facts concerning an accident or incident whilst only 11% disagreed and 44% were not sure which may suggest the fact that legal privilege is a detriment to the open provision of all the facts relating to an accident or incident in order to learn the lession's. The not sure category would suggest the lack of education and knowledge in the industry regarding legal people's involvement.

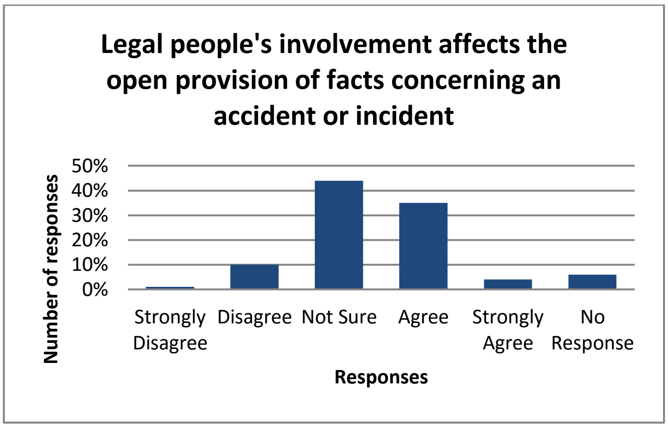


Figure 7.47 Legal People's Involvement Affects the Open Provision of Facts Concerning an Accident or Incident

7.8.7 Prosecution Policies should only be used as a Last Resort when Wilful and Reckless Disregard for Safety is the Case

In Figure 7.48 it can be observed that 54% of survey respondents agreed or strongly agreed that prosecution policies should only be used as a last resort when wilful and reckless disregard for safety is the case whilst 19% disagreed and 24% were not sure. The industry needs to take note of this result which indicates that the current prosecution policies need to be changed such as to allow all accident and incident information to flow freely and be able to share the lessons learned which will have huge benefits for safety improvement in the industry.

Regarding the need for prosecutions it would make eminent good sense to adopt the "Robens Report" recommendations which essentially state that those who act "wilfully and recklessly" should be prosecuted.

In regard to offences involving recklessness being treated as a criminal offence it is interesting to note the following comment contained in the Robens Report:

"*We recommend that criminal proceedings should, as a matter of policy, be instituted only for infringement of a type where the imposition of exemplary punishment would be generally expected and supported by the public. We mean by this, offences of flagrant, wilful or reckless nature which either have or could have resulted in serious injury*" (Robens 1972).

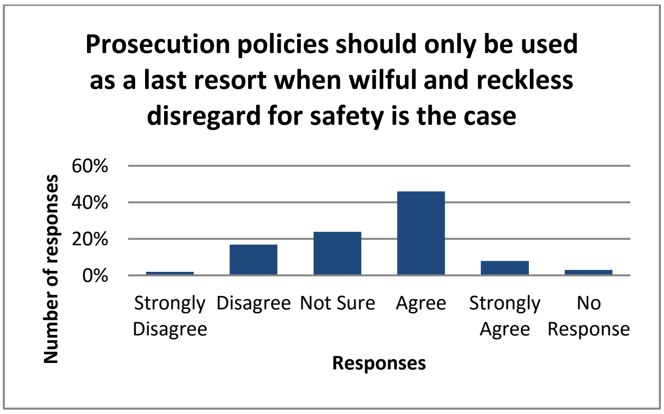


Figure 7.48 Prosecution Policies should only be used as a Last Resort when Wilful and Reckless Disregard for Safety is the Case

7.8.8 The Root Causes of Accidents and Incidents are not being Examined for Fear of Prosecution

In Figure 7.49 it can be observed that 38% of survey respondents disagreed or strongly disagreed that the root causes of accidents and incidents are not being examined for fear of the company being prosecuted whilst 22% agreed and 37% were not sure. However if over a fifth of the respondents agreed this suggests that prosecution is an issue regarding being able to examine the root causes of accidents and incidents. It is imperative that all accident and incident information is free flowing allowing the lessons to be learned.

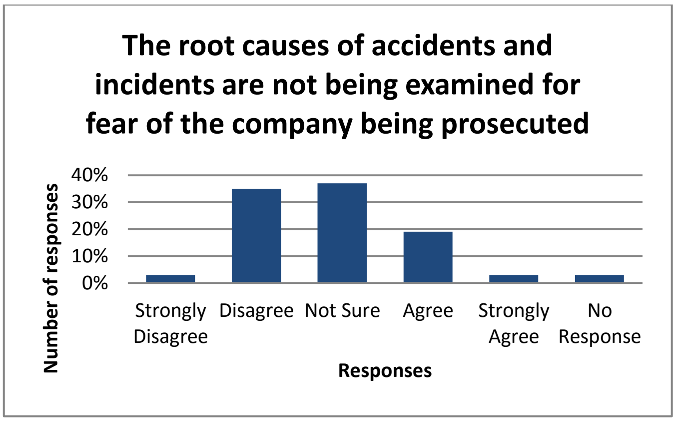


Figure 7.49 The Root Causes of Accidents and Incidents are not being Examined for Fear of the Company being Prosecuted

7.8.9 An Official Inquiry would produce better Outcomes if there was no Fear of Prosecution

In Figure 7.50 it can be observed that 55% of survey respondents agree or strongly agreed that an official inquiry would produce better outcomes if there was no fear of prosecution whilst only 14% disagreed and 28% were not sure.

In summary, if the current prosecution philosophy continues valuable information which could help prevent accidents and incidents will be lost to the detriment of improving the safety performance in the Australian mining industry and attracting mining engineers into mine management positions. One way of preventing this happening would be for the mining industry to move away from the automatic prosecution policies and adopt a no blame culture with the aid of a system similar to the Former Wardens Court in Queensland where there was no fear of automatic prosecution which encouraged a free flow of information. The finding and recommendations are completed in a much quicker time frame which means that the lessons learned are available in a much shorter time span than the current outcomes in Queensland, New South Wales and Western Australia with a consequent positive outcome for safety improvement in the mining industry.

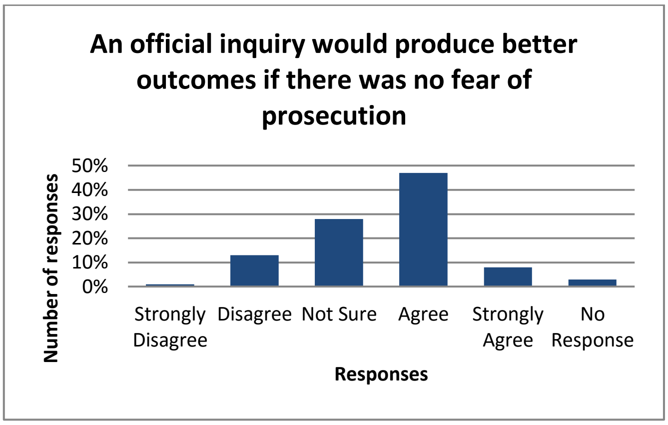


Figure 7.50 An Official Inquiry would produce better Outcomes if there was no Fear of Prosecution

7.9 Fly In Fly Out (FIFO)

7.9.1 Are you a FIFO Worker includes drive in drive out and bus in bus out.

Some 331 FIFO workers responded to the survey which equates to 33% of survey respondents, since only FIFO workers were asked to participate in the FIFO questionnaire.

7.9.2 FIFO Working Increases Stress Levels and Poor Health

In Figure 7.51 it can be seen that 48% of survey respondents disagreed or strongly disagreed that FIFO working increases stress levels and poor health whilst 34% agreed and 18% were not sure. If over a third of respondents agree that FIFO causes stress levels and poor health then industry needs to look at ways to reduce these issues in order to improve safety performance especially on night shift.

According to the Queensland Department of Natural Resources and Mines Guidance Notes for Fatigue Risk Management (2013), cumulative or long term exposure to fatigue, associated with shift work have been linked to long-term health problems, such as:

- Heart disease
- Digestive problems and
- Stress and other psychosocial issues.

The Australian Coal and Energy Survey (2012) highlights many aspects of mining and energy work that are subject to substantial change, including rapidly advancing hours and unpredictable shift patterns. This study reinforces evidence that variable shift patterns, and in particular night shift, are causing sleep disruption, which has significant health and safety implications. There also appear to be significant linkages between this variability and sleep disruption on one hand and physical health on the other.

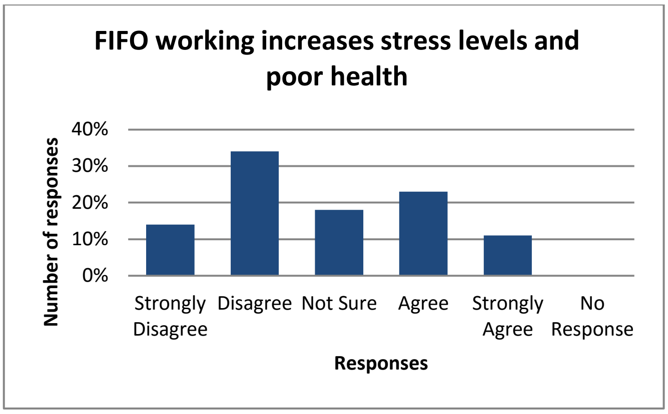


Figure 7.51 FIFO Working Increases Stress Levels and Poor Health

7.9.3 FIFO Operations are Contributing to Poor Quality Relationships and Leading to Increased Break-Ups and Divorce

In Figure 7.52 it can be observed that 44% of survey respondents agreed or strongly agreed that FIFO operations are contributing to poor quality relationships and leading to increased break-ups and divorce whilst 34% disagreed and 22% were not sure. This result substantiates the fact that FIFO operations are causing social problems which has been extensively discussed in Chapter 2.

In a submission to a Queensland Government Parliamentary Inquiry, the Australian Medical Association (AMA) said the initial influx of predominantly unskilled FIFO workers into regional Queensland during the mining boom had been a health disaster.

“These workers found themselves in a dynamic where they suddenly had buying power for which they had no experience,’’.

“(AMA) members (2015) reported widespread abuse of drugs and alcohol, obesity and a general increase in a number of other factors known to be detrimental to health’’ and offering jobs on a fly-in, fly-out basis leads to major psychological and social disruption for mine workers and their families.

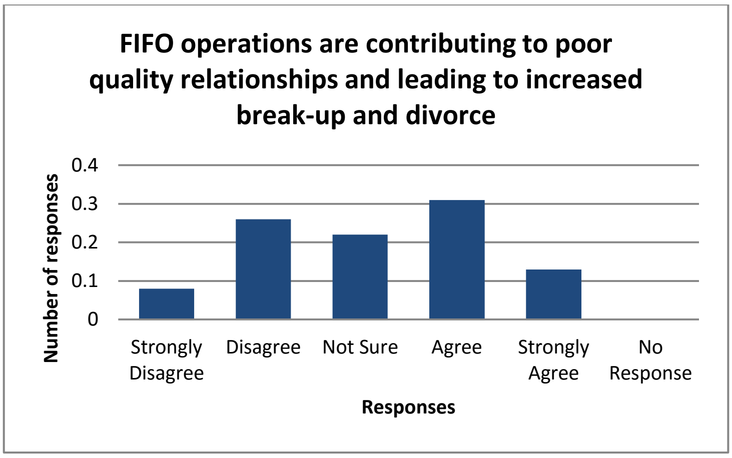


Figure 7.52 FIFO Operations are Contributing to Poor Quality Relationships and Leading to Increased Break-Ups and Divorce

7.9.4 FIFO Operations Causes Family Disruptions and Stress

In Figure 7.53 it can be observed that 45% of survey respondents agreed or strongly agreed that FIFO operations cause family disruptions and stress whilst 34% disagreed and 19% were not sure.

A recent parliamentary committee has been told that FIFO is destroying towns in Central Queensland and that marriage breakdowns and struggling businesses in a once-thriving community features heavily in submissions to the Government. Many of the submissions have been made by mineworkers and most say that FIFO arrangements are discriminatory as they prevent locals from gaining employment and " the FIFO workforce arrangements need to cease or it will destroy local businesses and townships" reported in the Australian (2015).

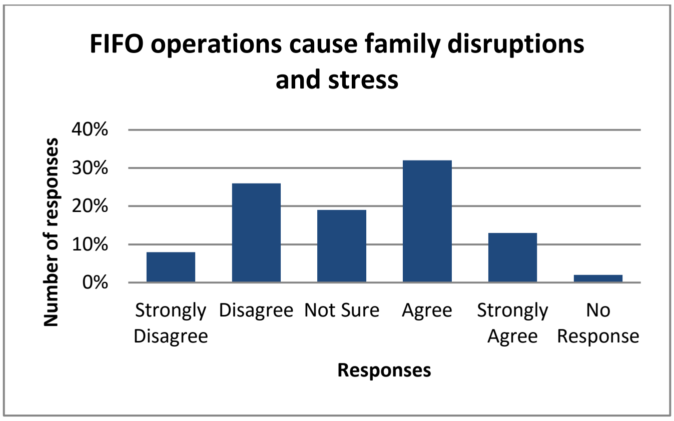


Figure 7.53 FIFO Operations Cause Family Disruptions and Stress

7.9.5 FIFO Workers have Reduced Social and Community Interaction and Feelings of Loneliness and Isolation

In Figure 7.54 it can be seen that 41% of survey respondents agreed or strongly agreed that FIFO workers have reduced social and community interaction and feelings of loneliness and isolation whilst 37% disagreed and 20% were not sure.

A comprehensive review of FIFO literature has been undertaken by Lenny (2010) and Watts (2004). The impact on FIFO employees and their families are as follows;

Amongst the adverse effects suggested in the literature are:

- Increased stress levels and poor health including depression, binge drinking, recreational drug use and obesity
- Poor quality relationships leading to increased break-ups and divorce
- Family disruption and stress
- Reduced social and community interaction by FIFO workers
- Reduced socialisation by partners and

- Feelings of loneliness and isolation.

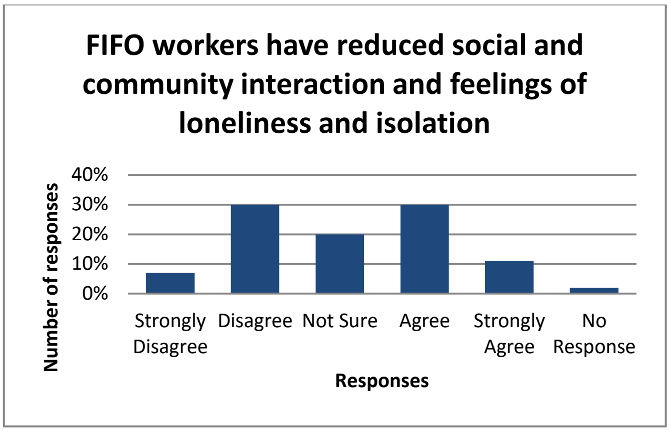


Figure 7.54 FIFO Workers have Reduced Social and Community Interaction and Feelings of Loneliness and Isolation

7.9.6 FIFO Operations Improves Financial Circumstances from high Wages and Lower Living Costs

In Figure 7.55 it can be seen that 53% of survey respondents agreed or strongly agreed that FIFO working improves financial circumstances from high wages and lower living costs whilst 21% disagreed and 24% were unsure.

The beneficial impacts noted in the academic mainstream literature are:

- Improved financial circumstances from high wages and lower living costs and living away from mining based towns thereby lowering financial stress
- The availability of cheap housing for FIFO workers at worksites
- The opportunity for workers to make lifestyle choices for themselves and their families or to pursue volunteer, recreational or leisure activities and
- A heightened sense of empowerment by FIFO employee partners.

  See Chapter 2.

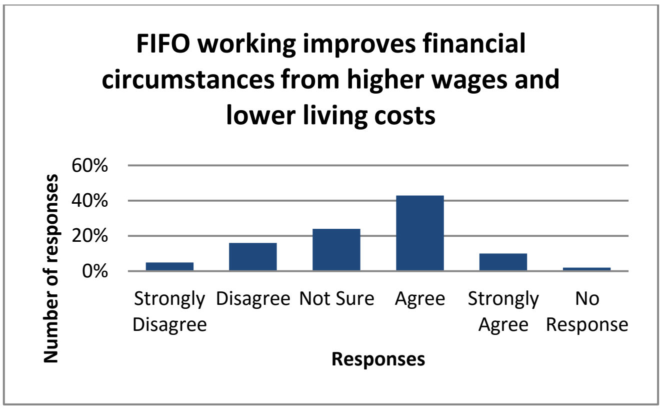


Figure 7.55 FIFO Working Improves Financial Circumstances from high Wages and Lower Living Costs

7.9.7 FIFO Operations Allow Workers to make Lifestyle Choices for Themselves and their Families

In Figure 7.56 it can be observed that 67% of survey respondents agreed or strongly agreed that FIFO operations allow workers to make lifestyle choices for themselves and their families whilst 11% disagreed and 20% were not sure.

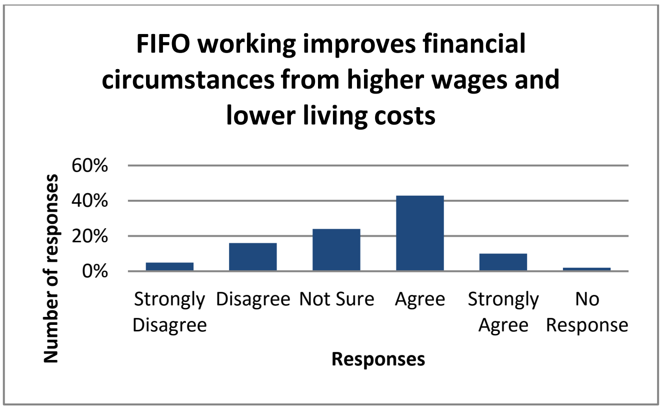


Figure 7.56 FIFO Operations Allow Workers to make Lifestyle Choices for Themselves and their Families

7.9.8 FIFO Operations allow Uninterrupted Blocks of time to Enable Workers to Spend Better Quality time with their Partners and Families

In Figure 7.57 It can be seen that 58% of survey respondents agreed or strongly agreed that FIFO operations allow uninterrupted blocks of time to enable workers to spend better quality time with their partners and families whilst 19% disagreed and 20% were not sure.

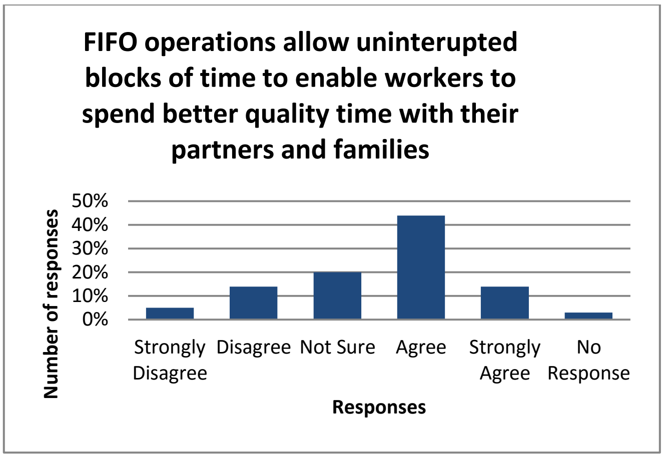


Figure 7.57 FIFO Operations allow Uninterrupted Blocks of time to Enable Workers to Spend Better Quality time with their Partners and Families

7.10 Discussion

The field survey of the participating coal mines that completed the manual survey of 993 respondents resulted in the collection of a significant amount of data which has been analysed. The responses indicate that of the 993 responses 58% were in open cut and 42% were in underground operations. The most important issues that have been raised are included in the following categories:

1. Experience and Competence
2. General Safety
3. Risk Assessment
4. Safety and Health Management Systems
5. Fatigue and Awareness
6. Prosecution and
7. Fly In Fly Out

7.10.1 Experience and Competence

- The survey results reflect some of the inherent problems in the mining industry today and that there is a lack of experienced personnel in the industry. It has been shown that 28% of the workforce has only 0-5 years in the industry and 33% have 5-10 years which reflects a relatively young workforce and consequently one with little experience. It is the Department of Natural Resources and Mines (DNRM) (2013) contention;
  "that safety standards are slowly eroding due to persons being appointed who do not adequately comprehend the task at hand. A process cannot be managed effectively without comprehending the process. This is being demonstrated, not only in the increasing number of concerning incidents, but also in the declining safety standards and reduced productivity being observed. People are being promoted to supervisor level and above who do not understand legislative requirements, hazard identification or the risk management process. The Queensland Mines Inspectorate, continually through investigations or audits, uncover a poor basic understanding of the processes these people are required to be managing or supervising.
- It has been shown that 59% of the workforce have worked at the mine for between 0-4 years. According to Gutzke (2015) who reported that inexperienced workers are a factor in mine death increase. Mine safety inspector Doug Barclay said an influx of inexperienced mine workers is partly to blame for the increase in workplace fatalities in the WA resources industry.
- Safety standards are slowly eroding due to persons being appointed who do not adequately comprehend the task at hand:
  According to DNRM (2013) the Queensland Mines Inspectorate has found and continues to find persons being appointed to positions who do not meet the competency standards required by the respective Acts, and further suggests that the standard of competency training and assessment provided by some registered training organisations is highly questionable.
- People are being promoted to supervisor level and above who do not understand legislative requirements, hazard identification or the risk management process

- The Queensland Mines Inspectorate, continually through investigations or audits, uncover a poor basic understanding of the processes these people are required to be managing or supervising
- The effective management of contractors continues to be a cause of concern of the Queensland Inspectorate with alarming incidents and near misses which continue to occur: According to the Queensland Mines Inspectorate "Consultation Regulatory Impact Statement 2013"
  "The effective management of contractors is a continuing cause of concern of the Queensland Inspectorate. Alarming incidents and near misses involving contractors continue to occur. Coronial findings have emphasised the importance of there being only one safety and health management system at a mine and this needs to be followed by all workers whether employees or contractors. Eight of the nine deaths in Queensland coalmines and ten of the twenty deaths in Queensland metalliferous mines and quarries have been contractors since the current mining safety and health legislation came into force in 2001.
- Some contractors and sub-contractors were not reporting all accidents and incidents due to safety targets being a condition of their contracts.

7.10.2 General Safety

- 12% of survey respondents were not able to support the fact that safety was improving on their mine site. According to Hoyle 2015 worker deaths are on the rise among the big miners. David Cliff, professor of occupational health and safety in mining at the University of Queensland stated that there is a danger mining companies' recent success might have bred some complacency. The pressure on mines to improve productivity and cut staff could *"lead to a reversal of the safety cultural improvement through the focus on doing what has to be done rather than what should be done".*

- 27% of the survey respondents disagreed or were not sure that accident and incident information was acted upon to make improvements
- 17% of survey respondents disagreed or were not sure that accident and incident information is communicated satisfactorily to permanent and temporary employees
- 27% of survey respondents disagreed or were not sure that human error violations are deviations from safe operating procedures which are frequently encountered which involve cutting corners to get the job done:
  Reason (1990) stated, when describing the variability paradox, that error is implicated in 70-80% of all accidents. Hopkins (1995) reported that 95% of accidents occur because of acts of people. They do something they are not supposed to do and are trained not to do, but do so anyway. Durham (2012) stated that "a hazard is defined as something with the potential to cause harm, and that potential only becomes actual harm after some form of human involvement. A large number of accidents are the result of human behaviour, essentially someone doing something wrong. Even worse, in many cases the individual knew it was wrong or was observed by others who knew it to be wrong".
- If 43% of survey respondents are not aware of unsafe acts, errors and procedural violations and deviations from safe operating procedures, this would indicate a lack of training and education regarding a safe workplace
- 20% of survey respondents did not agree or were not sure that they were encouraged by their employers to have their say on safety matters
- 33% of survey respondents disagreed that the main causes of accidents and incidents is a poor safety culture which is a poor reflection on industry since workforce culture plays an important part in accidents and incidents on mine sites. Reason (1997) contends that 'commitment, competence and cognisance' fuel the safety engine.
  "High levels of commitment are relatively rare and hard to sustain. This is why the organisation's safety culture is so important. Top management come and go. More organisational leaders are appointed to revive sagging commercial fortunes than to improve indifferent safety records. A good safety culture, on the other hand is something that endures beyond these palace revolutions and so provides the

necessary driving force irrespective of the inclinations of the latest CEO".

It is therefore a poor reflection on industry if nearly half the workforce does not understand that workforce culture plays a very important part in accidents and incidents on mine sites especially since according to the Research Solutions Survey (2011) 82% of Managers rated their industries performance to be a proactive, consultative safety culture.

7.10.3 Risk Assessments

- 86% of survey respondents agreed or strongly agreed that risk assessments are a useful part of safety management on their site.
- 32% of survey respondents either disagreed or were not sure that people who conduct risk assessments have sufficient training which supports the view of the CFMEU and safety practitioners. The CFMEU considers that "staff conducting risk assessments at site level, are not properly trained to perform the task, nor take into account the full nature of risks" (Wran 2005).
- The fact that nearly a fifth of survey respondents agreed that too many risk assessments are being conducted supports the unions view that says risk is not being assessed and managed adequately and that the necessary enforcement to ensure that it is, may be deficient and therefore wish to retain prescriptive legislation.
- A fifth of survey respondents felt disengaged from risk assessments. This fact is of deep concern for safety in the mining industry since risk management is now an integral part of the way the mining industry operates and is part of QLD and NSW legislation.
- Over half of the workforce which has been surveyed agrees that management influences affect the outcome of the risk assessment, which means that the risk assessment methodology may be manipulated in order to achieve a desired result. This situation goes against the principle that risk assessments should be conducted where all parties involved contribute in an unbiased manner in order to achieve a result which is truly representative of the parties involved with the risk assessment. This is also one of the reasons why unions have expressed negative views regarding

risk based legislation in favour of prescriptive legislation and also suggests that is one of the reasons for the reintroduction of statutory certification for some existing critical safety positions in Queensland mining legislation (DNRM 2013).

- 11% of survey respondents either agreed or were not sure that it was necessary to break the rules to get the job done.

7.10.4 Safety and Health Management Systems

- 28% of survey respondents disagreed or were not sure that adequate training is given for them to understand their obligations under the SHMS
- 17% of survey respondents agreed that the SHMS is too complex for them to understand. According to Forbes and Wilson (2005) a large percentage of the workforce is transient when compared to the workforce of several years ago when mines had long term employees who were relatively stable and experienced.
  This problem is further exacerbated when one considers the large numbers of contractors now employed in the industry. The main challenge for any safety management system is how do we communicate and implement the system for all to comprehend and comply with, especially those that move from site to site on a regular basis. This would suggest that people could be overlooked "therefore relying on their own understanding and experiences or judgement to get them through, with little or no knowledge of the mines requirements".
- 70% of survey respondents agreed that more time should be allowed for training in the SHMS and nearly a third disagreed that information concerning the SHMS is adequately communicated. This is another reason why the unions want more training.
- Over a fifth of survey respondents disagreed that safety inspections are done by persons in whom they have confidence to take action to make the workplace safe.

7.10.5 Fatigue and Awareness Issues

- If 22% of survey respondents agreed that fatigue is causing a problem regarding being able to operate safely this means that fatigue management needs to be addressed with some urgency if safety performance is going to improve. According to Muller (2008) from the School of Public Health and Tropical Medicine at James Cook University, miners working more than eight consecutive 12 hour day shifts were fatigued beyond the impairment expected from a blood alcohol concentration of 0.05%. According to David Logan (2013) fatigue is a serious issue in mining, particularly once mine workers get into a car to drive often long distances home after working long hours. Central Queensland Coroner Annette Hennessy recently made 24 recommendations for the industry following her investigation into the two separate fatal road accidents, one in Yeppoon in 2005 and the other in Dysart in 2007. She stated that driver fatigue was a potential factor in both incidents where coal miners were driving home following work.
- If nearly half the workforce believes that their concentration is reduced when working 12 hour night shift rosters it poses the question "How can workers operate machinery safely with reduced concentration especially on night shift". Of the 32 incidents analysed in Queensland, NSW and Western Australia mines (Chapter 4) it was found that the causes of these incidents were found to be that 78% are related to collisions and 22% to rollovers and all related incidents are attributable to fatigue and lack of safe work procedures. This would suggest that concentration is reduced when working 12 hour night shifts, which is a concern for safety improvement.
- If a fifth of survey respondents agreed that in working 12 hour shift rosters their decision making is impaired, and that travel times to work cause fatigue and awareness issues, again this poses the question "How can workers operate machinery safely with reduced concentration, fatigue and awareness issues especially on night shift".

7.10.6 Prosecution Policies

- Practically one fifth of survey respondents agreed that there are practices that limit the quality of accident information at their site
- 45% of survey respondents disagreed that company legal people should be involved in site accident investigations which supports the discussion in the thesis that company legal people should not be involved because of the issues of legal privilege which inhibit the sharing of accident information and the lessons learned. The lessons from accidents and incidents are not being learned because the companies fear being prosecuted which has created distrust between the parties. The mining companies are being encouraged to seek client "legal privilege" in order to protect the company and its directors because the findings could be used against the companies in future prosecutions.

  In the event of a serious incident or accident mining companies are advised by the legal profession to be very careful about generating reports about the incident or accident. Employees are encouraged not to write written reports in relation to the incidents and accidents without prior approval of the manager, because they may be damaging the company's legal position and the legal position of its employees, managers and directors. Very often, the first person on the site of an accident or incident these days is the company lawyer who then effectively takes charge of the investigation.

  "Documents produced for the purpose of obtaining legal advice or in the anticipation of possible prosecution may be subject to client legal privilege. This means there is a basis to say those documents do not need to be produced to the inspector or to a court or to a tribunal" (Humphreys, 2001). This problem is one of the main reasons for completing this research since "How is it possible to investigate a fatality or serious injury if the information is not readily available".

  Near miss reporting, audits and high potential incidents are also subject to prosecutions which means that vital information is withheld and as a consequence not available in order to prevent a recurrence of the accident or incident. More importantly it moves away from the no blame culture which is the most important part of any safety improvement programme and instead promotes a defensive culture

- 66% of survey respondents agreed that accident investigation would best be *conducted by mine management and the site safety and health representative* and not legal people
- Over a fifth of survey respondents agreed that the root causes of accidents and incidents are not being examined for the fear of prosecution
- 54% of survey respondents agreed that prosecution policies should only be used as a last resort when wilful and reckless disregard for safety is the case. The industry needs to take note of this result which indicates that the current prosecution policies need to be changed such as to allow all accident and incident information to flow freely and be able to share the lessons learned which will have huge benefits for safety improvement in the industry and supports the authors hypothesis. Regarding the need for prosecutions it would make eminent good sense to adopt the "Robens Report" recommendations which essentially state,

  "*We recommend that criminal proceedings should, as a matter of policy, be instituted only for infringement of a type where the imposition of exemplary punishment would be generally expected and supported by the public. We mean by this, offences of flagrant, wilful or reckless nature which either have or could have resulted in serious injury"*

- 55% of survey respondents agreed that an official inquiry would produce better outcomes if there was no fear of prosecution.

  An analysis was conducted in Chapter 5 on the time taken to conduct investigations at the Wardens Court 0.6years, NSW prosecutions 4.7 years and the Queensland Coronors Court 3 years which found that the Wardens Court is not only more efficient in its process, but because there is no fear of prosecutions, it is able to find out what happened, why it happened and what needs to be done to prevent a recurrence without the fear of the legal process and legal privilege. The Warden's Court outcomes allow free flow of information where lessons can be learned and trust between all parties can be restored, instead of information being locked up which is unavailable to prevent a recurrence.

7.10.7 Fly In Fly Out (FIFO)

- Over a third of survey respondents agreed that FIFO working increases stress levels and poor health and 44% agreed that FIFO operations are contributing to poor quality relationships which lead to increased break-ups and divorce.
  According to Cleary (2011) FIFO workers maximise mine efficiency, at a cost to the community. They live in Dongas which are defined as "makeshift shelters" (or a portable aluminium sheds) which are used to house thousands of miners who live in sprawling work camps near mines.

- 41% of survey respondents agreed that FIFO workers have reduced social and community interaction and feelings of loneliness and isolation. Dr David Mountain stated that we know that FIFO work has major effects on health of workers themselves and also on the communities that host those workers "There are major issues related to their mental health and wellbeing, it's quite a stressful way of working and it's quite disruptive socially and hard for them to stay in touch with wife, family and friends" McHugh (2012).
  According to Petkova et al (2009) "Communities with higher proportions of itinerant workers such as fly-in fly-out or drive-drive-out workers may have a greater risk of mental illness. In these instances, population turnover has occurred as families leave communities because of lack of non-mining employment opportunities and also where there has been a rapid increase in population (often with a greater ratio of males to females) requiring housing for singles". According to Gutzke (2015) Fly in fly out workers are suffering from depression at more than twice the rate of the general Australian population, according to research conducted from Edith Cowan University. On 27 March 2015 the Queensland Government commissioned a parliamentary inquiry into FIFO and other long distance commuting work practices in regional Queensland, including mental health impacts.

  In March 2016 The Minister for State Development and Minister for Natural Resources and Mines Dr Anthony Lynham stated that the government would legislate for the discontinuation of 100 per cent FIFO operations in new mines where nearby regional towns has a capable workforce. The legislation would also see existing 100 per cent FIFO operations consider locals for employment. He went on to say that if people want to live in regional communities they should have the opportunity to apply for jobs at nearby resource projects and that the government's plans would deliver strong and sustainable resource communities for Queenslanders.

It may be observed from Figure 7.58 that the fatalities in the minerals sector have ranged from 7 fatalities in 2001-02 to 16 fatalities in 2013-14 which is a 44% increase. This information was sourced from the Mineral Industry Safety Performance Reports 2014.

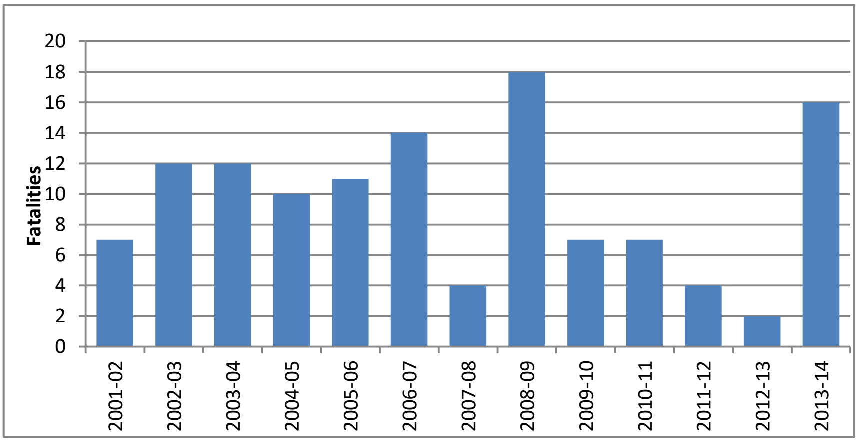


Figure 7.58 Fatalities in the Minerals Industry from 2001-02 to 2013-14

According to the ABC 7.30 Report on the 19th August 2014 there have been 9 deaths in the last year due to suicides in the minerals industry from FIFO Western Australian operations. The WA government is so concerned that they are considering a parliamentary inquiry (Uhlmann 2014). In addition, Fiona White - Hartig who is a Councillor of the City of Karratha stated that there are two to three divorces per week in the Pilbara and these are usually domiciled in Queensland.

If the 9 fatalities are added to the 16 which occurred in the Mineral Industry in 2014 which makes a total of 25 which is illustrated in Figure 7.59 it may be observed that fatalities in the minerals industry now range from 7 in 2001-02 to 25 in 2013-14 which is a 280% increase. Over the period from 2001-02 to 2013-14 the trend line for fatalities in the minerals industry is increasing. If safety is to improve in the mining industry this message needs to be addressed with some urgency.

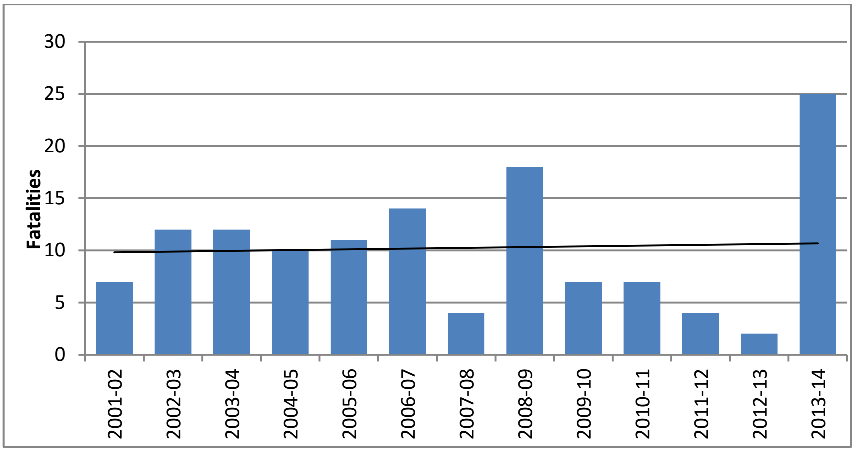


Figure 7.59 Fatalities in the Minerals Industry from 2001-02 to 2013-14

The above mentioned research has tested the authors hypothesis that safety performance in the Australian Mining Industry has not improved despite all the rhetoric in the industry and may even be deteriorating and that in order to improve safety performance the mining industry needs to change the culture and take due cognisance of the results of this survey. The industry needs to ensure with some urgency that legal privilege does not prevent the sharing of safety information and heeding the lessons learned from accidents and incidents on mine sites.

The Queensland government has recently confirmed six cases of Black Lung Disease and is on notice that two more are imminent, which are the first cases of black lung disease recorded in decades. This has resulted in a Senate Inquiry being established in March 2016 to investigate the matter. The Minister involved also stated that there had been inadequacies in coal mine regulation and monitoring and that eight out of ten underground coal mines over the past 12 months had breached the legal coal dust limits. This is a very concerning situation and strongly supports the hypothesis that safety performance is not improving in the mining industry.

The following Chapter 8 will make a comparison between the manual and electronic surveys with the Wilcoxson signed rank test using the Statistical Package for Social Sciences (SPSS).

CHAPTER 8

8. A STATISTICAL COMPARISON BETWEEN THE MANUAL AND ELECTRONIC SURVEYS

8.1 Introduction

The main objective of the of the surveys was to ascertain the views on a range of safety issues from a cross section of mineworkers both working underground and open cut, with the emphasis being on operators which would ensure a representative sample of the workforce. However, in the case of the electronic survey the only people that could complete the survey needed access to a computer, which resulted in only supervisors and senior operators being able to complete the electronic survey. With this fact in mind, it was necessary to conduct a statistical comparison of the two surveys to find out if there was statistically any difference between the two surveys.

The questions were categorised into six main groups consisting of general safety, risk assessment, safety and health management systems, fatigue and awareness issues, prosecution policies, and fly in fly out questions. A total of 37 coal mines were invited to participate in the survey. The questionnaire was completed initially by approximately 1200 respondents manually and electronically.

In order to make a statistical comparison between the Manual and Electronic surveys it has been necessary to conduct The Wilcoxon Signed Rank Test using the Statistical Package for Social Sciences (SPSS).

Nonparametric methods require only a few assumptions to be made about the format of the data, and they may therefore be preferable when the assumptions required for parametric methods are not valid. The Wilcoxon signed rank test applies to matched pairs studies. For two tail test, it tests the null hypothesis that there is no systematic difference within pairs against alternatives that assert a systematic difference.

Many parametric statistical methods require assumptions to be made about the format of the data to be analysed. One of the underlying assumptions of parametric tests used in hypothesis testing is that the populations from which the data are sampled are normal in shape (Conover and Iman 1981).

8.2. Analysis of the 50 questions using the Wilcoxon Signed Rank Test

The Wilcoxon Signed Rank Test was conducted for 50 questions on the following subjects; The Confidence Type was determined using the Related Samples – Hodges-Lehman Median Difference.

- Eight Questions on General Safety
- Eight Questions on Risk Assessments
- Ten Questions on Safety and Health Management Systems
- Eight Questions on Fatigue and Awareness Issues
- Nine Questions on Prosecution Policies and
- Seven Questions on Fly In Fly Out Bus In Bus Out

All these questions are detailed in Table 8.1

Table 8.1 : Survey Questions

Categories	Questions
General Safety	Is safety performance improving on your mine site?
	Are all accidents and incidents investigated and reported at your mine site?
	Is accident and incident information acted upon to make improvements?
	Accident and incident information is communicated satisfactorily to permanent and temporary employees.
	Human error is a major factor in causing accidents and incidents.
	Accidents and incidents can be eliminated.
	I am encouraged by my employers to have my say on safety matters.
	The main causes of accidents and incidents is a poor safety culture.

Risk Assessments	Risk assessments are a useful part of safety management at my site.
	People who conduct risk assessments have sufficient training.
	Too many risk assessments are conducted in my workplace.
	I get benefit from risk assessments concerned with my workplace.
	I am involved in risk assessments concerned with my workplace.
	Management influences affect the outcome of my risk assessments.
	There should be less risk management and more prescriptive regulations.
	Is it necessary to break the rules and regulations to get the job done?
Safety & Health Management Systems (SHMS)	A lack of experienced people is causing safety issues at my workplace.
	My training is adequate to carry out my role safely.
	I understand my obligations under the Safety and Health Management System (SHMS).
	Adequate training is given for me to understand my obligations under the SHMS.
	The SHMS is too complex for me to understand.
	More time should be allowed for training in the SHMS.
	My knowledge of the SHMS is updated on a regular basis.
	Information concerning the SHMS is adequately communicated.
	The SHMS drives improved safety performance.
	Safety inspections are done by persons in whom I have confidence will take strong action to make the workplace safe.
Fatigue & Awareness Issues	Fatigue is causing a problem regarding me being able to operate safely
	My current roster allows sufficient quality time with family and friends to support a sustainable work life balance.
	My concentration is reduced when working 12 hour night shift rosters.
	My current roster results in poor judgement of my own performance.

	Working my current shift roster affects my ability to assess problems and determine solutions.
	When working 12 hour shift rosters my decision making is impaired.
	When working my current roster my awareness and communication skills are impaired.
	Travel times to work cause me fatigue and awareness issues.
Prosecution Policies	There are practices that limit the quality of accident investigation at my site.
	Information regarding an accident is free flowing on my site.
	I believe that company legal people should be involved in site accident investigations.
	Accident investigation would be best conducted by independent experts who are not legal people.
	I am concerned about the current inspectorate prosecution policies that are in place.
	Legal people's involvement affects the open provision of facts concerning an accident or incident.
	Prosecution policies should be used as a last resort when wilful and reckless disregard for safety is the case.
	The root causes of accidents and incidents are not being examined for fear of the company being prosecuted.
	An official inquiry would produce better outcomes if there was no fear of prosecution.
FLY IN FLY OUT (FIFO) Includes drive in drive out and bus in bus out.	FIFO working increases stress levels and poor health.
	FIFO operations are contributing to poor quality relationships and leading to increased break-ups and divorce.
	FIFO operations cause family disruptions and stress.
	FIFO workers have reduced social and community interaction and feelings of loneliness and isolation.

	FIFO working improves financial circumstances from high wages and lower living costs.
	FIFO operations allow workers to make lifestyle choices for themselves and their families.
	FIFO operations allow uninterrupted blocks of time to enable workers to spend better quality time with their partners and families.

8.2.2 Results

The results of the first question: Is safety improving on your mine site is shown below;

Sheet 1, Question 1: Is safety performance improving on your mine site?

The confidence summary was determined using the related-sample Hodges-Lehman Median Difference, which is the median difference between the Manual and Electronic surveys - 0.967 (95% Confidence level). In the hypothesis test summary using the Wilcoxon Signed Rank Test the Asypotic Significance deviation was determined to be 0.753 which resulted in a null hypothesis.

The continuous field information for the manual survey resulted in a standard deviation of 23.78 and for the electronic survey the standard deviation resulted in a standard deviation of 23.32 Figure 8.1.

A null hypothesis is a statistical hypothesis that the observation is due to a change factor.

Null hypothesis is denoted by HO: $\mu 1 = \mu 2$ which shows that there is no difference between the two population means.

Every test in Hypothesis testing produces the significance value for that particular test. In Hypothesis testing , if the significance value of the test is greater than the predetermined significance level, then we accept the null hypothesis. If the significance value is less than the predetermined value, then we should reject the null hypothesis.

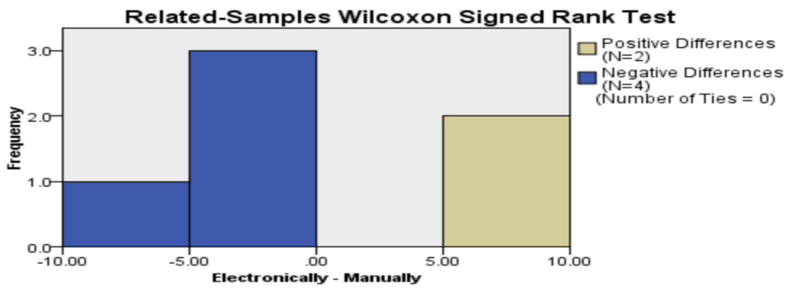
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.967	-5.445	6.575

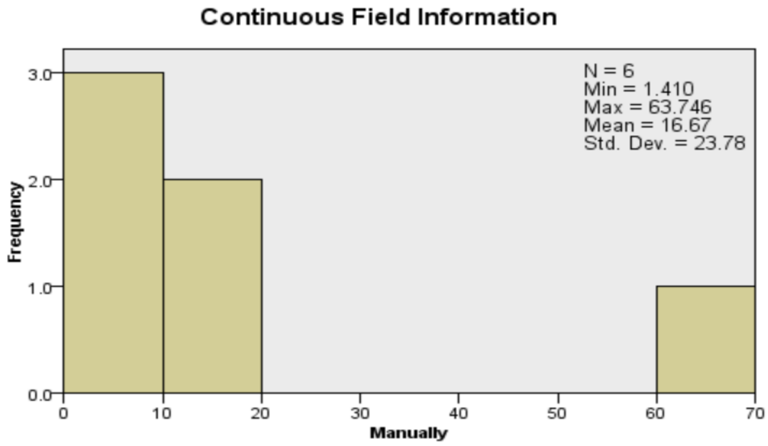
Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.753	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	9.000
Standard Error	4.770
Standardized Test Statistic	-.314
Asymptotic Sig. (2-sided test)	.753



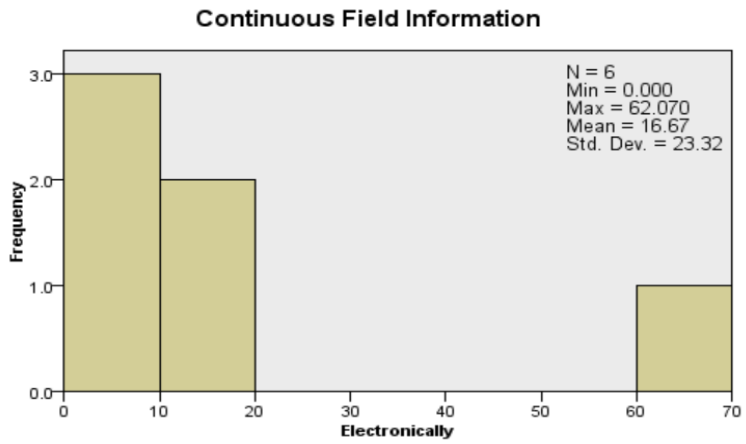


Figure 8.1 Confidence Interval Summary and Related Samples of the Wilcoxon Signed Rank Test

Due to the fact that the results of the remaining 49 questions needs 49 additional pages it was necessary to put all this information in Appendix 3.

The results of the 50 questions when using The Wilcoxon Signed Rank Test, which is the Statistical Package for Social Sciences (SPSS) are as follows:

8.2.3 General Safety

General Safety questions are shown in Table 1. The confidence interval for all questions has been calculated by SPSS software based on the Wilcoxon-signed-rank test. The results for 95% confidence interval are tabulated in Table 8.2. The estimation and calculation have been completed based on median of difference between manually and electronically conducted surveys by the Related-Samples Hodges-Lehman model.

Table 8.2: Confidence Interval Summary for General Safety Questions

Question	Estimate	95% Confidence Interval	
		Lower	Upper
1	-0.967	-5.445	6.575
2	-0.651	-6.285	7.416
3	-0.248	-6.167	6.941
4	-0.306	-3.616	3.922
5	-0.376	-6.553	6.929
6	-0.392	-5.973	6.365
7	0.212	-8.255	7.920
8	-0.146	-3.661	4.102
Confidence Interval Type: Related-Samples Hodges-Lehman Median Difference **Parameter:** Median of the difference between Manually and Electronically			

The results of the Wilcoxon test for the general safety questions have been illustrated in Table 8.3. Maximum positive difference between manual and electronic surveys for this group of questions is 3 and this value for negative difference is 4. The test statistics for questions are variable between 8 and 11 and standard error for all questions is the same; equal to 4.77. Negative value of standardized test statistic was calculated for all questions excluding question 7.

Table 8.3 : Related - Samples Wilcoxon-Signed-Rank Test for General Safety Questions

Question*	Positive Differences	Negative Differences	Test Statistic	Standardized Test Statistic	Asymptotic Sig. (2-sided test)
	2	4	9.000	-0.314	0.753
2	2	4	8.000	-0.524	0.600
3	2	4	10.000	-0.105	0.917
4	3	3	10.000	-0.105	0.917
5	3	3	10.000	-0.105	0.917
6	3	3	9.000	-0.314	0.753
7	3	3	11.000	0.105	0.917
8	3	3	10.000	-0.105	0.917

* All questions are presented in Table 8.1.

The results of Wilcoxon-signed-rank test to compare manual and electronic surveys for all 8 questions in the group of General Safety have been illustrated in Figure 8.2

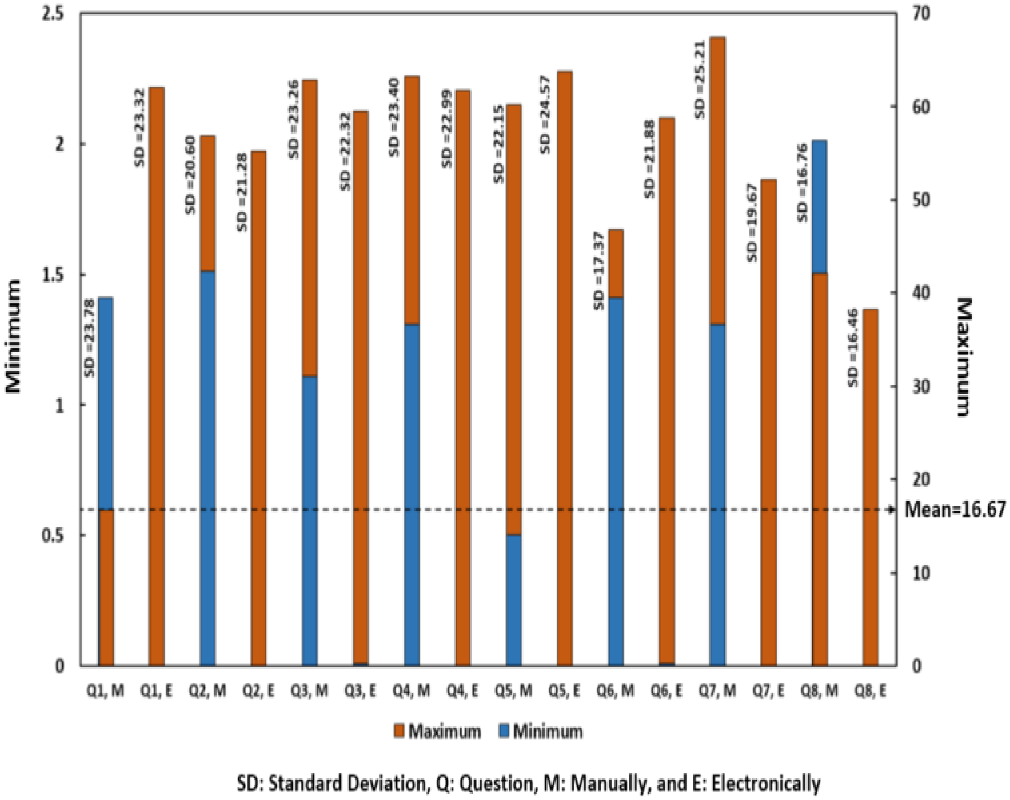


Figure 8.2 : Results of Wilcoxon-signed-rank test to compare manually and electronically conducted surveys for general safety questions

Figure 8.2 shows all collected data for both manually and electronically conducted surveys which do not have a clear distribution. All collected data have a significant variation for each question. This variation has been illustrated by Standard Deviation (SD) for all questions individually in Figure 8.2. The maximum SD has been calculated for the manually collected data for question 7. The value brings 25.21. The completed Wilcoxon model shows that the mean of all questions is 16.67 and this value is the same for all questions in the area of General Safety.

Figure 8.3 illustrates a summary of the hypothesis test completed by the Wilcoxon-signed-rank model for General Safety questions.

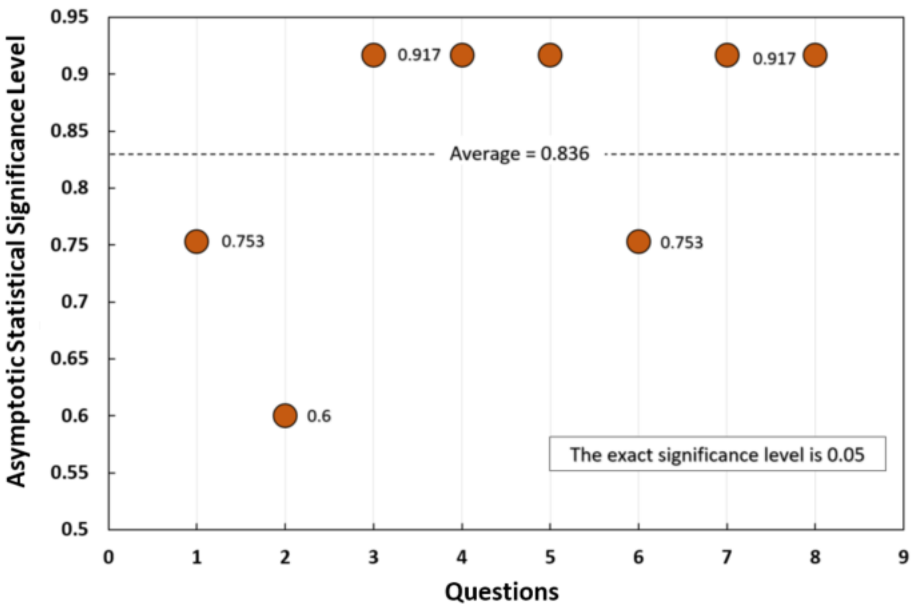


Figure 8.3 : Hypothesis Test Summary (General Safety)

The asymptotic statistical significance level for all questions in the field of General Safety has been shown in Figure 8.3. The average level has been calculated and the exact significance level is 0.05. The median of the differences between the manually and electronically conducted surveys is 0. It means that the decision will be retaining the null hypothesis for this group of questions.

8.2.4 Risk Assessment

The risk assessment questions are shown in (Table 8.1). Table 8.4 presents the confidence interval for all the related questions which have been calculated according to the developed Wilcoxon model. All calculations in this field have been completed based on the median of the difference between two presented surveys; manual and electronic.

Table 8.4 : Confidence Interval Summary for Risk Assessments Questions

Question	Estimate	95% Confidence Interval	
		Lower	Upper
1	-0.008	-2.892	3.148
2	-0.106	-3.828	4.577
3	0.444	-6.393	5.348
4	-0.246	-2.086	2.331
5	-0.435	-3.635	4.070
6	0.201	-4.458	4.257
7	-1.511	-6.365	8.649
8	-0.261	-4.981	5.764
Confidence Interval Type: Related-Samples Hodges-Lehman Median Difference **Parameter:** Median of the difference between Manually and Electronically			

The maximum upper difference with a 95% confidence interval has been calculated for question 7. And the minimum lower difference for this confidence interval has been estimated for question 3.

The results of the completed Wilcoxon model for the risk assessment questions have been illustrated in Table 8.5. This table shows that the maximum positive difference between manually and electronically conducted surveys for this group of questions is 4 and this value for negative difference is the same. The test statistics for questions are variable between 8 and 13 and the standard error for all questions is the same; equal to 4.77. The negative value of standardized test statistic was calculated for all questions and the results illustrate that the value of this estimated value is variable for all the questions.

Table 8.5 : Related - Samples Wilcoxon-Signed-Rank Test for Risk Assessments Questions

Question*	Positive Differences	Negative Differences	Test Statistic	Standardized Test Statistic	Asymptotic Sig. (2-sided test)
1	3	3	10.000	-0.105	0.917
2	3	3	10.000	-0.105	0.917
3	4	2	13.000	0.524	0.600
4	2	4	8.000	-0.524	0.600
5	3	3	10.000	-0.105	0.917
6	3	3	11.000	0.105	0.917
7	2	4	10.000	-0.105	0.917
8	2	4	9.000	-0.314	0.753

* All questions are presented in Table 8.1.

The results of Wilcoxon-signed-rank test to compare manually and electronically conducted surveys for all 8 questions in the field of risk assessment has been illustrated in Figure 8.4.

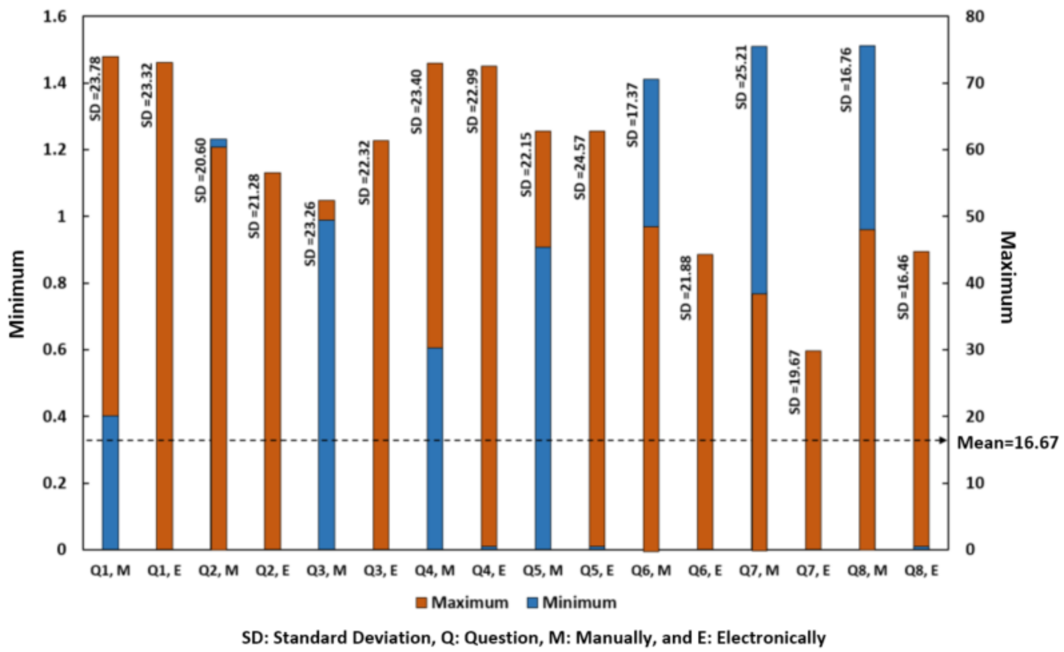


Figure 8.4 : Results of Wilcoxon-signed-rank test to compare manually and electronically conducted surveys for risk assessments questions

Figure 8.4 shows that there is not a clear distribution for all the collected data. This data has a significant variation for each question. The SD is variable between 16.46 and 25.21 in all groups of manually and electronically collected data for the questions in the field of risk assessment. The completed Wilcoxon model shows that the mean of all the questions is 16.67 and this value is the same for all questions in this area.

Figure 8.5 illustrates a summary of the hypothesis test completed by Wilcoxon-signed-rank model for all risk assessment questions.

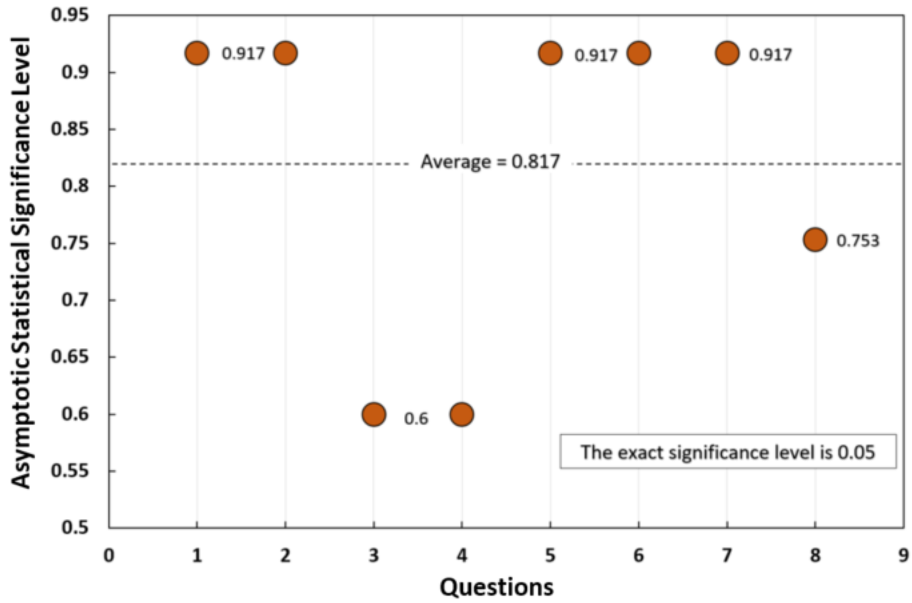


Figure 8.5 : Hypothesis Test Summary (Risk Assessment)

The asymptotic statistical significance level for all questions in the field of risk assessment has been shown in Figure 8.5. The average level has been calculated and the exact significance level is 0.05. The median of the differences between the manually and electronically conducted surveys is 0. This means that the decision will be retaining the null hypothesis for this group of questions.

8.2.5 Safety and Health Management Systems (SHMS)

The SHMS questions are shown in (Table 8.1). All the calculations and estimations for the 95% confidence interval have been completed based on the median of difference between the manually and electronically conducted surveys by the Related-Samples Hodges-Lehman model (Table 8.6).

Table 8.6 : Confidence Interval Summary for Safety & Health Management Systems (SHMS) Questions

Question	Estimate	95% Confidence Interval	
		Lower	Upper
1	-0.074	-4.834	4.907
2	-0.318	-5.886	6.526
3	0.027	-8.283	8.256
4	-0.465	-7.625	8.090
5	0.521	-6.584	6.063
6	0.225	-3.652	3.292
7	1.604	-6.977	5.212
8	0.062	-7.228	6.478
9	-0.206	-2.052	2.258
10	0.913	-7.241	5.857
Confidence Interval Type: Related-Samples Hodges-Lehman Median Difference **Parameter:** Median of the difference between Manually and Electronically			

The maximum upper difference is 8.256 calculated for question 3 based on the 95% confidence interval. The minimum lower difference is -8.283 (Table 8.6).

The results of the completed Wilcoxon-signed-rank model for the safety and health management systems have been illustrated in Table 8.6. This table illustrates that the maximum positive difference between the manually and electronically conducted surveys for this group of questions is 4 and this value for the negative difference is the same. The test statistics for questions are variable between 9 and 12 and standard error for all questions is the same; equal to 4.77. The negative value of standardized test statistic was calculated for all questions and the results illustrate that in Table 8.6 the value of this estimated value is variable for the questions. The value of this parameter can be positive or negative. The value of asymptotic significance for two sided tests is positive and variable with an average equal to 0.835.

Table 8.7 : Related - Samples Wilcoxon-Signed-Rank Test for Safety & Health Management Systems (SHMS) Questions

Question*	Positive Differences	Negative Differences	Test Statistic	Standardized Test Statistic	Asymptotic Sig. (2-sided test)
1	3	3	10.000	-0.105	0.917
2	2	4	9.000	-0.314	0.753
3	3	3	11.000	0.105	0.917
4	3	3	10.000	-0.105	0.917
5	3	3	12.000	0.314	0.753
6	4	2	11.000	0.105	0.917
7	4	2	12.000	0.314	0.753
8	4	2	11.000	0.105	0.917
9	3	3	9.000	-0.314	0.753
10	4	2	12.000	0.314	0.753

* All questions are presented in Table 8.1.

The results of Wilcoxon-signed-rank test to compare manually and electronically conducted surveys for all 10 questions in the field of safety and health management systems have been presented in Figure 8.6.

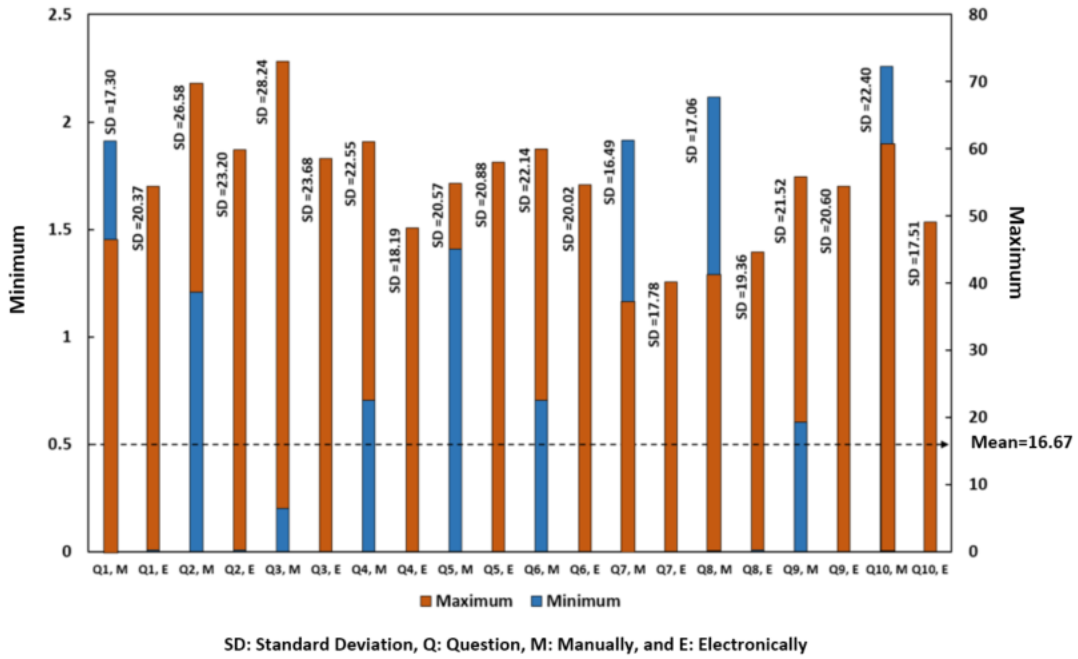


Figure 8.6 : Results of Wilcoxon-signed-rank test to compare manually and electronically conducted surveys for Safety & Health Management Systems (SHMS) questions

Figure 8.6 shows no clear distribution with significance variance for all questions. The standard deviations have different values between 17.06 and 28.24 in all groups of collected data from manually and electronically conducted surveys. The completed Wilcoxon model shows that the mean of all questions is 16.67 and this value is the same for all questions in this field.

Figure 8.7 illustrates a summary of the hypothesis test completed by Wilcoxon-signed-rank model for safety and health management systems questions.

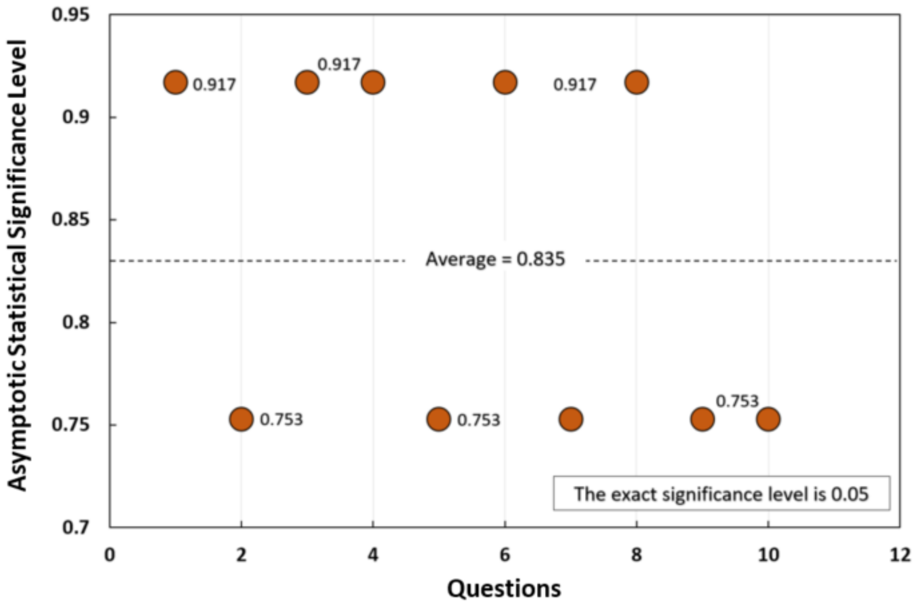


Figure 8.7 : Hypothesis Test Summary (Safety & Health Management Systems)

The asymptotic statistical significances level for all questions in the field of safety and health management systems has been shown in Figure 8.7. The average level has been calculated and the exact significance level is 0.05. The median of the differences between the manually and electronically conducted surveys is 0. This means that the decision will be retaining the null hypothesis for this group of questions.

8.2.6 Fatigue and Awareness Issues

Fatigue and Awareness issue questions are shown in Table 8.1. A summary of the confidence interval for all the questions has been tabulated in Table 8.8 individually. The results have been calculated based on the median of difference between the manually and electronically conducted surveys calculated by the Wilcoxon model.

Table 8.8 : Confidence Interval Summary for Fatigue & Awareness Issues Questions

Question	Estimate	95% Confidence Interval	
		Lower	Upper
1	0.109	-2.273	1.892
2	1.362	-8.372	6.532
3	-2.228	-8.926	11.702
4	-0.083	-3.854	4.898
5	-0.447	-5.205	6.699
6	0.075	-4.295	3.721
7	0.067	-2.767	2.700
8	-0.362	-4.578	5.102

Confidence Interval Type:
Related-Samples Hodges-Lehman Median Difference
Parameter:
Median of the difference between Manually and Electronically

The upper difference for 95% confidence interval is variable between 1.892 and 11.702 and the lower one has been changed from -8.926 to -2.273 (Table 8.8).

The results of the developed Wilcoxon model for the fatigue and awareness issues have been tabulated in Table 8.9. This table illustrates that the maximum positive and negative difference between manually and electronically conducted surveys for this group of questions is 4. The test statistics for the questions are variable between 9 and 13 and the standard error for all questions is the same; equal to 4.77. The negative value of the standardised test statistic was calculated for all questions and the results illustrate that the value of this estimated value is variable for the questions. The value of this parameter can be positive or negative. The value of the asymptotic significance for two sided tests is positive and variable between 0.6 and 0.917.

Table 8.9 : Related - Samples Wilcoxon-Signed-Rank Test for Fatigue & Awareness Issues Questions

Question*	Positive Differences	Negative Differences	Test Statistic	Standardized Test Statistic	Asymptotic Sig. (2-sided test)
1	4	2	11.000	0.105	0.917
2	4	2	13.000	0.524	0.600
3	2	4	8.000	-0.524	0.600
4	2	4	10.000	-0.105	0.917
5	2	4	10.000	-0.105	0.917
6	3	3	11.000	0.105	0.917
7	3	3	11.000	0.105	0.917
8	3	3	9.000	-0.314	0.753

* All questions are presented in Table 8.1.

Figure 8.8 presents the results of the Wilcoxon-signed-rank test to compare manually and electronically conducted surveys for all 8 questions in the field of fatigue and awareness issues.

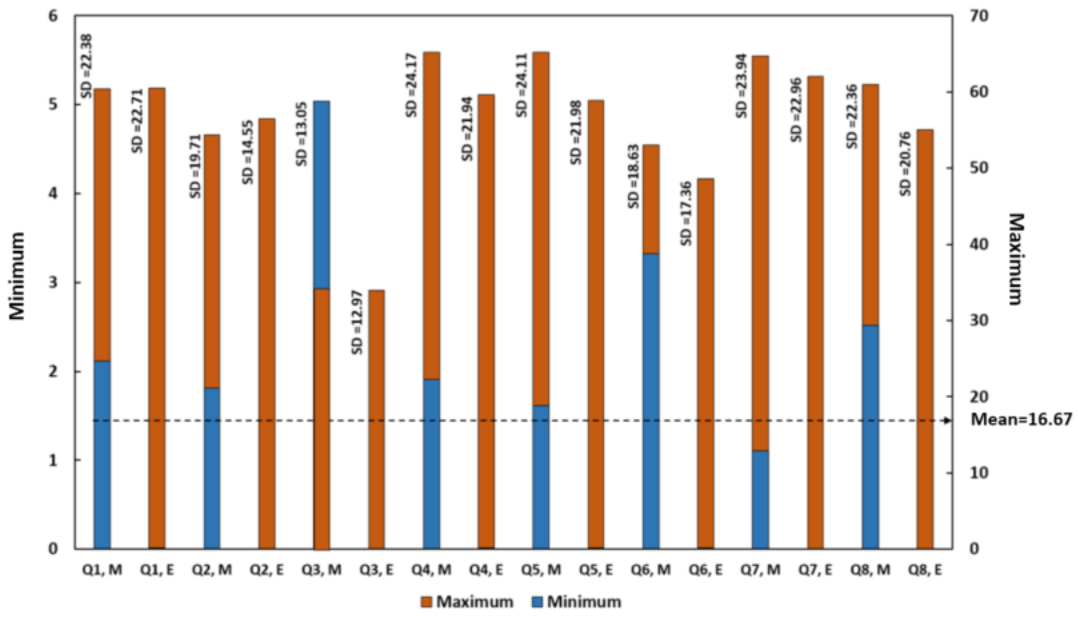


Figure 8.8: Results of Wilcoxon-signed-rank test to compare manually and electronically conducted surveys for fatigue & awareness issues questions

The distribution of the collected data is unclear and there is a significance variation. The calculated mean of data based on the developed model is completely the same for both of the surveys and it equals 16.67. The standard deviation has different values ranging 12.97 to 24.17 in all groups of collected data from the two surveys.

Figure 8.9. illustrates a summary of the hypothesis test completed by Wilcoxon-signed-rank model for fatigue and awareness issue questions.

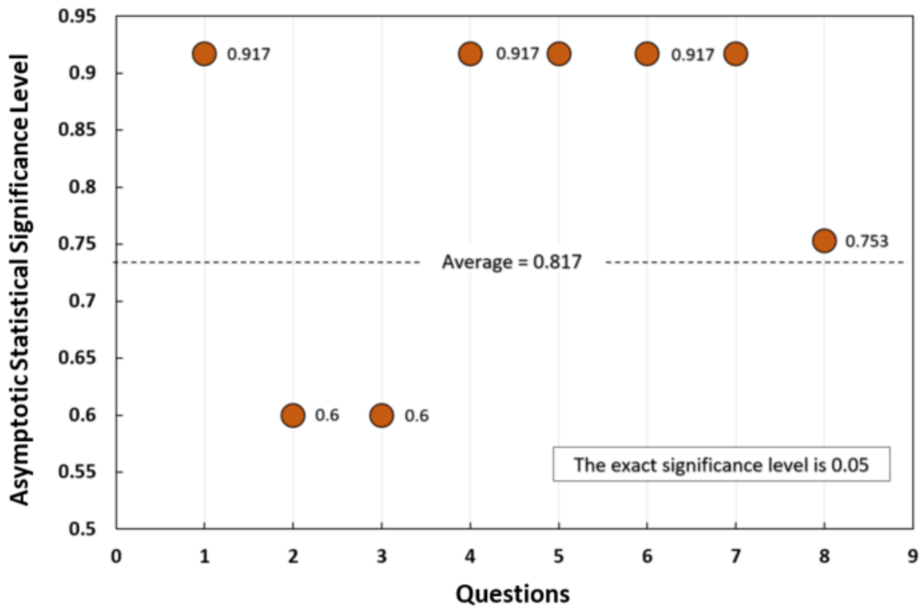


Figure 8.9 : Hypothesis Test Summary (fatigue & awareness issues)

The asymptotic statistical significances level for all questions in the field of fatigue and awareness issues has been shown in Figure 8.9. The average level has been calculated and the exact significance level is 0.05. The median of differences between manually and electronically conducted surveys is 0. This means that the decision will be retaining the null hypothesis for this group of questions.

8.2.7 Prosecution Policies

Prosecution policies are one of the main challenges in this study and the questions are shown in Table 8.1. Table 8.10 illustrates the results of using the developed Wilcoxon model to calculate the lower and upper difference between the two surveys when the confidence interval is 95%. All calculations have been completed based on the median analysis by the Related-Samples Hodges-Lehman model.

Table 8.10 : Confidence Interval Summary for Prosecution Policies Questions

Question	Estimate	95% Confidence Interval	
		Lower	Upper
1	0.019	-9.190	9.171
2	-0.849	-4.919	6.678
3	-0.723	-11.195	12.643
4	-3.286	-8.616	11.902
5	-0.916	-8.815	9.731
6	0.432	-6.594	8.215
7	1.029	-9.369	8.318
8	-0.628	-6.570	8.595
9	-0.116	-6.667	7.721
Confidence Interval Type: Related-Samples Hodges-Lehman Median Difference **Parameter:** Median of the difference between Manually and Electronically			

The assumed confidence interval, for the minimum lower difference is -11.195 estimated by the developed model for question 3 and the maximum upper difference is 12.678 for this question also (Table 8.10).

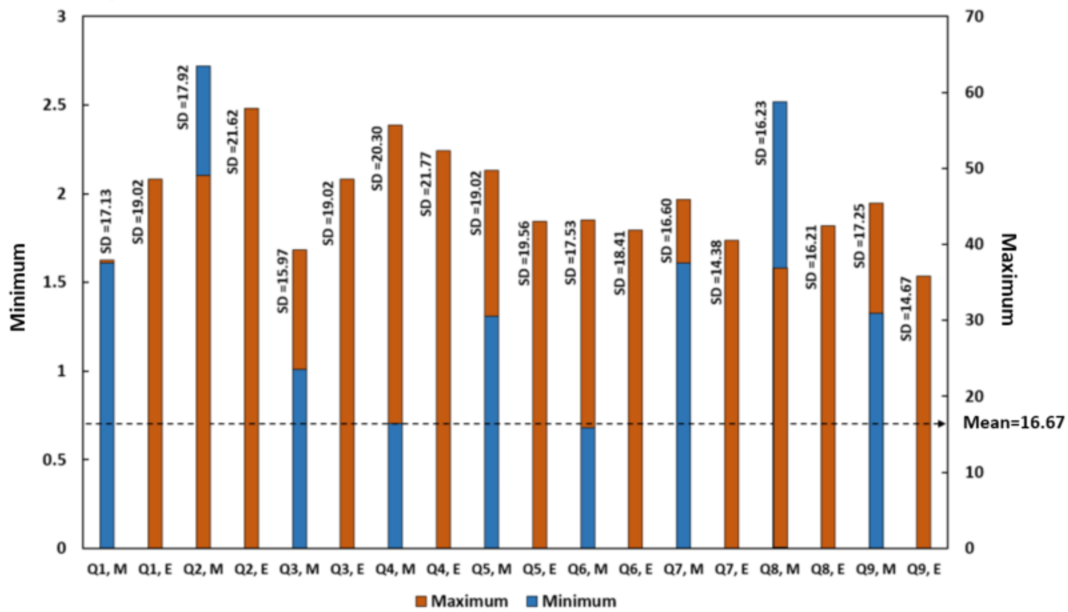
The results of the completed Wilcoxon model for the prosecution Policies Questions have been presented in Table 8.11. This table illustrates that the maximum positive difference between the manually and electronically conducted surveys for this group of questions is 3. The minimum negative difference between the two surveys is 3. The test statistics for the questions are variable between 6 and 12 and standard error for all the questions is the same; equal to 4.77. The value of the standardised test statistic was calculated for all the questions and the results illustrate that the value of this estimated value is not only variable for the questions but also, it can be positive or negative. The value of the asymptotic significance for the two sided tests is positive and variable between 0.345 and 0.917.

Table 8.11 : Related - Samples Wilcoxon-Signed-Rank Test for prosecution Policies Questions

Question*	Positive Differences	Negative Differences	Test Statistic	Standardized Test Statistic	Asymptotic Sig. (2-sided test)
1	3	3	11.000	0.105	0.917
2	2	4	10.000	-0.105	0.917
3	2	4	9.000	-0.314	0.753
4	1	5	6.000	-0.943	0.345
5	3	3	9.000	-0.314	0.753
6	2	4	11.000	0.105	0.917
7	3	3	12.000	0.314	0.753
8	2	4	10.000	-0.105	0.917
9	3	3	10.000	-0.105	0.917

* All questions are presented in Table 8.1.

The results of Wilcoxon-signed-rank test to compare manually and electronically conducted surveys for all 9 questions in the field of prosecution Policies have been illustrated in Figure 8.10.



SD: Standard Deviation, Q: Question, M: Manually, and E: Electronically

Figure 8.10 : Results of Wilcoxon-signed-rank test to compare manually and electronically conducted surveys for prosecution policy questions

The distribution of collected data is not clear and this data has a significant variance. The calculated mean of data based on the developed model is completely the same for both of the surveys and it equals to 16.67. The maximum SD adjusts to results of the electronic survey completed for question 4. This SD is equal to 21.77.

Figure 8.11 illustrates a summary of the hypothesis test completed by Wilcoxon-signed-rank- test model for prosecution policy questions.

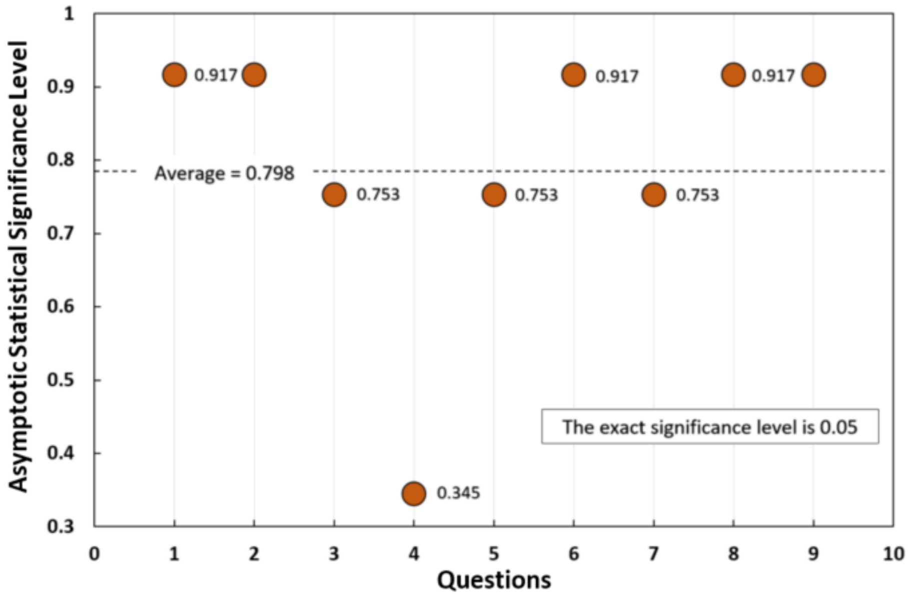


Figure 8.11 : Hypothesis Test Summary (Prosecution Policies)

The asymptotic statistical significance level for all questions in the field of prosecution policies has been shown in Figure 8.11. The average level has been calculated and the exact significance level is 0.05. The median of differences between the manually and electronically conducted surveys is 0. This means that the decision will be retaining the null hypothesis for this group of questions.

8.2.8 Fly In Fly Out (FIFO)

The Fly in fly out group of questions are shown in Table 8.1. The confidence Interval for all questions has been calculated by the SPSS based on the Wilcoxon-signed-rank test. The results for the 95% confidence interval are tabulated in Table 8.12. The estimation and calculation has been completed based on the median of the difference between the manually and electronically conducted surveys by the Related-Samples Hodges-Lehman model.

Table 8.12 : Confidence Interval Summary for Fly In Fly Out (FIFO) Questions

Question	Estimate	95% Confidence Interval	
		Lower	Upper
1	-0.519	-6.133	6.652
2	-0.292	-6.974	8.711
3	-1.354	-6.229	7.583
4	-0.049	-5.961	6.225
5	-0.846	-4.814	6.445
6	-0.473	-7.296	8.741
7	0.272	-4.839	6.254
Confidence Interval Type: Related-Samples Hodges-Lehman Median Difference **Parameter:** Median of the difference between Manually and Electronically			

The results of the Wilcoxon test for the FIFO questions have been illustrated in Table 8.13. The maximum positive difference between the manually and electronically conducted surveys for this group of questions is 3 and this value for negative difference is 4. The test statistics for the questions are variable between 7 and 11 and the standard error for all questions is the same; equal to 4.77. The negative value of the standardized test statistic was calculated for all questions (Table 8.13). The value of the asymptotic significance for the two sided tests is positive and variable between 0.753 and 0.917.

Table 8.13 : Related - Samples Wilcoxon-Signed-Rank Test for Fly In Fly Out (FIFO) includes drive in drive out and bus in bus out

Question*	Positive Differences	Negative Differences	Test Statistic	Standardized Test Statistic	Asymptotic Sig. (2-sided test)
1	2	3	7.000	-0.135	0.893
2	2	4	9.000	-0.314	0.753
3	2	4	9.000	-0.314	0.753
4	3	3	10.000	-0.105	0.917
5	2	4	9.000	-0.314	0.753
6	2	4	10.000	-0.105	0.917
7	3	3	11.000	0.105	0.917

* All questions are presented in Table 8.1.

The results of Wilcoxon-signed-rank test to compare the manually and electronically conducted surveys for all 7 questions in the group of FIFO questions has been illustrated in Figure 8.12.

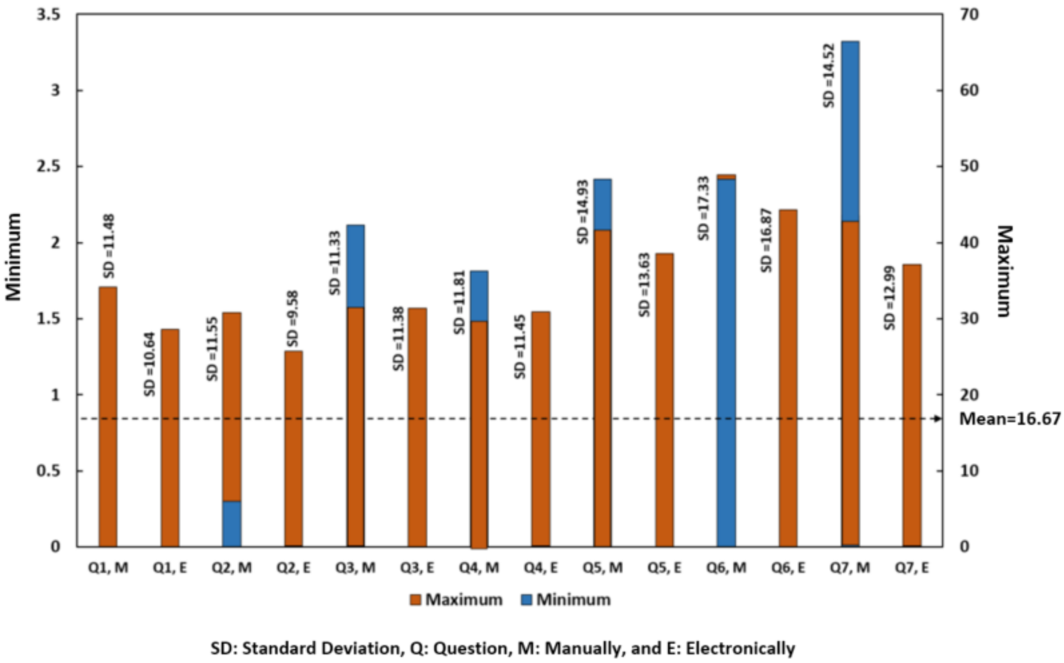


Figure 8.12 : Results of Wilcoxon-signed-rank test to compare manually and electronically conducted surveys for (FIFO) includes drive in drive out and bus in bus out questions.

Figure 8.12 shows all the collected data for both the manually and electronically conducted surveys and shows no clear distribution. All the collected data has a significant variation for each question. This variation has been illustrated by the SD for all questions individually in Figure 8.12. The maximum SD has been calculated for the collected manual data for question 6. The value of this SD is 17.33. The completed Wilcoxon model shows that the mean of all the questions is 16.67 and this value is the same for all questions.

Figure 8.13 illustrates a summary of the hypothesis test completed by the Wilcoxon-signed-rank model for FLY IN FLY OUT questions.

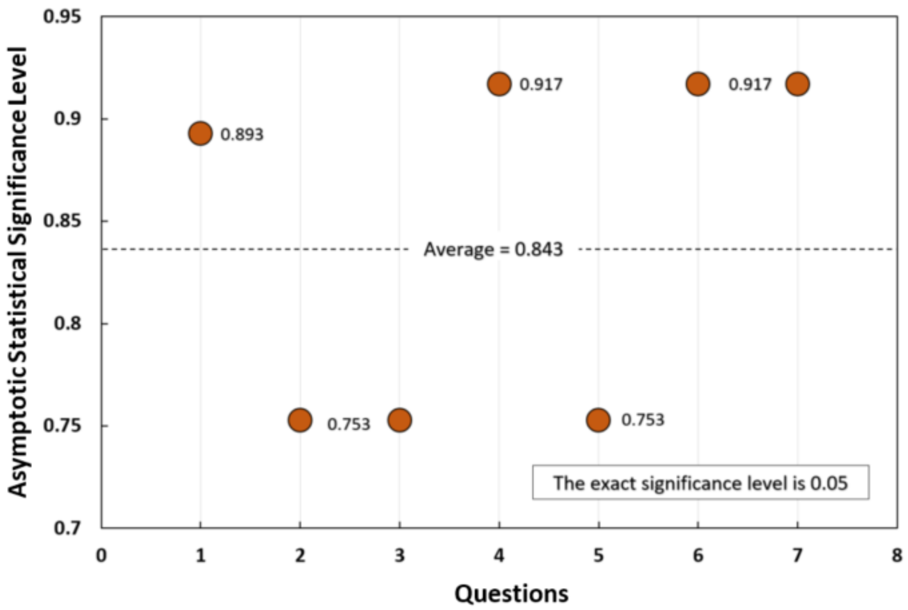


Figure 8.13 : Hypothesis Test Summary (FLY IN FLY OUT)

The asymptotic statistical significances level for all questions in the field of FLY IN FLY OUT has been shown in Figure 8.13. The average level has been calculated and the exact significance level is 0.05. The median of differences between the manually and electronically conducted surveys is 0. This means that the decision will be retaining the null hypothesis for this group of questions.

8.2.9 Confidence Interval Summary Estimates

It can be observed in Figure 8.14 that the Confidence Interval Summary Estimate has been compared for all 50 questions and that by far the majority of the answers range between 0 and -1 which has resulted in the following analysis:

Ten observations are positive and 40 observations are negative, which has resulted in the following analysis. The highest positive value being 1.604 and the highest negative value being -3.286.

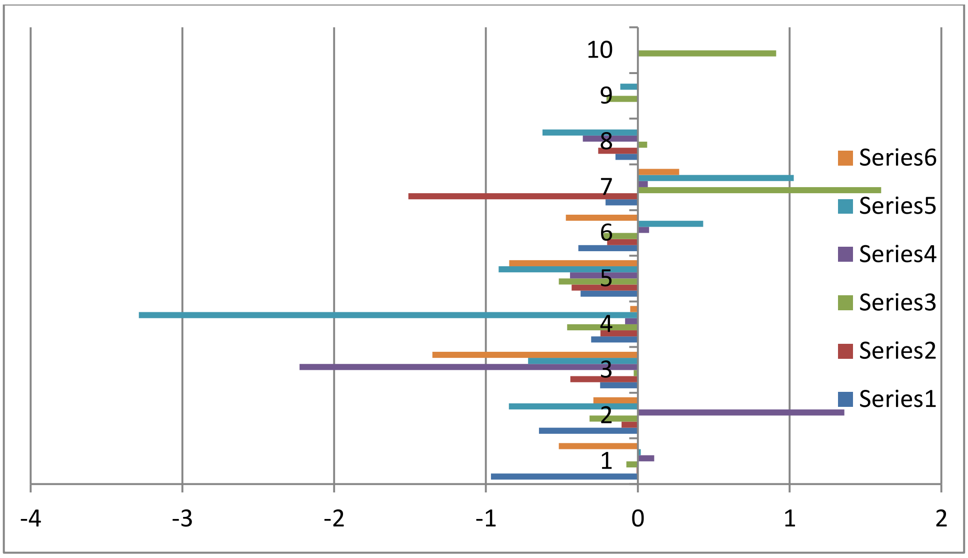


Figure 8.14 Confidence Interval Summary – Estimate

8.3 Discussion

A statistical comparison of two surveys has been conducted, the first one was completed by manually filling out the questionnaire and the second survey was completed electronically via a computer. The questions were categorised into six main groups consisting of general safety, risk assessment, safety and health management systems, fatigue and awareness issues, prosecution policies, and fly in fly out questions. A total of 37 coal mines were invited to participate in the survey. The questionnaire was completed initially by approximately 1200 respondents manually and electronically. The results of the two surveys were analysed by SPSS software individually and then a Wilcoxon-signed-rank test as a nonparametric method was applied to compare all the analysed data collated by the two mentioned surveys. The results have shown that distribution of all analysed data for all questions did not have a particular shape. The results of Wilcoxon-signed-rank test to compare manually and electronically conducted surveys for all groups of questions were illustrated and explained by different types of tables and figures. Finally, the asymptotic statistical significances level for all questions was presented. The median of differences between manually and electronically conducted surveys for all questions was 0. This means that the decision will be retaining the null hypothesis for all groups of questions. Therefore from a statistical point of view, there is no difference between the manually and electronically derived survey results.

CHAPTER 9

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

The research undertaken for this thesis was able to fill significant knowledge gaps in the area of safety in the Australian mining industry and substantiates the author's hypothesis that safety performance is not improving despite all the rhetoric in the industry. This research was mainly undertaken because the mining industry has an unacceptable level of fatalities; people are still being killed and seriously injured on mine sites due to human behaviour factors, such as not complying with rules, procedures and management failings. Another important reason is that accident investigations are currently not being conducted with a no blame culture.

This research has addressed the following specific aims:

- To analyse the safety paradigm and determine if the safety performance is improving in the Australian mining industry by conducting a rigorous qualitative and quantitative analysis of the safety performance data
- Conducting an international safety performance comparison which compares Australia with the United States of America, United Kingdom, South Africa and Canada of coal and metalliferous mining operations
- Compare the safety performance in the Australian mining industry with other Australian industries.
- Examine the mine safety environment and determine the effects that mining industry culture, risk management processes, safety management systems and the effects of fatigue are having on safety improvement
- Investigate why companies are still sheltering behind legal privilege regarding the facts involving fatalities, serious injuries and high potential injuries and

- Investigate the impact that fly in fly out and drive in drive out operations are having on safety performance.

A literature review of mine legislation in the United Kingdom and Australia set the initial context for the research. An historical background to legislative development in the United Kingdom and the impact of disasters on legislative development demonstrated how these disasters were instrumental in bringing about changes in safety attitudes and the ultimate progression of mine safety legislation. It was demonstrated that the introduction of legislation and technology have played a significant role in improving safety and health in the mining industry.

The work presented in this thesis has addressed the above mentioned objectives in the following way:

1. Safety performance is not improving as demonstrated in Chapters 1 and 2 of the thesis. A detailed evaluation of the safety performance of the three large mining states namely Queensland, NSW and Western Australia has been undertaken which supports the hypothesis that safety performance is not improving in the mining industry and evidence to support this statement is to be found below. It has been found that the LTIFR has plateaued and the 16 fatalities recorded in the mineral industry in 2013-14 are a cause for concern as are the number of suicides which are occurring in the industry which have been attributed to FIFO operations.
2. It has been demonstrated that the Australian mining industry safety performance compares very favourably with other major mining countries (Chapter 1).
3. It has been shown that the Australian mining safety performance compares very favourably with other Australian industry segments (Chapter 2).
4. This thesis has demonstrated that when considering the mining safety environment the following effects on safety performance have been investigated.

General Safety

- It has been agreed that if safety performance is going to improve in the mining industry it needs to change the safety culture of the industry and implement programmes that achieve the objective of changing the attitudes and behaviour on mine sites.

- It has been shown that about 40% of the Australian workforce is in insecure work and this rise of insecure work in Australia over the past few decades has made employees less able to speak up for their rights and consequently made workplaces less safe. The creeping rise of insecure work is a threat to mine safety when considering labour hire, casualization and contracting out, along with FIFO and DIDO. Contractors are increasingly favoured by some mining companies over permanent employees because they are cheaper and many contractors are non-union-orientated and are less likely to raise concerns. Industry studies point to a link between a lack of safety in mines and the growth of contract employees in the industry.
- A lasting safety culture cannot be created with a mobile, temporary workforce and it is well known that a lack of job security makes it more difficult for people to speak up for their rights, particularly about occupational health and safety (Chapter 2).

Risk Management

- One of the main issues with the risk management process is that it takes away the ability of miners to think for themselves in order to carry out a task. They are forced to use the system which causes the miner to become like a robot, which may have serious consequences for safety improvement. These practices encourage supervisors to abdicate responsibility and just rely on the outcomes of the risk assessment.
- There are some concerns within the mining industry that risk management is not being properly or rigorously applied. Like many mature processes there is a risk of increasing complacency. There are examples where risk assessments appear to be done to reach an outcome and to avoid more work rather than control a risk. Some people seem to be doing Job Safety Analyses to meet quotas rather than to improve safety.
- Over half of the workforce which has been surveyed agrees that management influences affect the outcome of the risk assessment, which means that the risk assessment methodology may be manipulated in order to

achieve a desired result. This situation goes against the principle that risk assessments should be conducted where all parties involved contribute in an unbiased manner in order to achieve a result which is truly representative of the parties involved with the risk assessment. This is also one of the reasons why unions have expressed negative views regarding risk based legislation in favour of prescriptive legislation and also suggests that is one of the reasons for the reintroduction of statutory certification for some existing critical safety positions in Queensland mining legislation.

Safety and Health Management Systems

- Safety and Health Management Systems (SHMS) are now enshrined in legislation and consequently are part of the way forward. However in order to improve the implementation they need to be less complex and more easily understood by the average mine worker and the elements need to be standardised across industry. Most importantly, mine workers need to be trained in order that they understand their obligations under the SHMS. It has been shown that the increasing number of contract workers in Queensland mines are more likely to be injured on mine sites, sometimes fatally, which is why new proposals will clarify that everyone, contractor or mine employee, is required to operate under a single safety and health management system on site.
- One of the biggest problems with SHMS is the lack of understanding by the workforce of the key elements due to its complexity and in some cases the limited communication and consultation by management. This problem is further exacerbated by the large number of contract workers who are now employed in the industry and in some cases are moving from site to site on a regular basis.
- This would suggest that people could be overlooked, therefore relying on their own understanding and experiences or judgement to get them through, with little or no knowledge of the mines requirements.

- Over 40% of the survey respondents agreed that their knowledge of the SHMS was not updated on a regular basis.

Fatigue Management and Hours of Work

- Fatigue and awareness issues are having a major impact on safety at work, which is particularly evident when people are working 12-hour shifts. The rapid expansion of the industry has required the growing use of contractors which in turn has produced a more inexperienced workforce.
- It has been established that in the NSW mining industry 53% of employees are working more than 48 hours per week. Based on the current information available it can be assumed that the situation in Queensland and WA would be similar to that of NSW if not worse.
- It was concluded from the analysis of 32 vehicle related incidents that they were all attributable to fatigue and lack of safe work procedures (Chapter 4). These incidents would increase considerably if all incidents regarding vehicle collisions and loss of control if all incidents were reported. Very few operators will admit to fatigue unless there is a witness or there is damage to the vehicle concerned, since these mainly dump truck operations particularly in open cut mining are repetitive and consequently can cause the operator to suffer weariness, boredom and fatigue particularly so when working 12 hour shifts.
- This thesis has demonstrated that these 12 hour shifts being worked in the industry are creating serious safety fatigue issues. One way to effectively remove the issues with fatigue particularly for underground miners, is for the industry to go back to the 8-10 hour shift and in doing so improve mine safety throughout the mining industry.
- Over 22% of survey respondents agreed that fatigue is causing a problem regarding being able to operate safely which means that fatigue management needs to be addressed with some urgency if safety performance is going to improve.

- If nearly half the workforce believes that their concentration is reduced when working 12 hour night shift rosters it poses the question "How can workers operate machinery safely with reduced concentration especially on night shift".
- A fifth of survey respondents agreed that in working 12 hour shift rosters their decision making is impaired, and that travel times to work cause fatigue and awareness issues, again, this poses the question "How can workers operate machinery safely with reduced concentration, fatigue and awareness issues especially on night shift".

Prosecution Policies and the Effects of Legal Privilege

- If the current prosecution philosophy continues, valuable information which could help prevent accidents and incidents will be lost to the detriment of improving the safety performance in the Australian mining industry and attracting mining engineers into mine management positions. One way of preventing this happening would be for the mining industry to move away from the automatic prosecution policies and adopt a no blame culture with the aid of a system similar to the Wardens Court in Queensland where there was no fear of automatic prosecution which encouraged a free flow of information. The finding and recommendations are completed in a much quicker time frame which means that the lessons learned are available in a much shorter time span than the current outcomes in Queensland, New South Wales and Western Australia.
- It has been shown that 45% of survey respondents disagreed that company legal people should be involved in site accident investigations. This supports the discussion in the thesis that company legal people should not be involved because of the issues of legal privilege which inhibit the sharing of accident information and the lessons learned. The lessons from accidents and incidents are not being learned because the companies fear being prosecuted which has created distrust between the parties. The mining companies are being encouraged to seek client "legal privilege" in order to protect the

company and its directors because the findings could be used against the companies in future prosecutions.

- In the event of a serious incident or accident mining companies are advised by the legal profession to be very careful about generating reports about the incident or accident. Employees are encouraged not to write written reports in relation to the incidents and accidents without prior approval of the manager, because they may be damaging the company's legal position and the legal position of its employees, managers and directors. Very often, the first person on the site of an accident or incident these days is the company lawyer who then effectively takes charge of the investigation. This problem is one of the main reasons for completing this research since "How is it possible to investigate a fatality or serious injury if the information to do so is not readily available". Near miss reporting, audits and high potential incidents are also subject to prosecutions which means that vital information is withheld and as a consequence not available in order to prevent a recurrence of the accident or incident. More importantly it moves away from the no blame culture which is the most important part of any safety improvement programme and instead promotes a defensive culture.
- 66% of survey respondents agreed that accident investigation would best be conducted by mine management and the site safety and health representative and not legal people.
- 54% of survey respondents agreed that prosecution policies should only be used as a last resort when wilful and reckless disregard for safety is the case. The industry needs to take note of this result which indicates that the current prosecution policies need to be changed such as to allow all accident and incident information to flow freely and be able to share the lessons learned. This will have huge benefits for safety improvement in the industry and supports the author's hypothesis. Regarding the need for prosecutions it would make eminent good sense to adopt the "Robens Report" recommendations.

- 55% of survey respondents agreed that an official inquiry would produce better outcomes if there was no fear of prosecution. An analysis was conducted in Chapter 5 on the time taken to conduct investigations.

- **FIFO / DIDO**
- Today FIFO has become a common work practice in regional Australia, especially for new mining and resource developments located in in remote locations. Queensland and Western Australia are the two major mining states where a substantial proportion of their operations are carried out with FIFO work practices. The rapid expansion of FIFO work arrangements especially in recent years has raised many concerns particularly in mining based communities throughout Australia which was extensively discussed in Chapter 2.
- It has been found that the risk factors for mental illness are compounded by living alone, lack of local networks and for men high physical demands. Long working hours and associated fatigue have been shown to be associated with increased depression and anxiety. The policy of compulsory FIFO has been found to be detrimental to the physical wellbeing of the residents of the several small towns which have been directly affected by the policy of compulsory FIFO.
- It has been shown that in the three largest mining states 35,677 people suffered a mental illness in a 12 month period in 2011 at a cost to the industry of $1.526 Billion. If one takes into account the “Macho “culture in the mining industry this figure could be much higher.
- Over a third of survey respondents agreed that FIFO working increases stress levels and poor health and 44% agreed that FIFO operations are contributing to poor quality relationships which lead to increased break-ups and divorce.
- 41% of survey respondents agreed that FIFO workers have reduced social and community interaction and feelings of loneliness and isolation. Fly in fly out workers are suffering from depression at more than twice the rate of the

general Australian population, according to research conducted from Edith Cowan University.

In March 2016 the Queensland government stated that it would legislate for the discontinuation of 100 per cent FIFO operations in new mines where nearby regional towns has a capable workforce. The legislation would also see existing 100 per cent FIFO operations consider locals for employment.

It has been established in Chapter 7 that the fatalities in the minerals sector have ranged from 7 fatalities in 2001-02 to 16 fatalities in 2013-14 which is a 44% increase. There have been 9 deaths in 2013-2014 due to suicides in the minerals industry from FIFO Western Australian operations. If the 9 fatalities are added to the 16 which occurred in the Mineral Industry in 2014 this makes a total of 25. Therefore the fatalities in the minerals industry now range from 7 in 2001-02 to 25 in 2013-14. Over this period the trend line for fatalities in the minerals industry is increasing. If safety is to improve in the mining industry this message needs to be addressed with some urgency.

The Queensland government has recently confirmed six cases of Black Lung Disease and is on notice that two more are imminent, which are the first cases of black lung disease recorded in decades. This has resulted in a Senate Inquiry being established in March 2016 to investigate the matter. The Minister involved also stated that there had been inadequacies in coal mine regulation and monitoring and that eight out of ten underground coal mines over the past 12 months had breached the legal coal dust limits. This is a very concerning situation and strongly supports the hypothesis that safety performance is not improving in the coal mining industry.

The above mentioned research has tested the authors hypothesis that safety performance in the Australian Mining Industry has not improved despite all the rhetoric in the industry and may even be deteriorating and that in order to improve safety performance the mining industry needs to change the culture and take due cognisance of the results of this survey. The industry needs to ensure with some urgency that legal privilege does not prevent the sharing of safety information and heeding the lessons learned from accidents and incidents on mine sites. In discussion with CEOs and mine management in Queensland regarding prosecutions after the Gretley decision, it is the overwhelming view that management personnel are guilty until they can prove their innocence. They want the legislation to change such that in the event of a prosecution, management personnel are innocent until proven guilty, as is the case with civil prosecutions. This would transform safety accident investigation so that the industry could return to the no blame culture.

9.2 Recommendations

1. That the prosecution culture is changed such that the automatic prosecutions policy should only be used as a last resort when wilful and reckless disregard for safety is the case. The industry should consider adopting a no blame culture, a system similar to the Wardens Court of Inquiry where there is no fear of prosecution with a consequent reduction in the time taken to complete the inquiry.
2. Change the legislation such that “Legal Privilege” is discontinued during accident investigation on mine sites which will allow the investigation to be conducted with site and industry personnel and not overwhelmed by legal people.
3. That industry achieves a balance between permanent and casual workforce in the interests of promoting safety improvement and use contractors for peaks and troughs in the workplace.
4. In the interests of improving safety in the mining industry all FIFO operations should be reviewed.
5. More training is given to mine staff in order that they are able to conduct appropriate risk assessments and more training to be given to the workforce so that they understand their obligations under the SHMS.
6. The mining industry ensures that risk assessments are conducted in an unbiased manner in order to achieve better safety outcomes on mine sites.
7. It is recommended that 12-hour shifts for underground miners should be addressed with a view to using 8-10 hour shifts with hot seat changes which are used in the USA on the most productive longwalls in the world.
8. All companies should consider running more of these confidential safety surveys in order to find out what their employees really think regarding safety improvement.

9. From an industry perspective this type of survey because of its size would be better conducted by the Minerals Council of Australia.

10. In the interests of sharing safety information and for bench marking purposes, the MCA should immediately re-start the production of the Annual Safety and Health Performance Report.

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APPENDIX 1

Letter to CEOs

School of Mining Engineering
University of New South Wales
Sydney
NSW 2052
Phone 07 9385 4597
Fax 07 9663 4019
Date 29/11/2013

Dear Sir, Re Mining Industry Questionnaire
The School of Mining Engineering at the University of New South Wales is seeking your participation and involvement in a new PhD research project that aims to improve the safety performance on mine sites. In this regard, I am carrying out a survey of the mining workforce in Queensland and New South Wales on the following safety issues:

- General safety
- Risk assessments
- Safety & health management systems
- Fatigue & Awareness issues
- Prosecution policies
- Fly In Fly Out (FIFO) operations

This research is important because although significant advances have been made throughout the mining industry, people are still being killed and seriously injured on mine sites. The rapid expansion of the mining industry has required the growing use of contractors, hence creating a more inexperienced workforce. Fatigue and awareness issues are having an impact on safety at work, which is particularly evident when people are working 12 hour shift rosters which are associated with the increasing fly in fly out operations together with the social impact that is involved. Further, in order to improve safety performance, this research will ascertain if the training regarding risk management and safety and health management systems is considered appropriate.

The current approach to prosecution has resulted in the common use of legal professional privilege which inhibits safety investigations and causes a defensive rather than a proactive safety culture. This impedes the timely sharing of information within industry to help prevent recurrence of incidents.

The mining industry's safety performance improvement would be greatly enhanced if all your employees were to participate in this survey. The survey is voluntary and has been designed with the workforce in mind and can be filled out quickly and should take no more than 10 to 15 minutes which means that it could easily be completed during a safety meeting or in a crib break. The participants of the survey can be assured that the results will be totally confidential with each participating mine receiving;

- An analysis of the workforce's responses and
- A copy of the final report where your mines can be benchmarked against industry.

The survey procedure has been approved by the UNSW ethics committee. Any comments or feedback would be most welcome and I look forward to your participation.

Supervisor contacts	David Laurence	02 93854597	Email	d.laurence@edu.au
	Chris Daly	02 93854514	Email	c.daly@edu.au

Yours Sincerely

Ray Parkin

APPENDIX 2

Letter to survey respondents

UNIVERSITY OF NSW SOUTH WALES

School of Mining Engineering

MINING INDUSTRY QUESTIONNAIRE

The School of Mining Engineering at the University of New South Wales is seeking your assistance and involvement in a new research project that aims to improve the safety performance on mine sites. We are confident that with your involvement, this research will result in a positive outcome for safety performance improvement.

- The first step in the project is to seek your opinion on the following:
  - General safety
  - Risk assessments
  - Safety and Health Management Systems
  - Fatigue and awareness issues
  - Prosecution policies
  - Fly In Fly Out (FIFO) operations

Guidelines for completing the Questionnaire:

8. **Your input is important so please answer all questions**
9. **Each question will seek your agreement or disagreement**
10. **Please mark with an X the answer that closely matches your opinion**
11. **There are no right or wrong answers**
12. **The survey should take no longer than 10 to 15 minutes to complete**
13. **When you have finished pass on to your supervisor who will put all the responses into an envelope and seal same in your presence, this will ensure confidentiality**
14. **You can be assured that your responses will remain anonymous with only aggregated results going back to mine management.**

Personal information:

9. **Name of the mine …………………………………..type of mine O/C or U/G**
10. **My main job at the mine is… statutory officer, supervisor, permanent employee, contractor, consultant or plant operator, other**
11. **Years of experience in this job ……….**

12. **Years of experience in the industry….. (0 - 5yrs) (5 – 10yrs) (10 – 20yrs) (20 – 30yrs) (30yrs plus)**
13. **Your age…….(under 30) (30 – 39) (40 – 49) (50 – 59) (60 plus)**
14. **Years at this mine ………(Less than 2) (2 – 4) (5 – 9) (10 – 19) (20 plus)**
15. **I am employed by company ……….Yes No**
16. **I am employed by contractor ………Yes No**

GENERAL SAFETY QUESTIONS

1. Is safety performance improving on your mine site

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

2. Are all accidents and incidents investigated and reported at your mine site

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

3. Is accident and incident information acted upon to make improvements

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

4. Accident and incident information is communicated satisfactorily to permanent and temporary employees

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

5. Human error is a major factor in causing accidents and incidents

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

6. Accidents and incidents can be eliminated

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

7. I am encouraged by my employers to have my say on safety matters

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

8. The main causes of accidents and incidents is a poor safety culture

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

RISK ASSESSMENTS

1. Risk assessments are a useful part of safety management at my site

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

2. People who conduct risk assessments have sufficient training

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

3. Too many risk assessments are conducted in my workplace

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

4. I get benefit from risk assessments concerned with my workplace

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

5. I am involved in risk assessments concerned with my workplace?

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

6. Management influences affect the outcome of my risk assessments

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

7. There should be less risk management and more prescriptive regulations

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

8. Is it necessary to break the rules and regulations to get the job done

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

SAFETEY & HEALTH MANAGEMENT SYSTEMS (SHMS)

1. A lack of experienced people is causing safety issues at my workplace

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

2. My training is adequate to carry out my role safely

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

3. I understand my obligations under the Safety and Health Management System (SHMS)

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

4. Adequate training is given for me to understand my obligations under the SHMS

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

5. The SHMS is too complex for me to understand

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

6. More time should be allowed for training in the SHMS

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

7. My knowledge of the SHMS is updated on a regular basis

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

8. Information concerning the SHMS is adequately communicated

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

9. The SHMS drives improved safety performance

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

10. Safety inspections are done by persons in whom I have confidence will take strong action to make the workplace safe

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

FATIGUE & AWARENESS ISSUES

1. Fatigue is causing a problem regarding me being able to operate safely

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

2. My current roster allows sufficient quality time with family and friends to support a sustainable work life balance

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

3. My concentration is reduced when working 12 hour night shift rosters

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

4. My current roster results in poor judgement of my own performance

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

5. Working my current shift roster affects my ability to assess problems and determine solutions

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

6. When working 12 hour shift rosters my decision making is impaired

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

7. When working my current roster my awareness and communication skills are impaired

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

8. Travel times to work cause me fatigue and awareness issues

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

PROSECUTION POLICIES

1. There are practices that limit the quality of accident investigation at my site

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

2. Information regarding an accident is free flowing on my site

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

3. I believe that company legal people should be involved in site accident investigations

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

4. Accident investigation would be best conducted by mine management and the site safety and health representative and not legal people

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

5. I am concerned about the current inspectorate prosecution policies that are in place

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

6. Legal people's involvement affects the open provision of facts concerning an accident or incident

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

7. Prosecution policies should be used as a last resort when wilful and reckless disregard for safety is the case

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

8. The root causes of accidents and incidents are not being examined for fear of the company being prosecuted

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

9. An official inquiry would produce better outcomes if there was no fear of prosecution

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

FLY IN FLY OUT (FIFO) includes drive in drive out and bus in bus out.

1. Are you a FIFO worker………Yes No

If you answered (Yes) please complete the questionnaire
If you answered (No) you have now completed the questionnaire

2. FIFO working increases stress levels and poor health

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

3. FIFO operations are contributing to poor quality relationships and leading to increased break-ups and divorce.

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

4. FIFO operations cause family disruptions and stress

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

5. FIFO workers have reduced social and community interaction and feelings of loneliness and isolation

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

6. FIFO working improves financial circumstances from high wages and lower living costs

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

7. FIFO operations allow workers to make lifestyle choices for themselves and their families

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

8. FIFO operations allow uninterrupted blocks of time to enable workers to spend better quality time with their partners and families

Strongly Disagree	Disagree	Not sure	Agree	Strongly Agree

APPENDIX 3

Letter of approval from the UNSW Ethics Advisory Committee

THE UNIVERSITY OF
NEW SOUTH WALES

HUMAN RESEARCH ETHICS ADVISORY
PANEL 'H'
SCIENCE & ENGINEERING

19 November 2013

Mr Ray Parkin
School of Mining Engineering

Re: **To Investigate the Safety and Health Performance and Culture in the Australian Mining Industry**

Reference Number: 08/2013/75

Dear Mr Parkin

At its meeting of 12th November 2013 the Human Research Ethics Advisory Panel 'H' was satisfied that this project is of minimal ethical impact and meets the requirements as set out in the National Statement on Ethical Conduct in Human Research*. Having taken into account the advice of the Panel, the Deputy Vice-Chancellor (Research) has approved the project to proceed.

Your Head of School/Unit/Centre will be informed of this decision. This approval is valid for 12 months from the date of the meeting.

Yours sincerely

Professor Mike Regan
Panel Convenor
Human Research Ethics Advisory Panel 'H'

Cc: Head of School
Prof Bruce Hebblewhite
School of Mining Engineering

* http://www.nhmrc.gov.au

SYDNEY 2052 AUSTRALIA
Telephone: +61 (2) 9385 5774
Facsimile: +61 (2) 9385 6040
Email: m.regan@unsw.edu.au

APPENDIX 4

Letters of support from CEO's

PEABODY ENERGY
AUSTRALIA PTY LTD

ABN: 93 096 909 410

Level 14, BOQ Centre
259 Queen Street
Brisbane, Queensland 4000
GPO Box 164
Brisbane, Queensland 4001
Australia
Tel + 61 (0) 7 3225 5500
Fax + 61 (0) 7 3225 5555

11 July 2013

Attention: UNSW Human Research Ethics Advisory Committee

Dear Committee Members

I refer to the research project entitled:
"To Investigate the Safety and Health Performance and Culture in the Australian Mining Industry" by Ray Parkin.

This project has the full support of Peabody Energy Australia subject to the individual consent of the potential participant(s).

Yours faithfully

Eric Ford
Chairman - Australia

10 July 2013

Name: Greg Chalmers, CEO
Jellinbah Group Pty Ltd

Address: GPO Box 374
Brisbane Qld 4001

To: The UNSW Human Research Ethics Advisory Committee

I refer to the research project entitled:

To investigate the Safety and Health Performance and Culture in the Australian Mining Industry by Ray Parkin.

I have known Mr Parkin for many years and am confident of his ability and capacity to complete the project as outlined. Equally, I feel that the outcomes of the proposed research will be of tangible value to the Mining Industry.

Therefore, this project has the full support of Jellinbah Resources, subject to the individual consent of the potential participant(s).

Yours faithfully,

G B Chalmers
Chief Executive Officer

Jellinbah Group Pt y L td ABN 5 4 010 754 793
Level 7, 12 Creek Street , Brisbane
GPO Box 374 Brisbane Q 4 001 Australia
Telephone + 617 3877 6700 **Facsimile +617 32217119**
www.jellinbah.com. a u

10th July 2013

To: UNSW Human Research Ethics Advisory Committee

Dear Committee Members

My name is Andrew Vickers and I am the General Secretary of the Construction Forestry Mining and Energy Union – Mining and Energy Division, of Level 11, 215-217 Clarence Street Sydney, NSW 2000 (PO Box Q1641 Sydney 1230).

I write to advise that I have received a presentation from Mr Ray Parkin, whom I have known for many years in a professional capacity, in respect of his research project "Safety and Health Culture in the Australian Mining Industry". I first comment that in my view, Mr Parkin, who has displayed a passionate interest and involvement in mine safety in all of the years I have known him, is eminently qualified to undertake such a project.

Second, I am pleased to inform you that the Union, which represents some 20,000 members in the black coal mining industry in Australia, is fully supportive of the project as outlined to me by Mr Parkin, and will afford him every assistance, subject to the individual consent of potential participants.

Yours faithfully

A. Vickers

Andrew Vickers

GENERAL SECRETARY

CFMEU Mining & Energy **t:** +61 2 9267 1035 **f:** +61 2 9267 3198 **e:** info@cfmeu.com.au
www.cfmeu.com.au Level 11, 215-217 Clarence Street, Sydney NSW 2000 PO Box Q1641, Sydney NSW 1230 Australia

APPENDIX 5

Participant information Statement and Consent Form

<u>School of Mining Engineering</u>

Approval No 08/2013/75

THE UNIVERSITY OF NEW SOUTH WALES, PEABODY ENERGY AUSTRALIA, JELLINBAH GROUP AND THE CFMEU

PARTICIPANT INFORMATION STATEMENT AND CONSENT FORM

TO INVESTIGATE THE SAFETY AND HEALTH PERFORMANCE AND CULTURE IN THE AUSTRALIAN MINING INDUSTRY

[Participant selection and purpose of study]

You are invited to participate in a study of a research project which aims to improve the safety performance on mine sites. The first step in the project is to seek your opinion on the following topics:

- General safety
- Risk assessments
- Safety and Health Management Systems
- Fatigue and awareness issues
- Prosecution policies and
- Fly in Fly out (FIFO) operations

You were selected as a possible participant in this study because we believe that with your input will result in a positive outcome for safety performance improvement on mine sites.

[Description of study]

If you decide to participate in this survey you will be asked questions on the abovementioned topics. The Likert five point scale will be used which allows individuals to express how much they agree or disagree with a particular statement. Voluntary participation requires that people will not be coerced into participating into the research. The questionnaire will be group administered where possible and participants will be able to complete the survey electronically or in hard copy. It is expected that most participants will be able to complete the survey during a safety meeting or a crib break in hard copy.
The survey should take no longer than 10 to 15 minutes to complete.

[Confidentiality and disclosure of information]

The participant's confidentiality is assured because they will not be asked to give their name, only the mine at which they work and any other identifying information will not be made available to anyone who is not directly involved in the study. When participants have completed the questionnaire their responses will be placed in a sealed envelope in their presence which will ensure that the confidentiality, privacy and anonymity of all participants are maintained at all stages of the research project.

Any information that is obtained in connection with this study cannot be identified with you, since you have not been asked to give your name only the mine that you work at.
Your information will remain confidential at all times.

[Feedback to participants]

You can rest assured that your responses will remain anonymous with only aggregated results going back to mine management and these results will be available to you.

Complaints may be directed to the Ethics Secretariat, The University of New South Wales, SYDNEY 2052 AUSTRALIA (phone (02) 9385 4234, fax (02) 9385 6648, email ethics.gmo@unsw.edu.au). Any complaint you make will be investigated promptly and you will be informed of the outcome.

[Your consent]
Your decision whether or not to participate will not prejudice your future relations with the University of New South Wales and the other participating organisations. If you decide to participate, you are free to withdraw your consent and to discontinue participation at any time without prejudice.

If you have any questions, please feel free to ask us. If you have any additional questions later please contact First Investigator Ray Parkin 0733963138 who will be happy to answer them.
You will be given a copy of this form to keep.

APPENDIX 6

Analysis of Survey Questions Using the Wilcoxon Signed Rank Test and the Hodges and Lehman Confidence Type.

Sheet 1, Question 1: Is safety performance improving on your mine site?

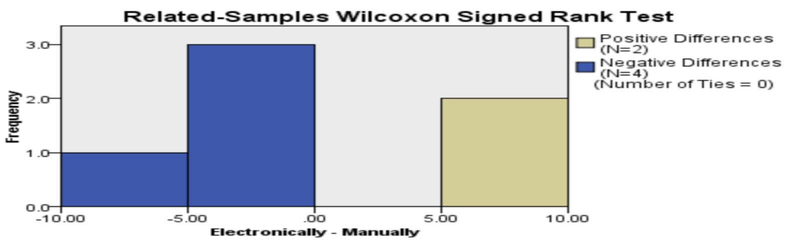
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.967	-5.445	6.575

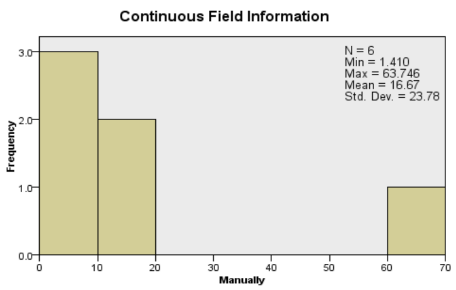
Hypothesis Test Summary

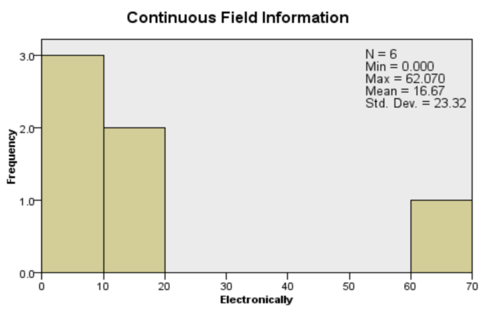
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.753	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	9.000
Standard Error	4.770
Standardized Test Statistic	-.314
Asymptotic Sig. (2-sided test)	.753





Sheet 1, Question 2: Are all accidents investigated and reported at your mine site?

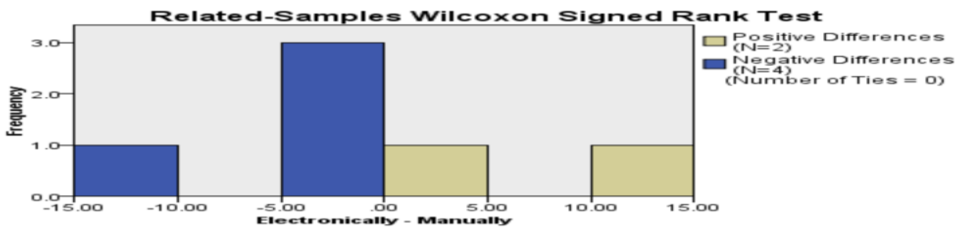
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.651	-6.285	7.416

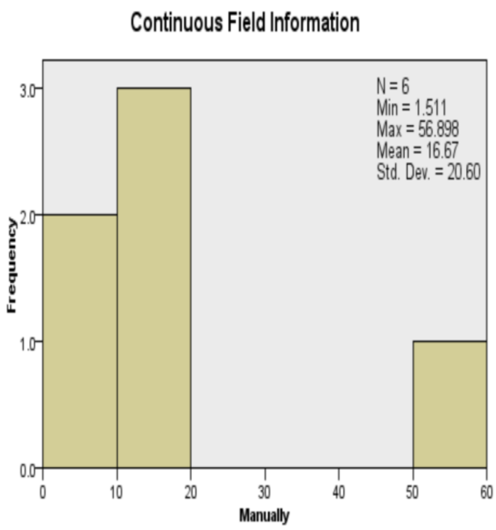
Hypothesis Test Summary

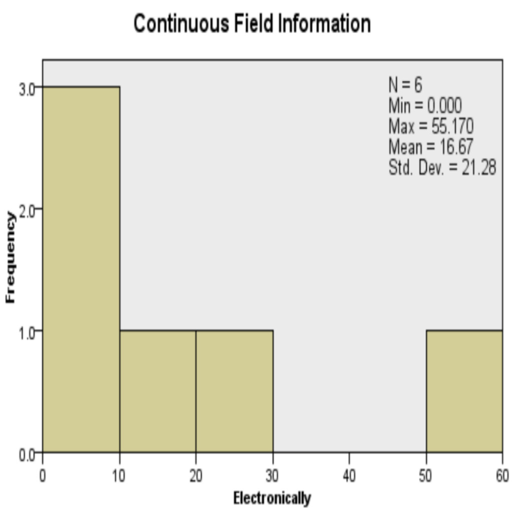
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.600	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	8.000
Standard Error	4.770
Standardized Test Statistic	-.524
Asymptotic Sig. (2-sided test)	.600





Sheet 1, Question 3:

Is accident and incident information acted upon to make improvements?

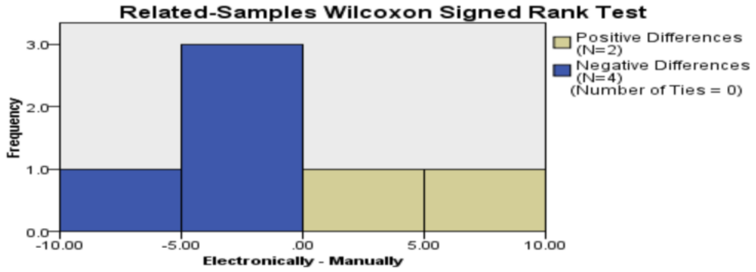
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.248	-6.167	6.941

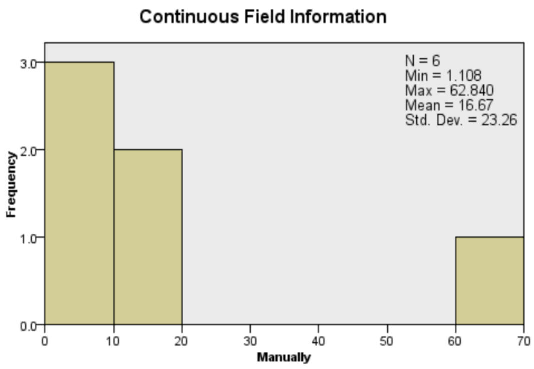
Hypothesis Test Summary

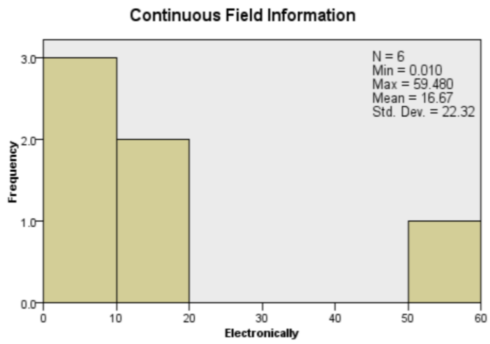
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	10.000
Standard Error	4.770
Standardized Test Statistic	-.105
Asymptotic Sig. (2-sided test)	.917





Sheet 1, Question 4:

Accident and incident information is communicated satisfactorily to permanent and temporary employees?

Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.306	-3.616	3.922

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
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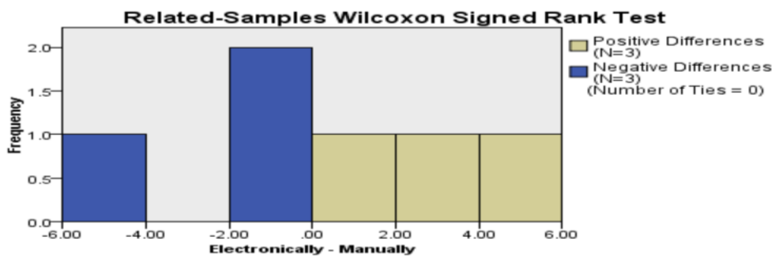
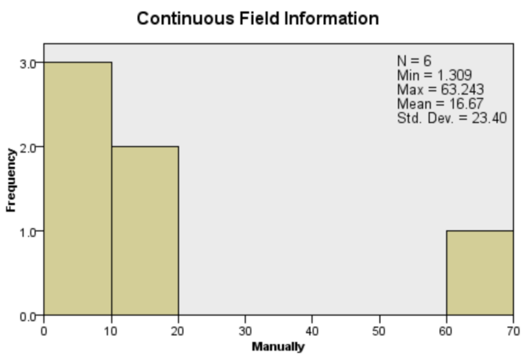
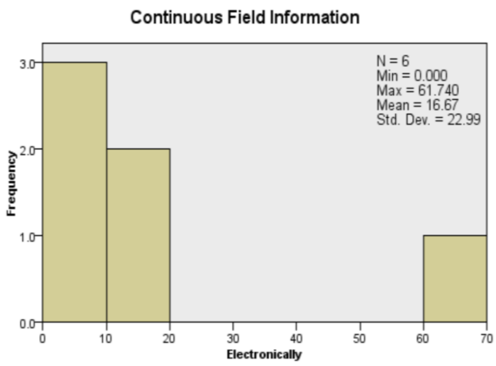
Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	10.000
Standard Error	4.770
Standardized Test Statistic	-.105
Asymptotic Sig. (2-sided test)	.917





Sheet 1, Question 5:

Human error is a major factor in causing accidents and incidents?

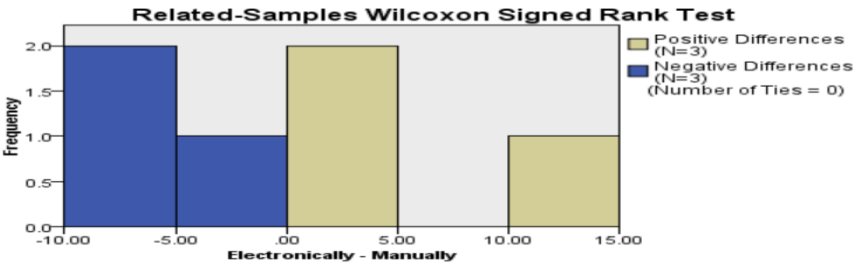
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.376	-6.553	6.929

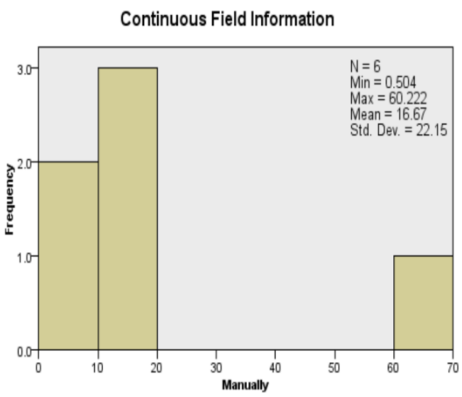
Hypothesis Test Summary

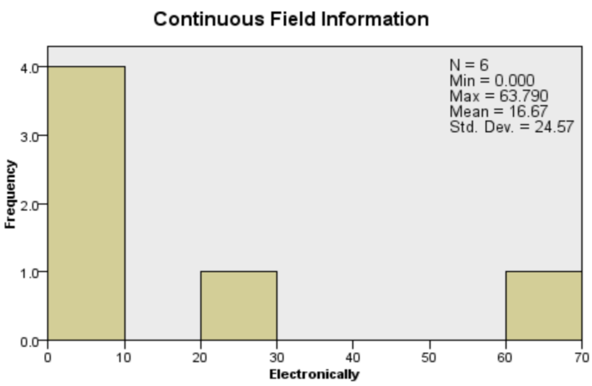
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	10.000
Standard Error	4.770
Standardized Test Statistic	-.105
Asymptotic Sig. (2-sided test)	.917





Sheet 1, Question 6:

Accidents and incidents can be eliminated?

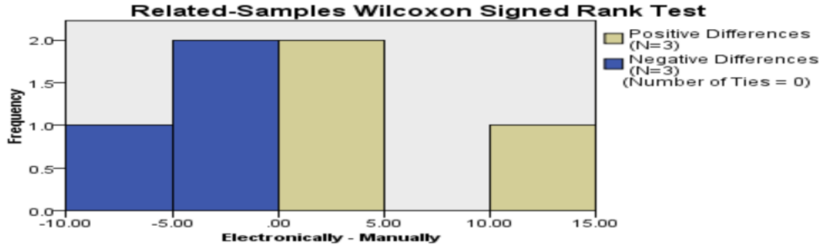
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.392	-5.973	6.365

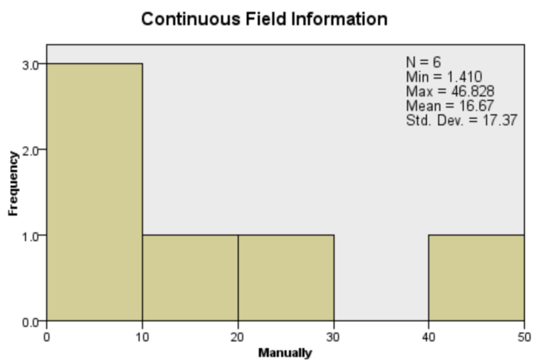
Hypothesis Test Summary

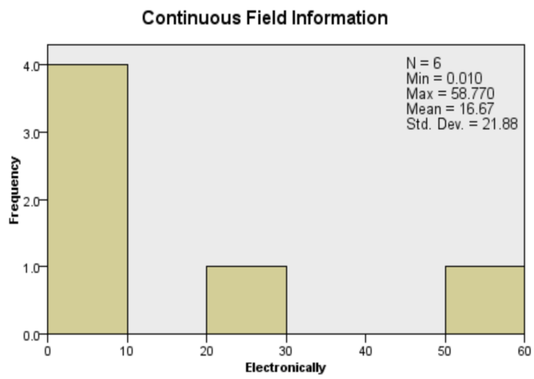
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.753	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	9.000
Standard Error	4.770
Standardized Test Statistic	-.314
Asymptotic Sig. (2-sided test)	.753





Sheet 1, Question 7:

I am encouraged by my employers to have my say on safety matters?

Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	.212	-8.255	7.920

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
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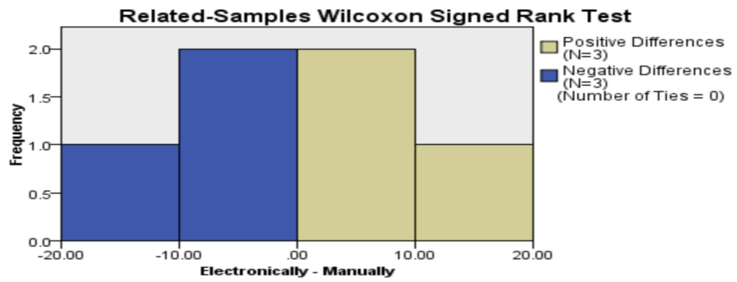
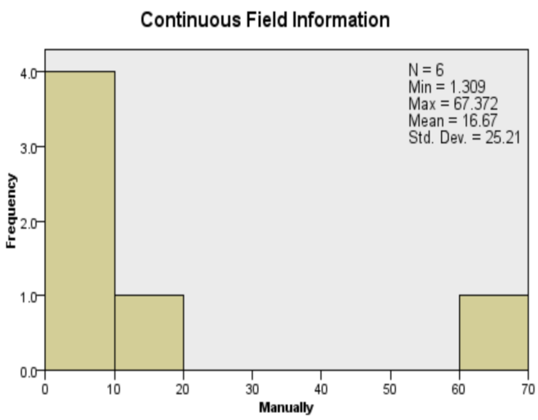
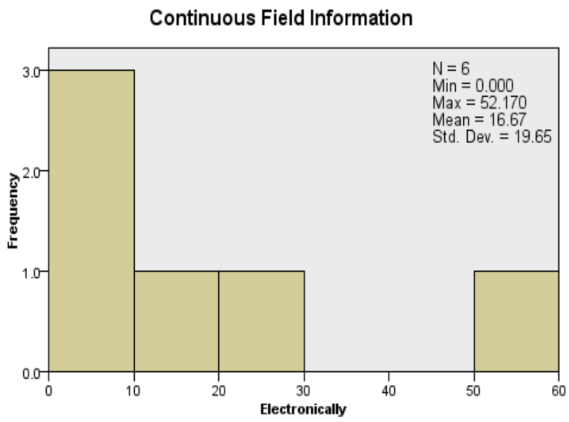
Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	11.000
Standard Error	4.770
Standardized Test Statistic	.105
Asymptotic Sig. (2-sided test)	.917





Sheet 1, Question 8:

The main causes of accidents and incidents is a poor safety culture?

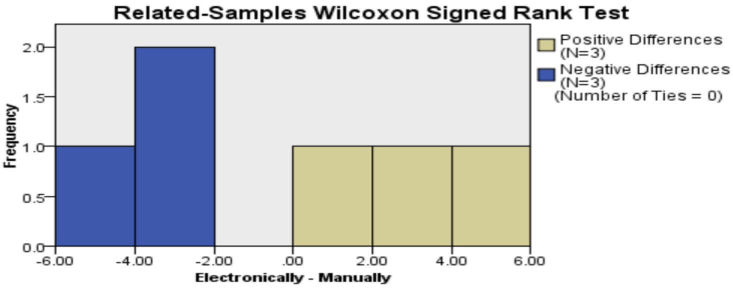
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.146	-3.661	4.102

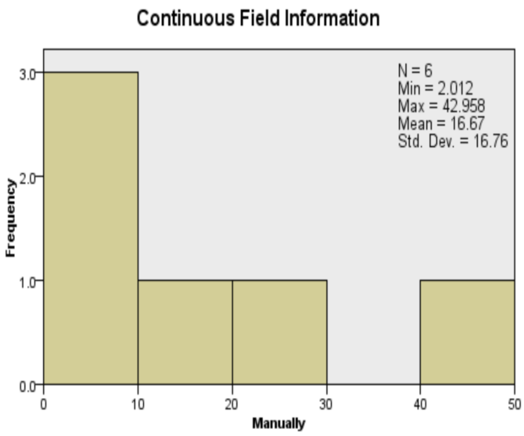
Hypothesis Test Summary

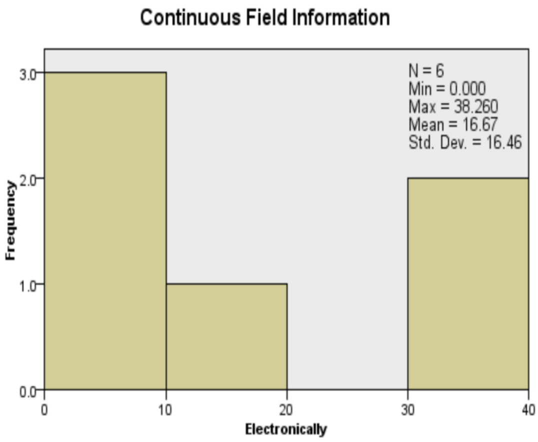
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	10.000
Standard Error	4.770
Standardized Test Statistic	-.105
Asymptotic Sig. (2-sided test)	.917





Sheet 2, Question 1:

Risk assessments are a useful part of safety management at my site?

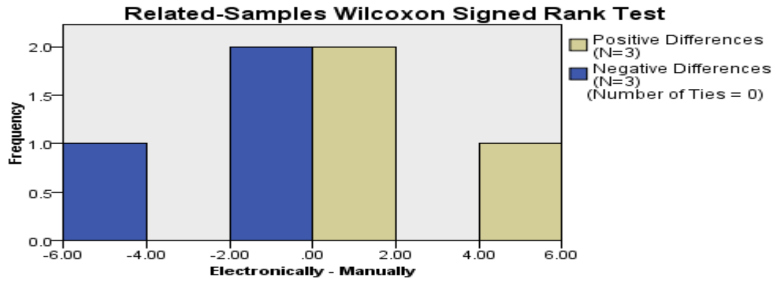
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.008	-2.892	3.148

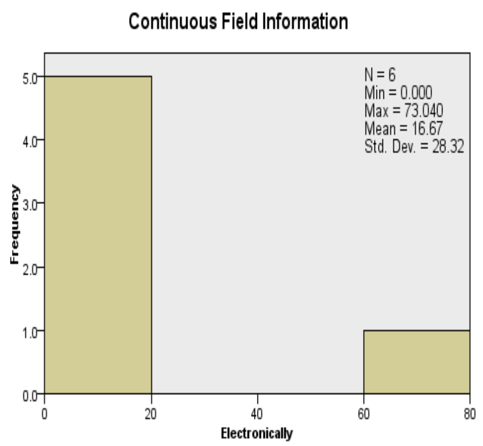
Hypothesis Test Summary

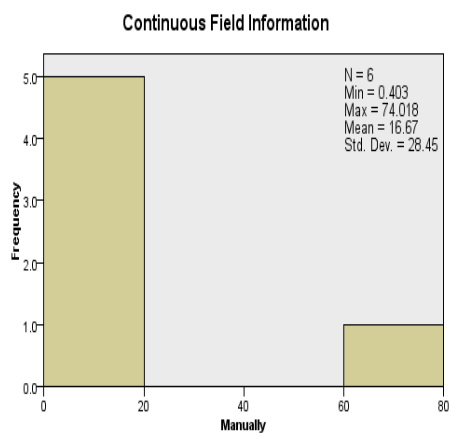
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	10.000
Standard Error	4.770
Standardized Test Statistic	-.105
Asymptotic Sig. (2-sided test)	.917





Sheet 2, Question 2:

People who conduct risk assessments have sufficient training?

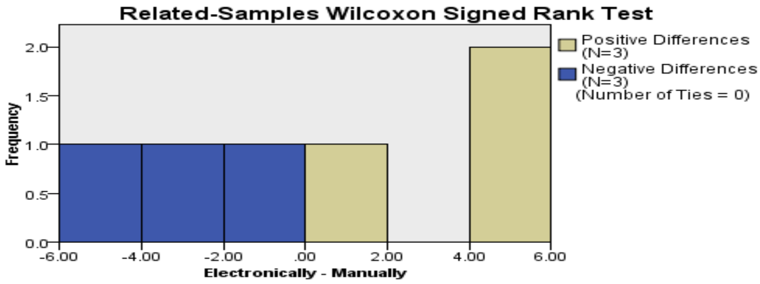
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.106	-3.828	4.577

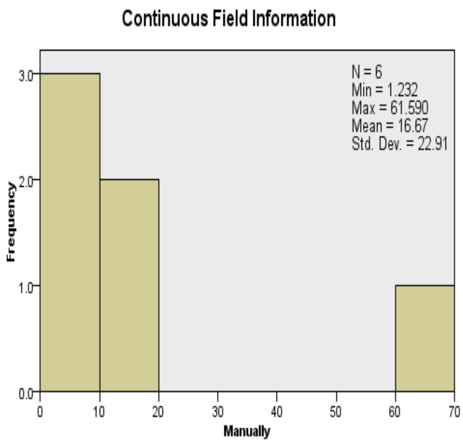
Hypothesis Test Summary

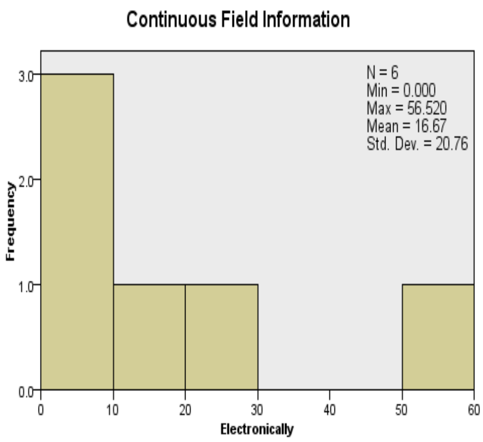
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	10.000
Standard Error	4.770
Standardized Test Statistic	-.105
Asymptotic Sig. (2-sided test)	.917





Sheet 2, Question 3:

Too many risk assessments are conducted in my workplace?

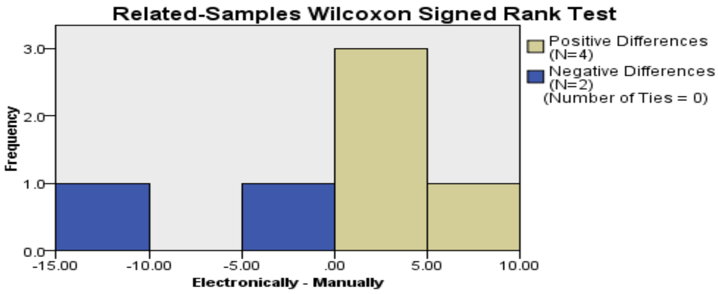
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	.444	-6.393	5.348

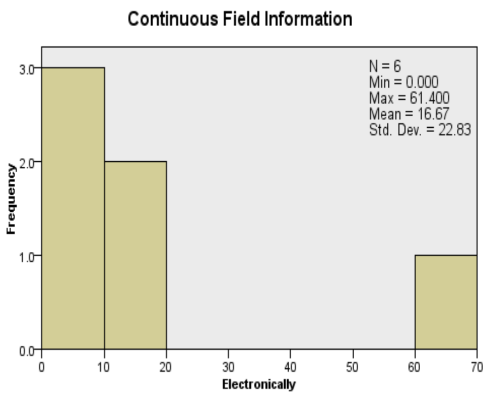
Hypothesis Test Summary

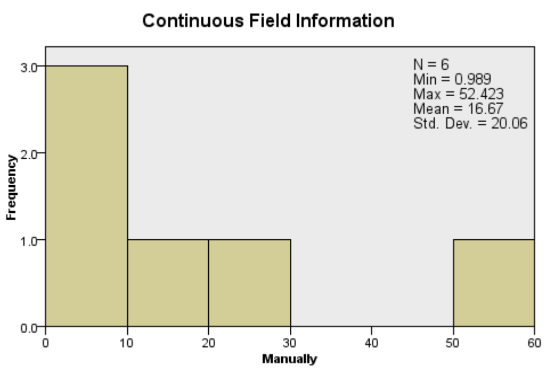
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.600	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	13.000
Standard Error	4.770
Standardized Test Statistic	.524
Asymptotic Sig. (2-sided test)	.600





Sheet 2, Question 4:

I get benefit from risk assessments concerned with my workplace?

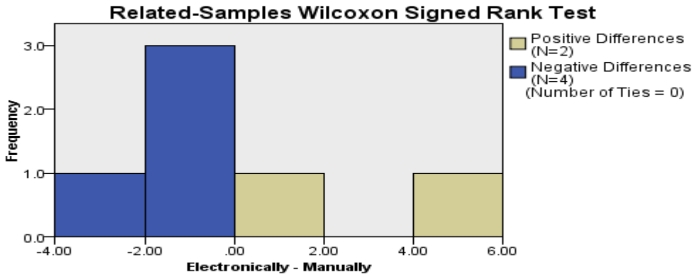
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.246	-2.086	2.331

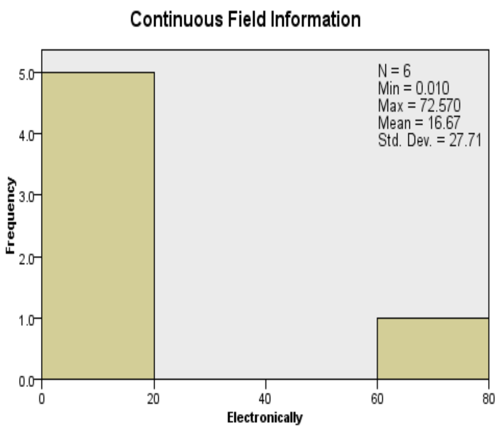
Hypothesis Test Summary

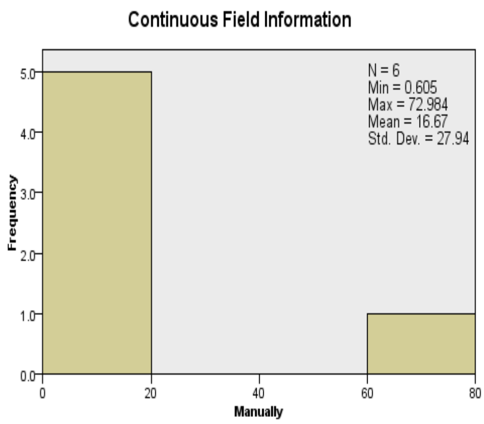
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.600	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	8.000
Standard Error	4.770
Standardized Test Statistic	-.524
Asymptotic Sig. (2-sided test)	.600





Sheet 2, Question 5:

I am involved in risk assessments with my workplace?

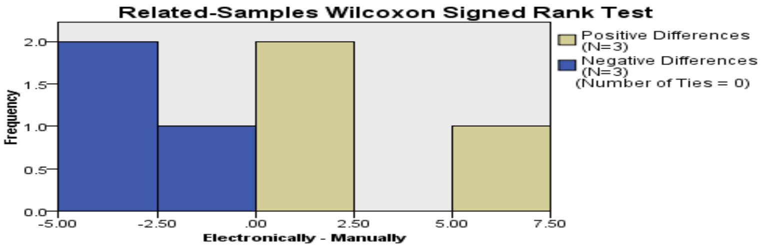
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.435	-3.635	4.070

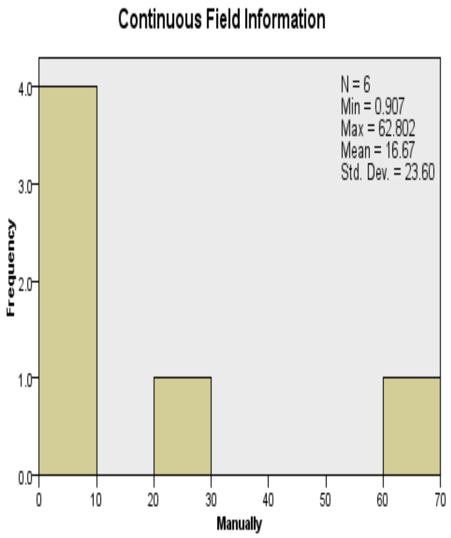
Hypothesis Test Summary

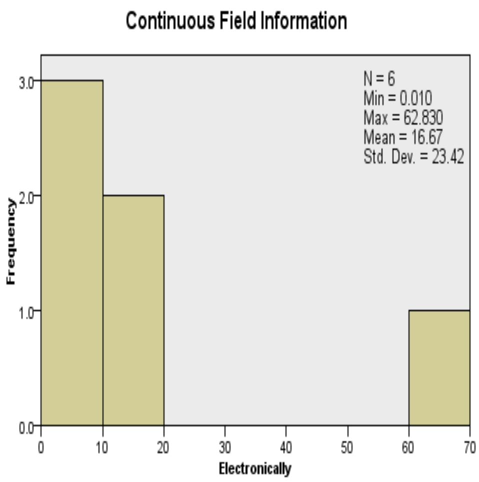
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	10.000
Standard Error	4.770
Standardized Test Statistic	-.105
Asymptotic Sig. (2-sided test)	.917





Sheet 2, Question 6:

Management influences affect the outcome of my risk assessments?

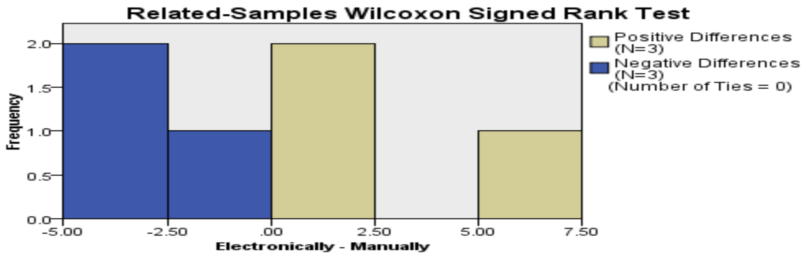
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	.201	-4.458	4.257

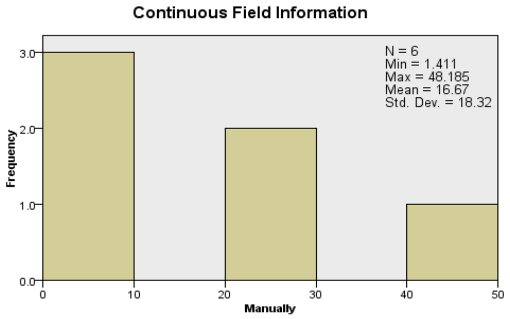
Hypothesis Test Summary

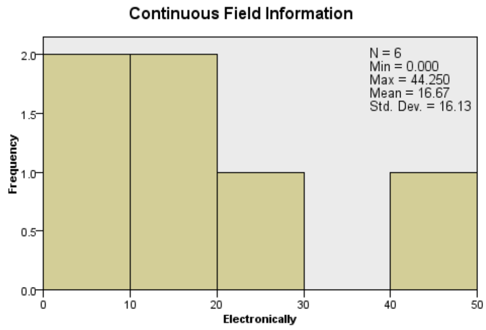
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	11.000
Standard Error	4.770
Standardized Test Statistic	.105
Asymptotic Sig. (2-sided test)	.917





Sheet 2, Question 7:

There should be less risk management and more prescriptive regulations?

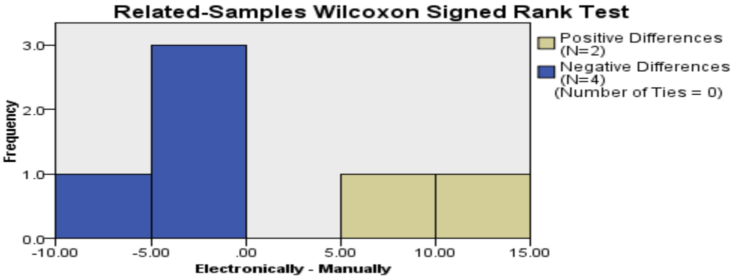
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-1.511	-6.365	8.649

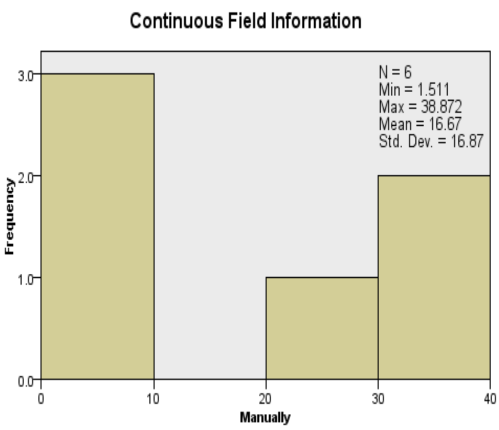
Hypothesis Test Summary

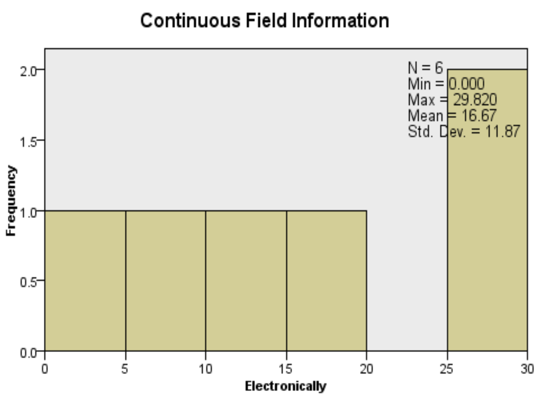
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	10.000
Standard Error	4.770
Standardized Test Statistic	-.105
Asymptotic Sig. (2-sided test)	.917





Sheet 2, Question 8:

Is it necessary to break rules and regulations to get the job done?

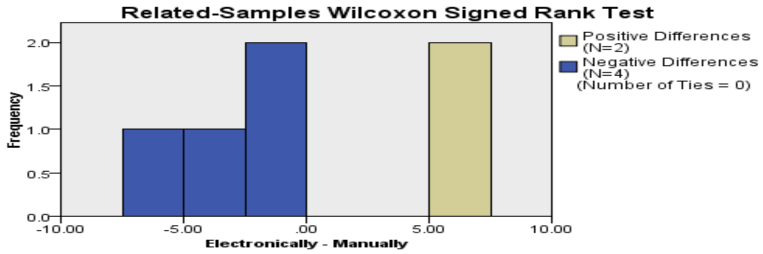
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.261	-4.981	5.764

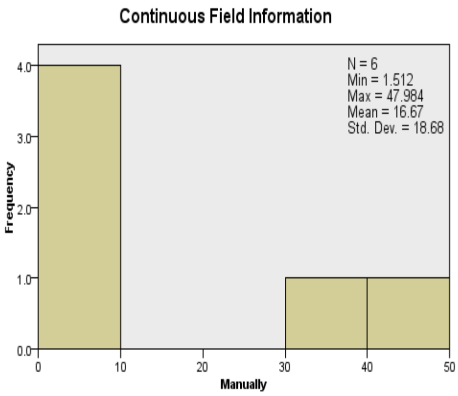
Hypothesis Test Summary

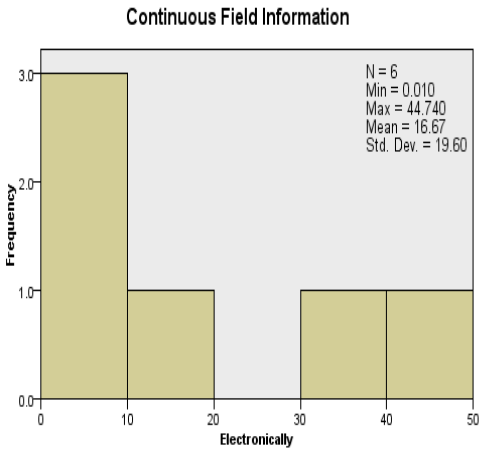
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.753	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	9.000
Standard Error	4.770
Standardized Test Statistic	-.314
Asymptotic Sig. (2-sided test)	.753





Sheet 3, Question 1:

A lack of experienced people is causing safety issues at my workplace?

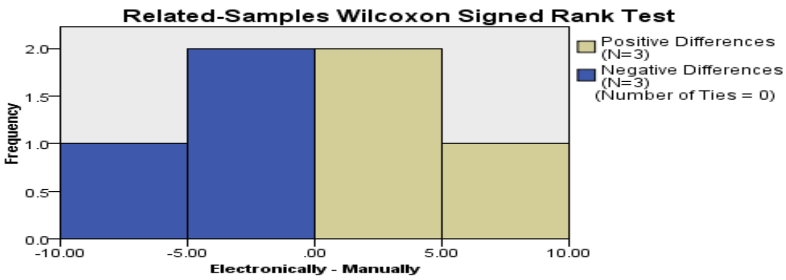
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.074	-4.834	4.907

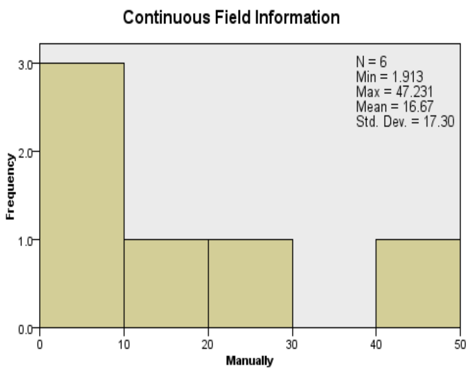
Hypothesis Test Summary

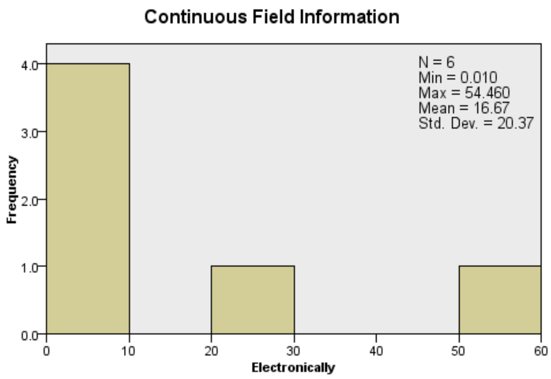
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	10.000
Standard Error	4.770
Standardized Test Statistic	-.105
Asymptotic Sig. (2-sided test)	.917





Sheet 3, Question 2:

My training is adequate to carry out my role safely?

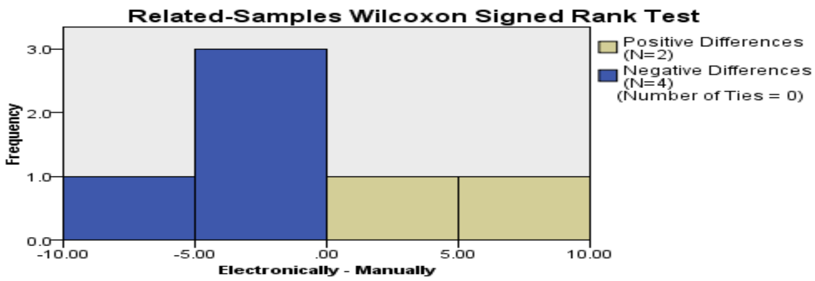
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.318	-5.886	6.526

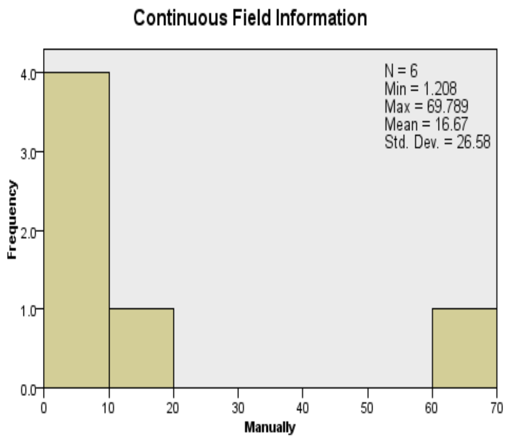
Hypothesis Test Summary

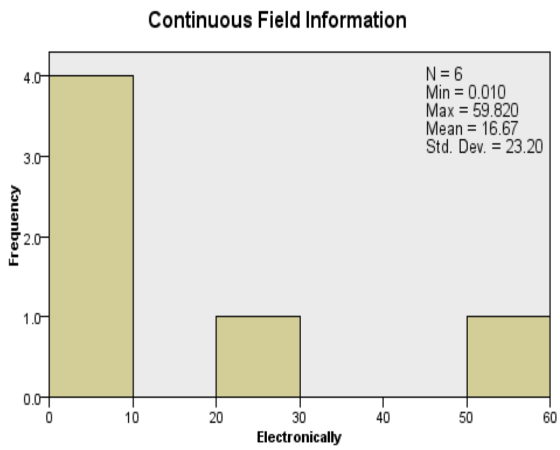
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.753	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	9.000
Standard Error	4.770
Standardized Test Statistic	-.314
Asymptotic Sig. (2-sided test)	.753





Sheet 3, Question 3:

I understand my obligations under the Safety and Health Management System (SHMS)?

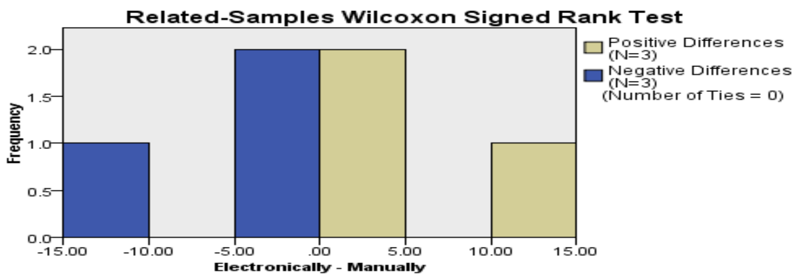
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	.027	-8.283	8.256

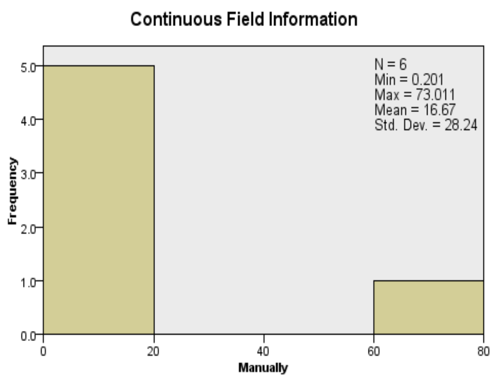
Hypothesis Test Summary

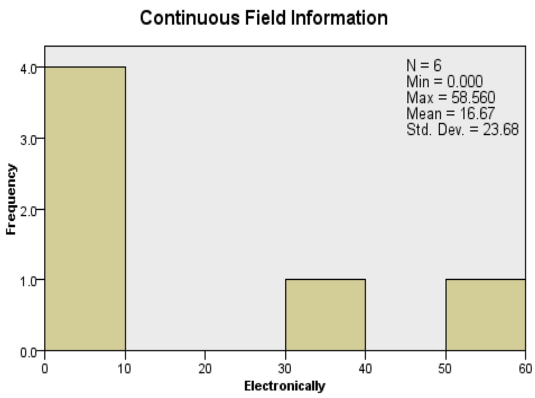
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	11.000
Standard Error	4.770
Standardized Test Statistic	.105
Asymptotic Sig. (2-sided test)	.917





Sheet 3, Question 4:

Adequate training is given for me to understand my obligations under the SHMS?

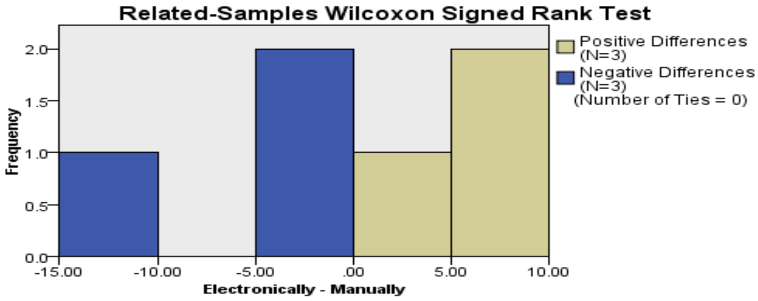
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.465	-7.625	8.090

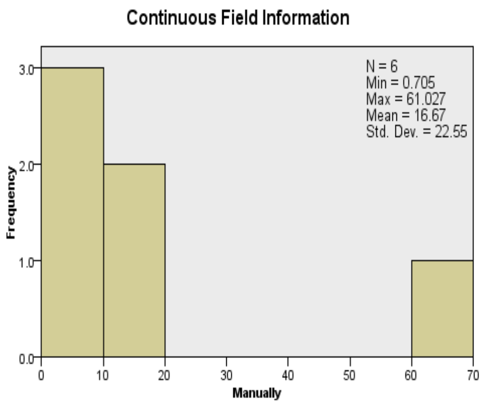
Hypothesis Test Summary

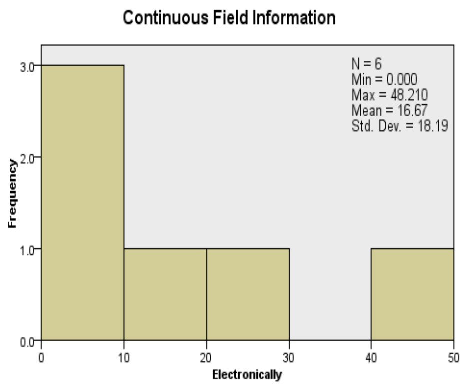
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	10.000
Standard Error	4.770
Standardized Test Statistic	-.105
Asymptotic Sig. (2-sided test)	.917





Sheet 3, Question 5:

The SHMS is too complex for me to understand?

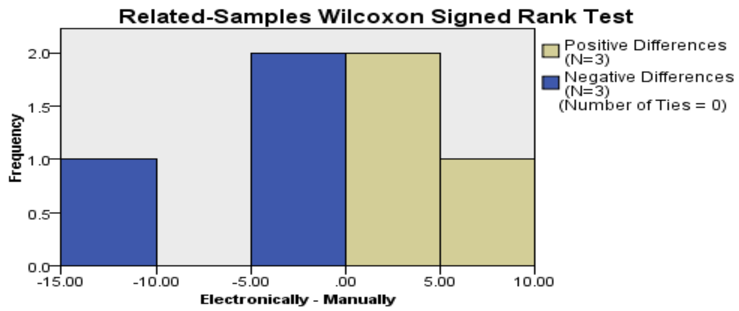
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	.521	-6.584	6.063

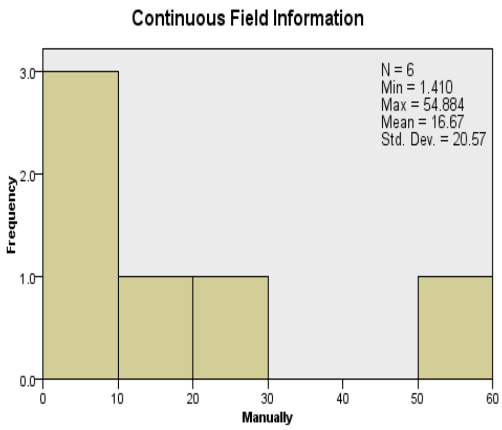
Hypothesis Test Summary

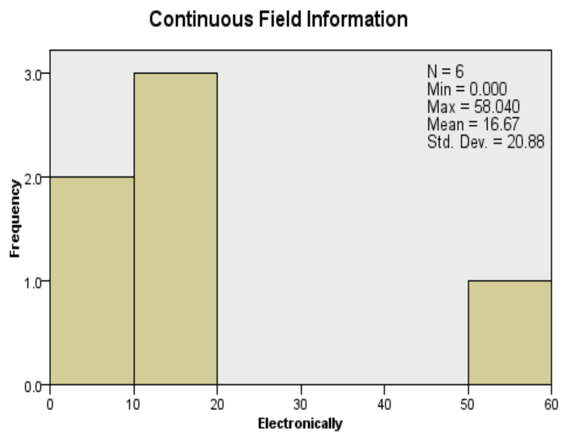
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.753	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	12.000
Standard Error	4.770
Standardized Test Statistic	.314
Asymptotic Sig. (2-sided test)	.753





Sheet 3, Question 6:

More time should be allowed for training in the SHMS?

Confidence Interval Summary

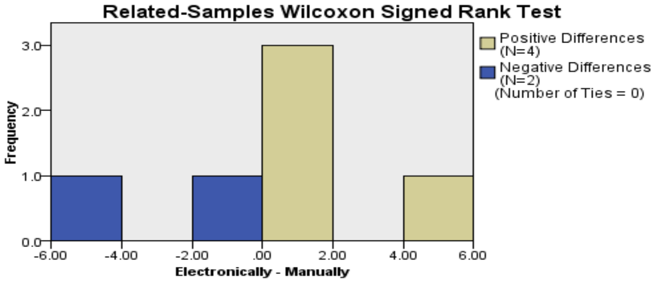
Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	.225	-3.652	3.292

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

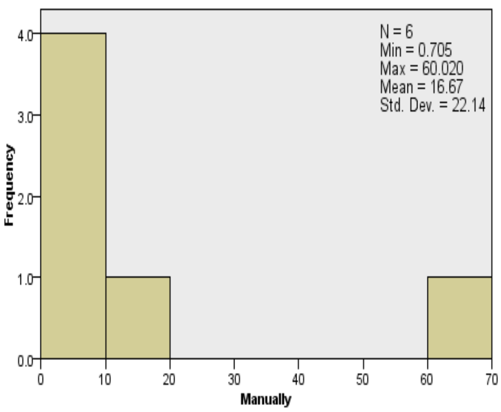
Asymptotic significances are displayed. The significance level is .05.

Related-Samples Wilcoxon Signed Rank Test

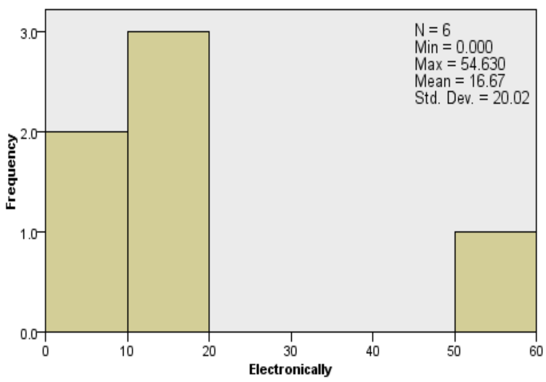


Total N	6
Test Statistic	11.000
Standard Error	4.770
Standardized Test Statistic	.105
Asymptotic Sig. (2-sided test)	.917

Continuous Field Information



Continuous Field Information



Sheet 3, Question 7:

My knowledge of the SHMS is updated on a regular basis

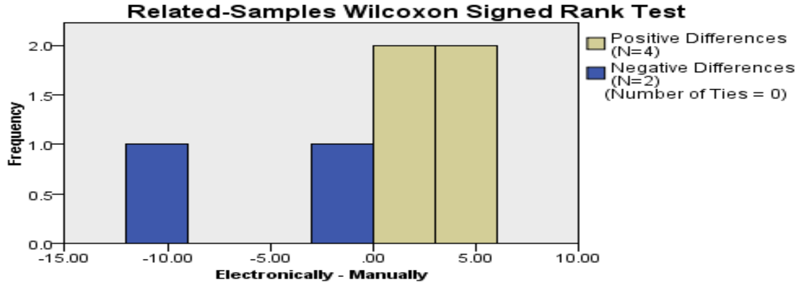
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	1.604	-6.977	5.212

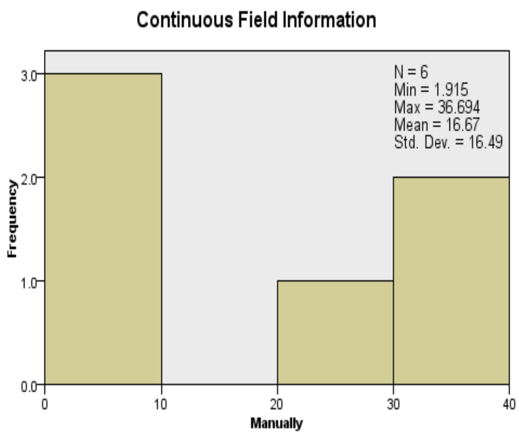
Hypothesis Test Summary

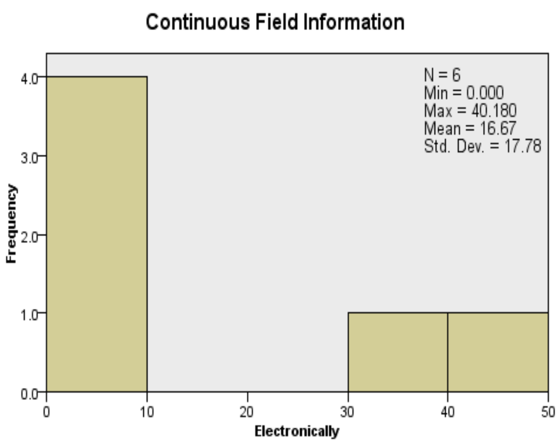
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.753	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	12.000
Standard Error	4.770
Standardized Test Statistic	.314
Asymptotic Sig. (2-sided test)	.753





Sheet 3, Question 8:

Information concerning the SHMS is adequately communicated?

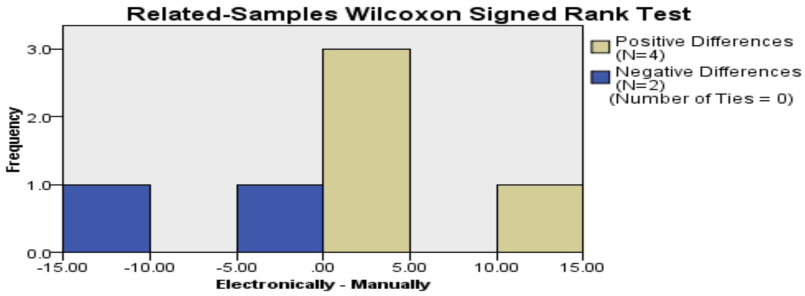
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	.062	-7.228	6.478

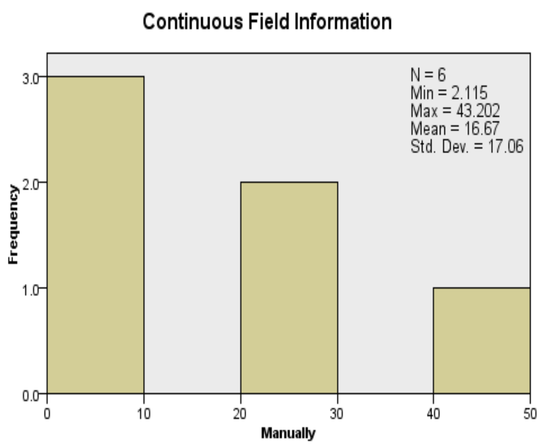
Hypothesis Test Summary

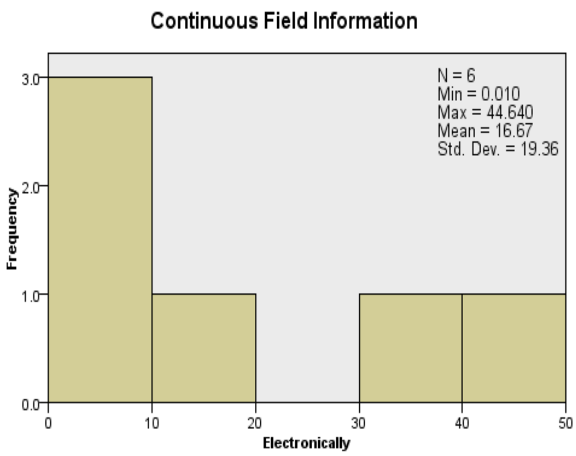
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	11.000
Standard Error	4.770
Standardized Test Statistic	.105
Asymptotic Sig. (2-sided test)	.917





Sheet 3, Question 9:

The SHMS drives improved safety performance?

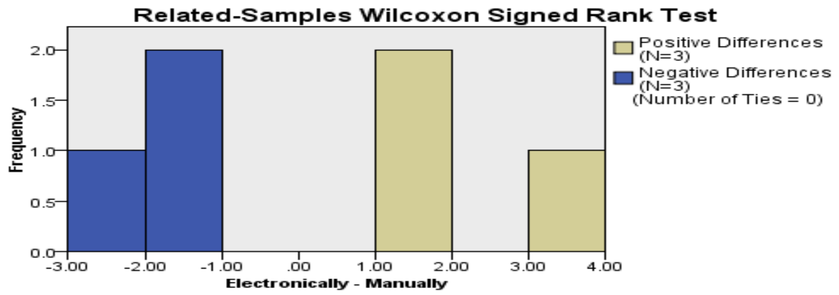
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.206	-2.052	2.258

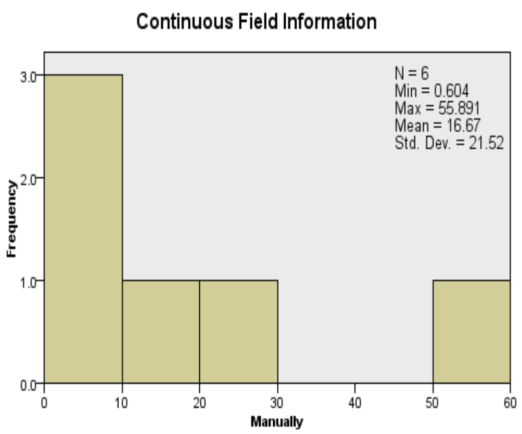
Hypothesis Test Summary

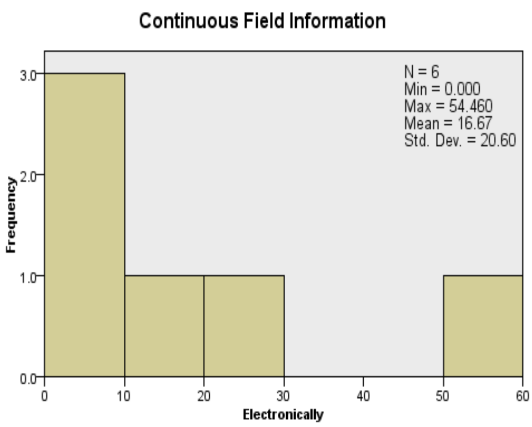
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.753	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	9.000
Standard Error	4.770
Standardized Test Statistic	-.314
Asymptotic Sig. (2-sided test)	.753





Sheet 3, Question 10:

Safety inspections are done by persons in whom I have confidence will take strong action to make the workplace safe?

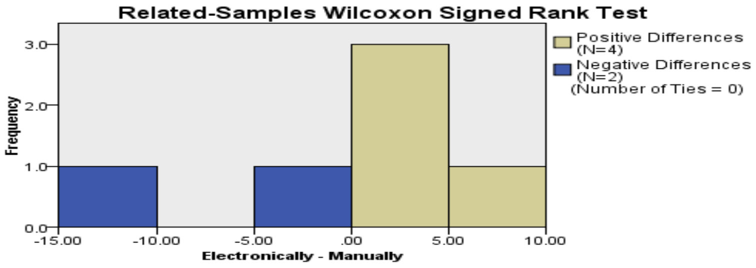
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	.913	-7.241	5.857

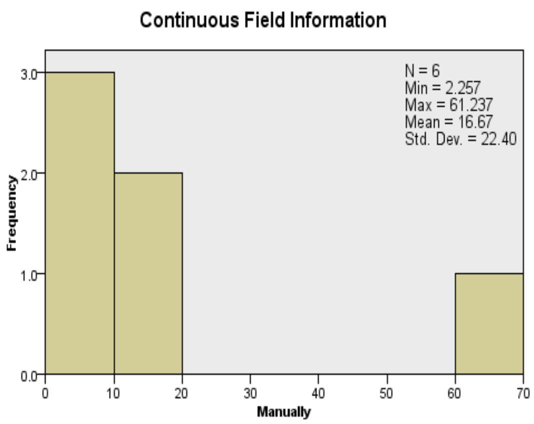
Hypothesis Test Summary

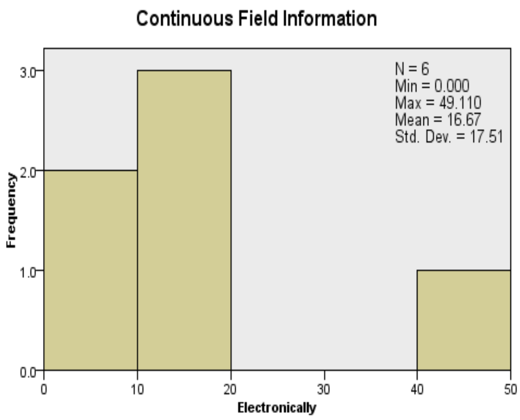
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.753	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	12.000
Standard Error	4.770
Standardized Test Statistic	.314
Asymptotic Sig. (2-sided test)	.753





Sheet 4, Question 1:

Fatigue is causing a problem regarding me being able to operate safely?

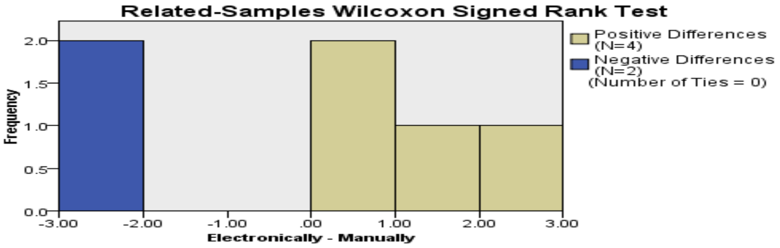
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	.109	-2.273	1.892

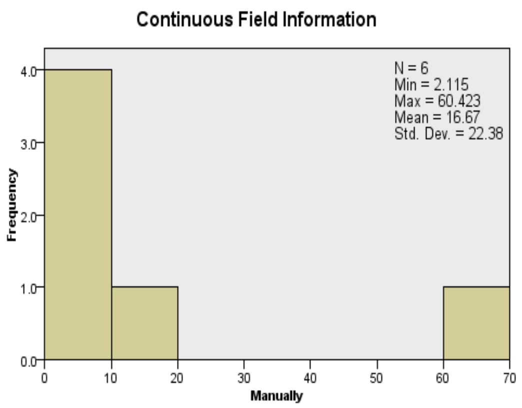
Hypothesis Test Summary

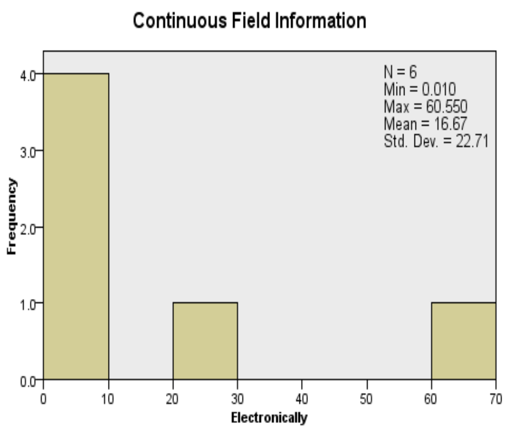
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	11.000
Standard Error	4.770
Standardized Test Statistic	.105
Asymptotic Sig. (2-sided test)	.917





Sheet 4, Question 2:

My current roster allows sufficient quality time with family and friends to support a sustainable work life balance?

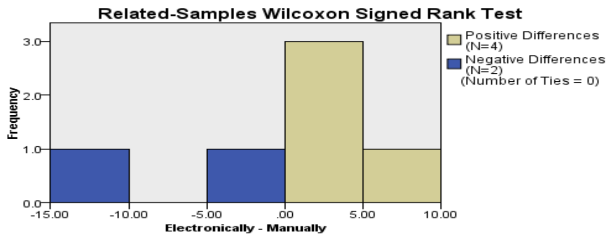
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	1.362	-8.372	6.532

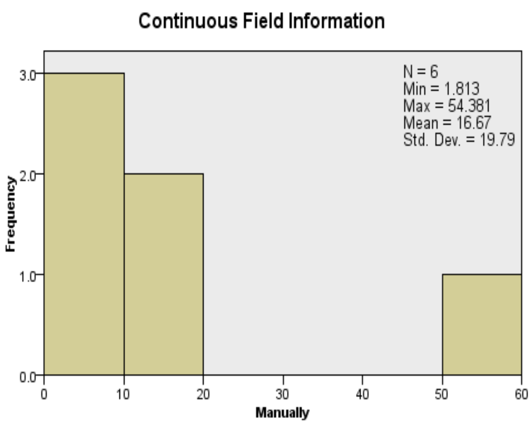
Hypothesis Test Summary

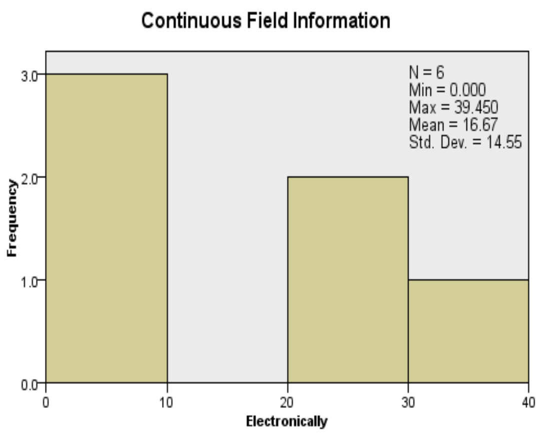
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.600	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	13.000
Standard Error	4.770
Standardized Test Statistic	.524
Asymptotic Sig. (2-sided test)	.600





Sheet 4, Question 3:

My concentration is reduced when working 12 hour night shift rosters?

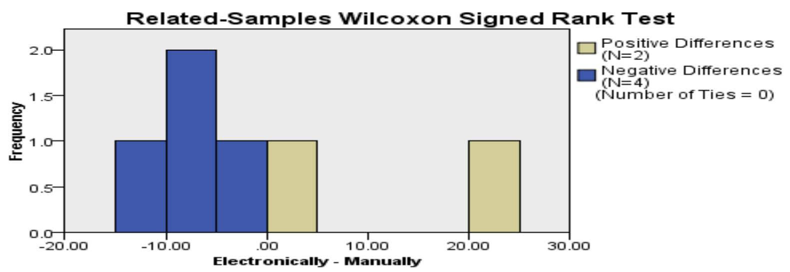
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-2.228	-8.926	11.702

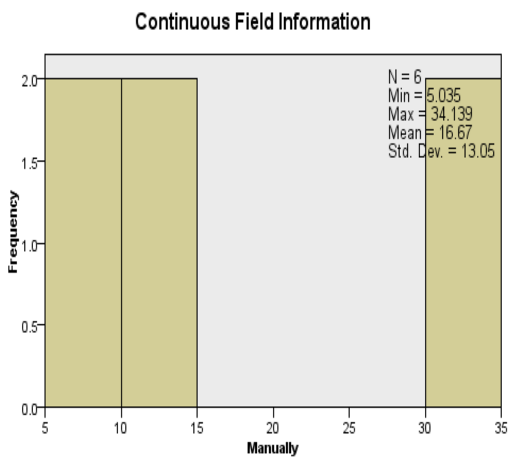
Hypothesis Test Summary

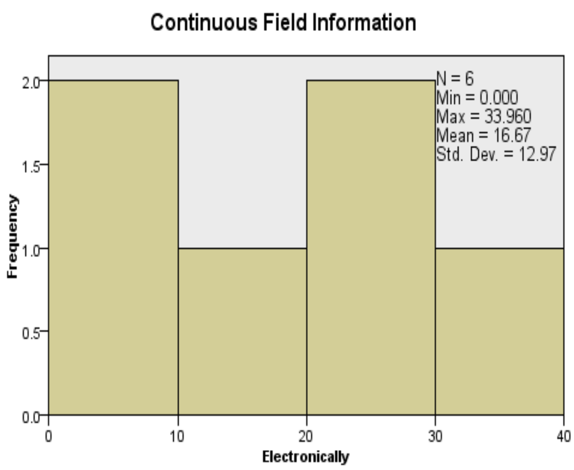
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.600	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	8.000
Standard Error	4.770
Standardized Test Statistic	-.524
Asymptotic Sig. (2-sided test)	.600





Sheet 4, Question 4:

My current roster results in poor judgement of my own performance?

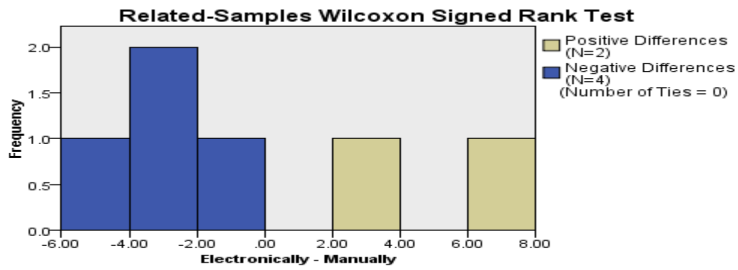
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.083	-3.854	4.898

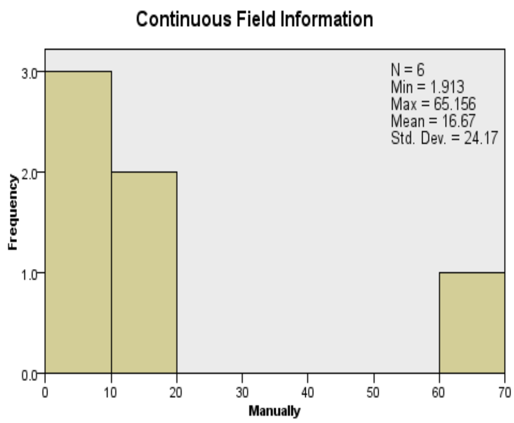
Hypothesis Test Summary

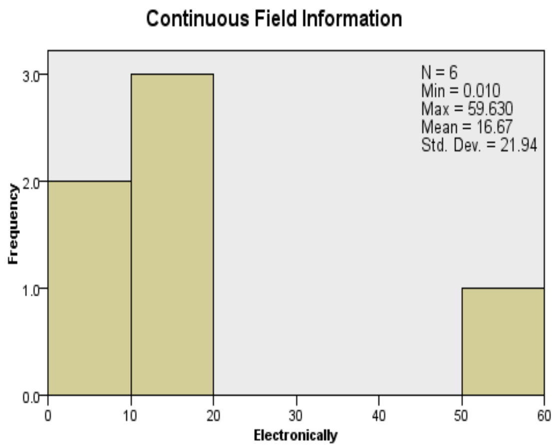
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	10.000
Standard Error	4.770
Standardized Test Statistic	-.105
Asymptotic Sig. (2-sided test)	.917





Sheet 4, Question 5:

Working my current shift roster affects my ability to assess problems and determine solutions?

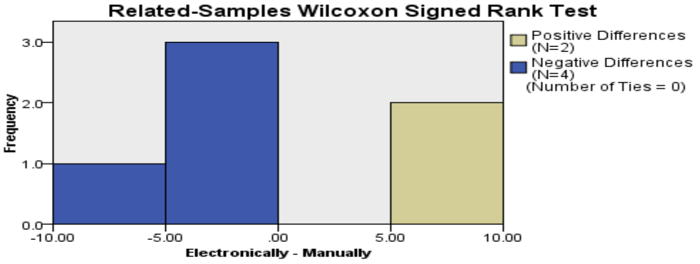
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.447	-5.205	6.699

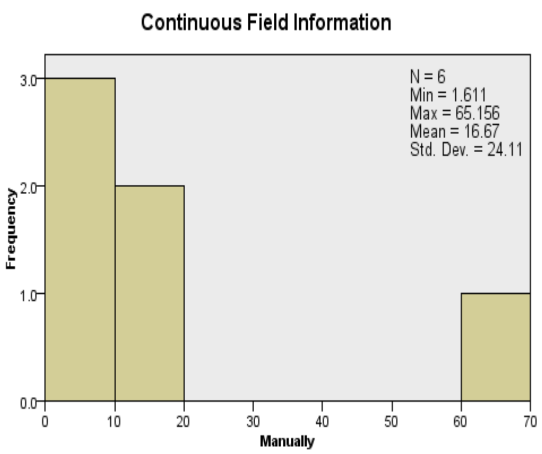
Hypothesis Test Summary

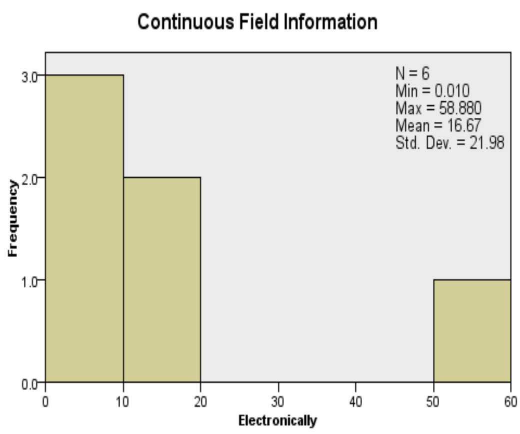
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	10.000
Standard Error	4.770
Standardized Test Statistic	-.105
Asymptotic Sig. (2-sided test)	.917





Sheet 4, Question 6:

When working 12 hour shift rosters my decision making is impaired?

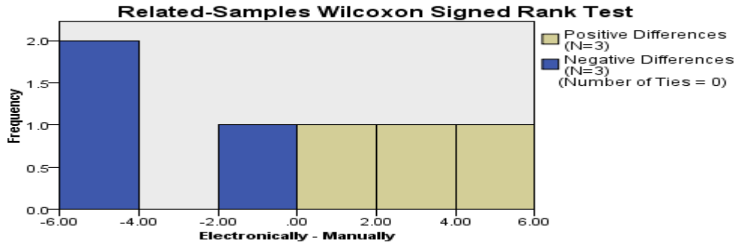
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	.075	-4.295	3.721

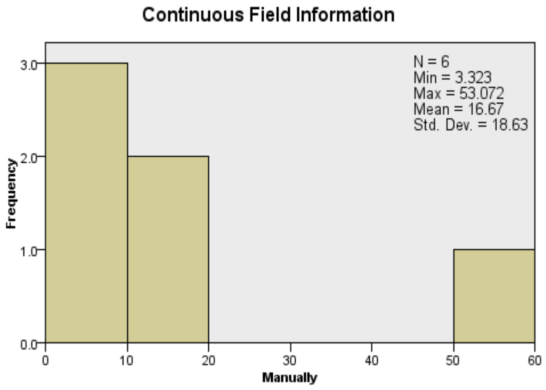
Hypothesis Test Summary

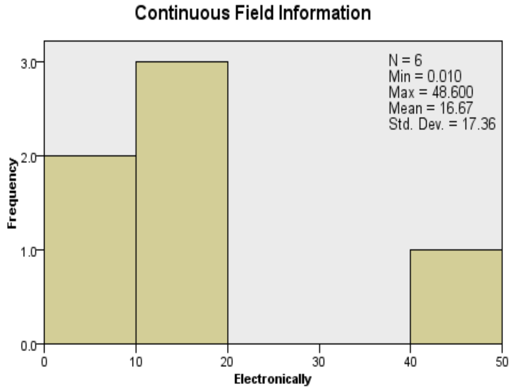
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	11.000
Standard Error	4.770
Standardized Test Statistic	.105
Asymptotic Sig. (2-sided test)	.917





Sheet 4, Question 7:

When working my current roster my awareness and communication skills are impaired?

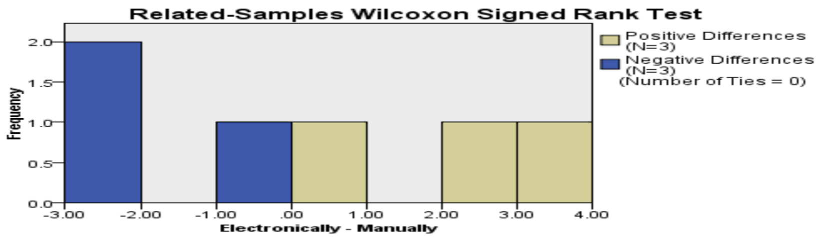
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	.067	-2.767	2.700

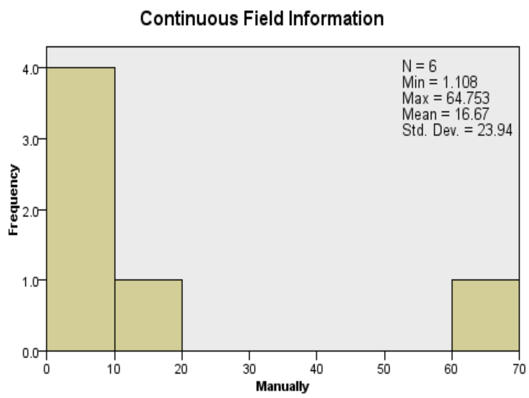
Hypothesis Test Summary

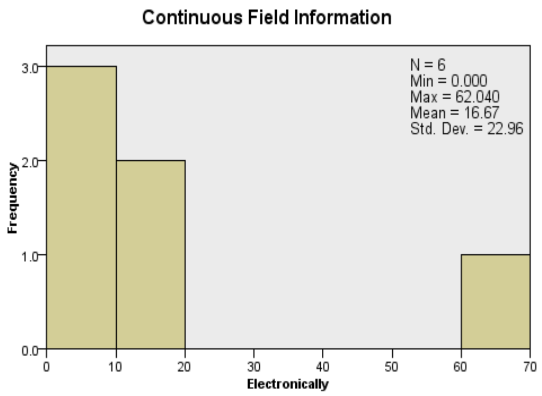
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	11.000
Standard Error	4.770
Standardized Test Statistic	.105
Asymptotic Sig. (2-sided test)	.917





Sheet 4, Question 8:

Travel times to work cause me fatigue and awareness issues?

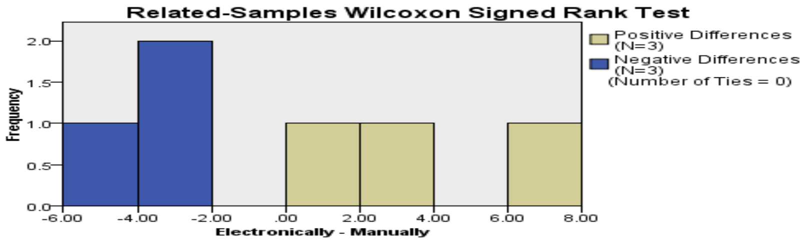
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.362	-4.578	5.102

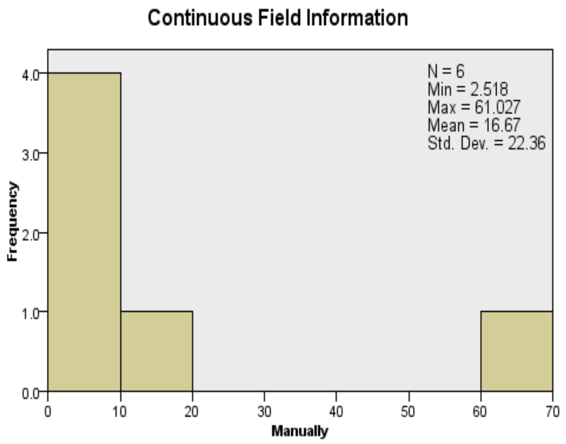
Hypothesis Test Summary

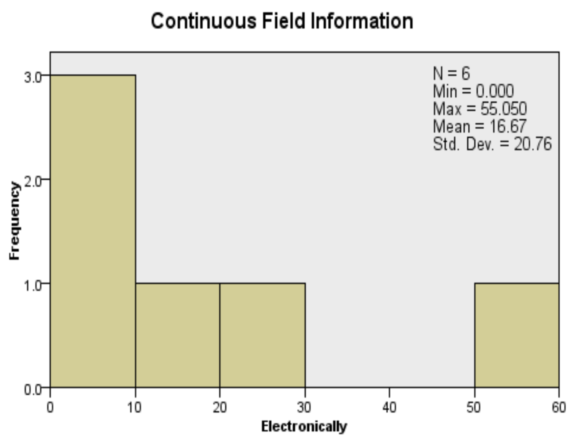
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.753	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	9.000
Standard Error	4.770
Standardized Test Statistic	-.314
Asymptotic Sig. (2-sided test)	.753





Sheet 5, Question 1:

There are practices that limit the quality of accident investigation at my site?

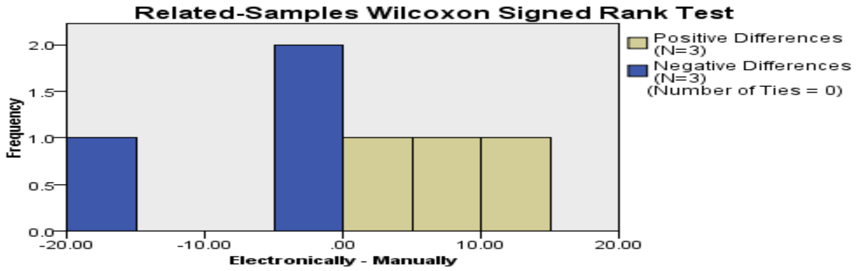
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	.019	-9.190	9.171

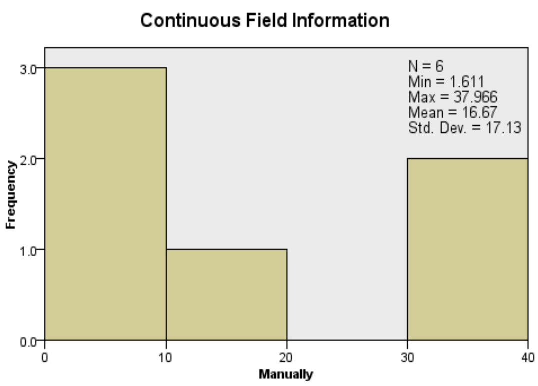
Hypothesis Test Summary

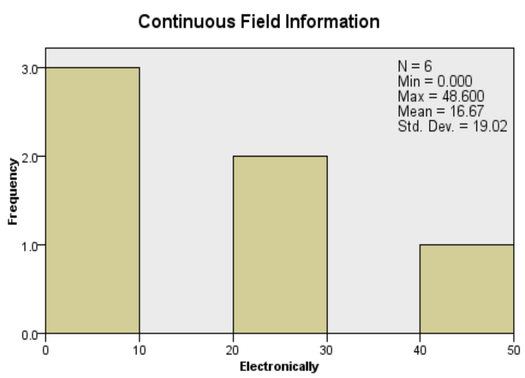
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	11.000
Standard Error	4.770
Standardized Test Statistic	.105
Asymptotic Sig. (2-sided test)	.917





Sheet 5, Question 2:

Information regarding an accident is free flowing on my site?

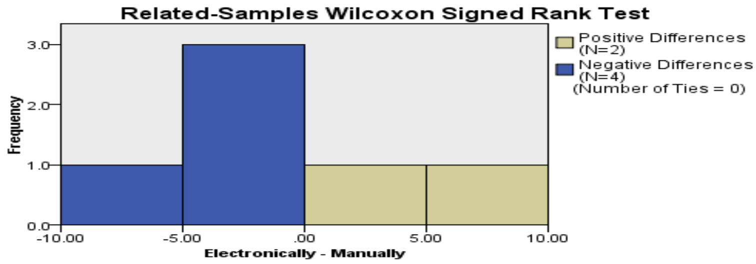
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.849	-4.919	6.678

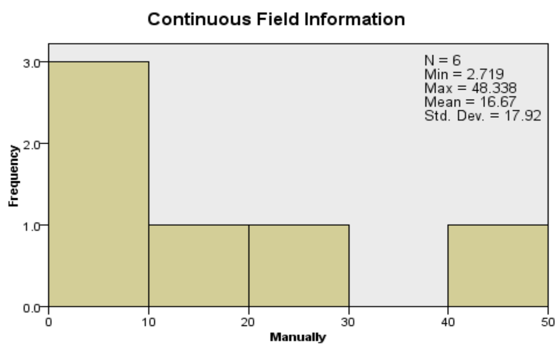
Hypothesis Test Summary

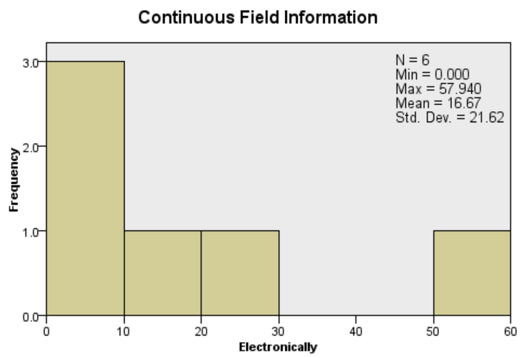
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	10.000
Standard Error	4.770
Standardized Test Statistic	-.105
Asymptotic Sig. (2-sided test)	.917





Sheet 5, Question 3:

I believe that company legal people should be involved in site accident investigations?

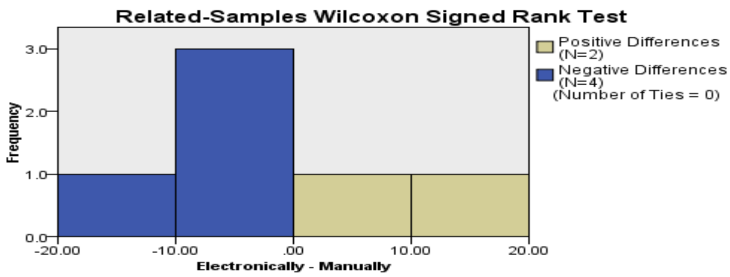
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.723	-11.195	12.643

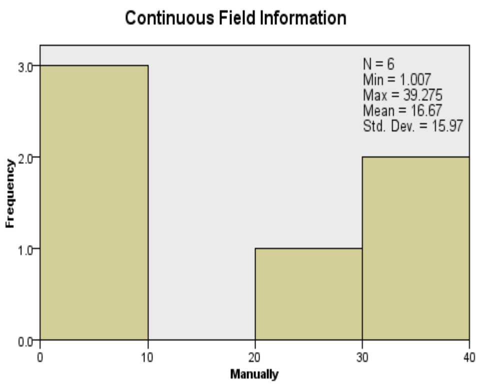
Hypothesis Test Summary

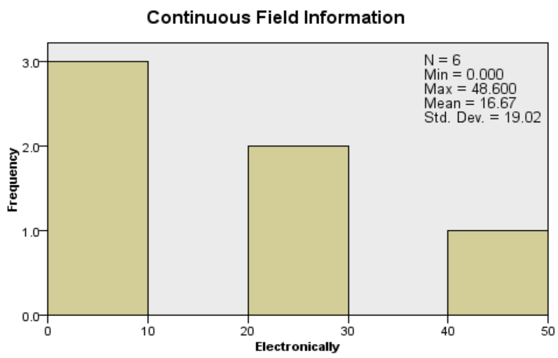
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.753	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	9.000
Standard Error	4.770
Standardized Test Statistic	-.314
Asymptotic Sig. (2-sided test)	.753





Sheet 5, Question 4:

Accident investigation would be best conducted by mine management and the site safety and health representative and not legal people?

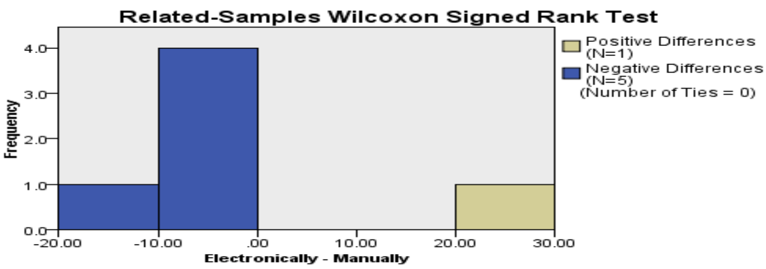
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-3.286	-8.616	11.902

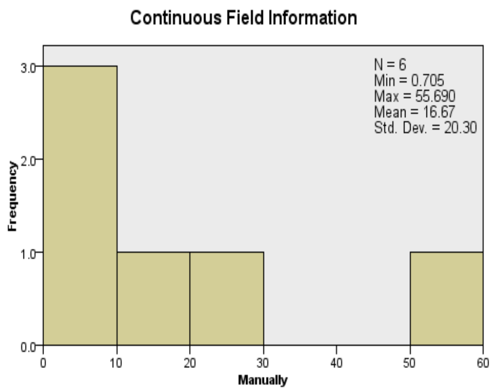
Hypothesis Test Summary

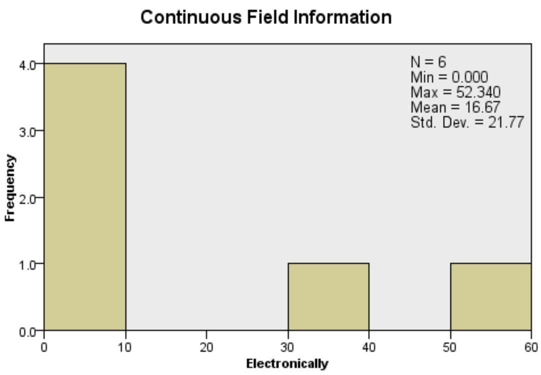
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.345	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	6.000
Standard Error	4.770
Standardized Test Statistic	-.943
Asymptotic Sig. (2-sided test)	.345





Sheet 5, Question 5:

I am concerned about the current inspectorate prosecution policies that are in place?

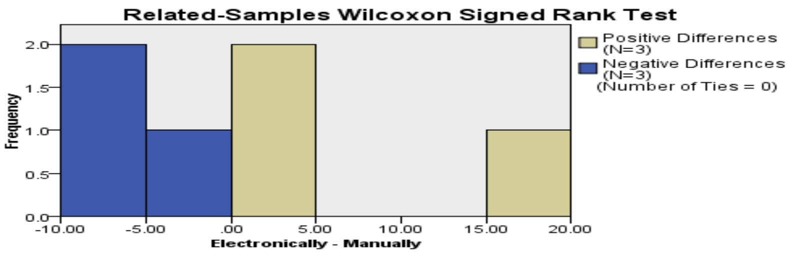
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.916	-8.815	9.731

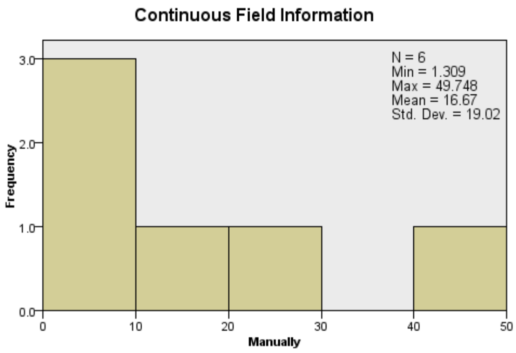
Hypothesis Test Summary

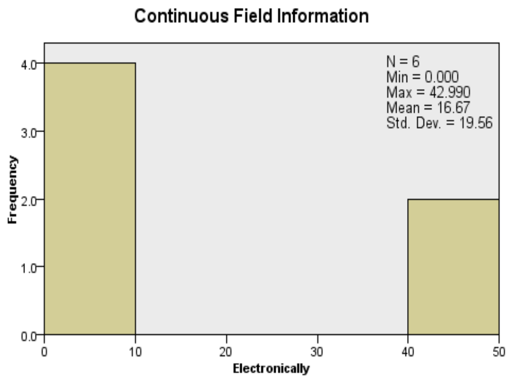
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.753	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	9.000
Standard Error	4.770
Standardized Test Statistic	-.314
Asymptotic Sig. (2-sided test)	.753





Sheet 5, Question 6:

Legal people's involvement affects the open provision of facts concerning an accident or incident?

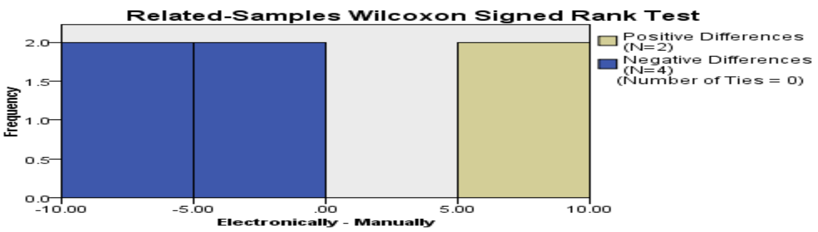
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	.432	-6.594	8.215

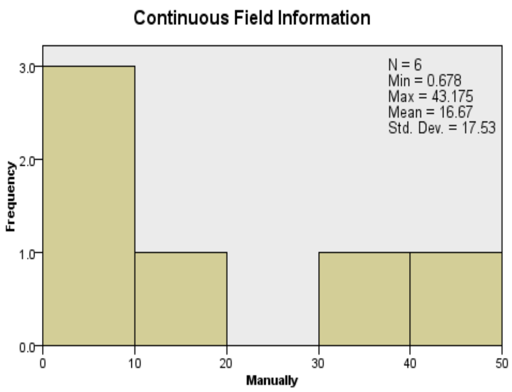
Hypothesis Test Summary

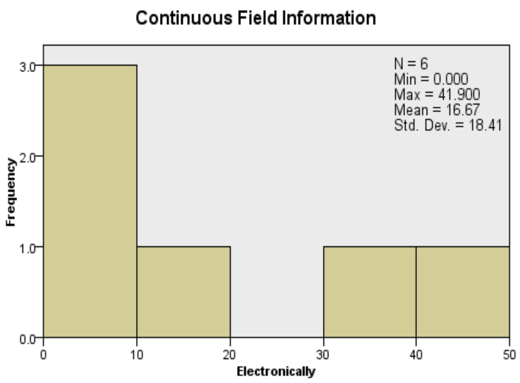
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	11.000
Standard Error	4.770
Standardized Test Statistic	.105
Asymptotic Sig. (2-sided test)	.917





Sheet 5, Question 7:

Prosecution policies should be used as a last resort when wilful and reckless disregard for safety is the case?

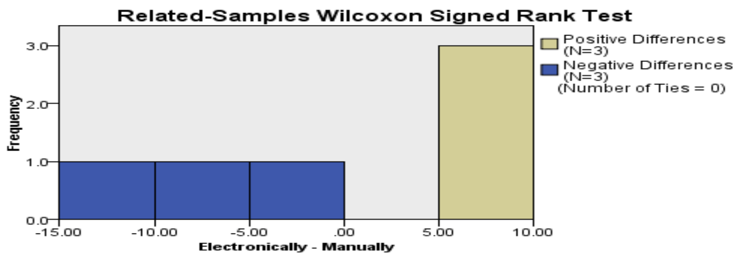
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	1.029	-9.369	8.318

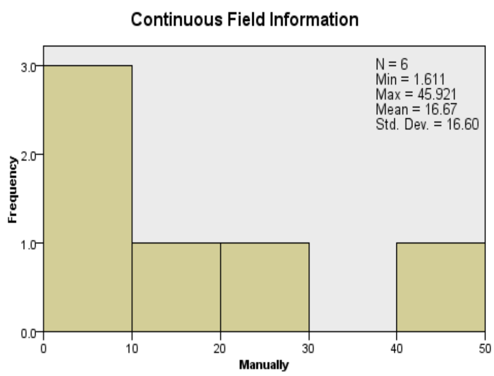
Hypothesis Test Summary

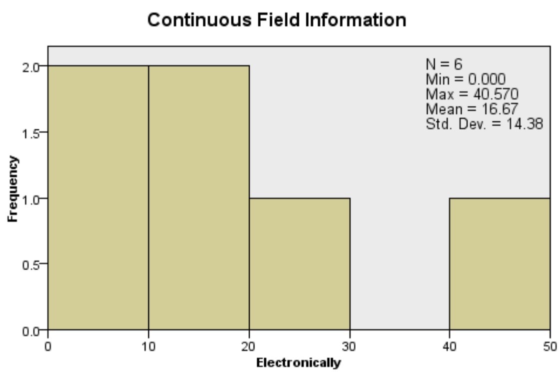
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.753	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	12.000
Standard Error	4.770
Standardized Test Statistic	.314
Asymptotic Sig. (2-sided test)	.753





Sheet 5, Question 8:

The root causes of accidents and incidents are not being examined for fear of the company being prosecuted?

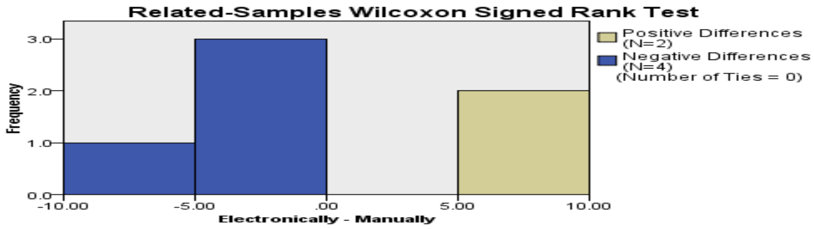
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.628	-6.570	8.595

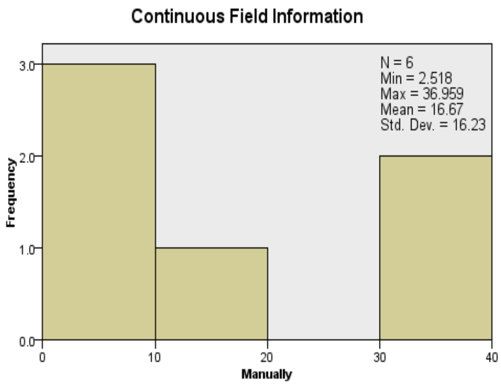
Hypothesis Test Summary

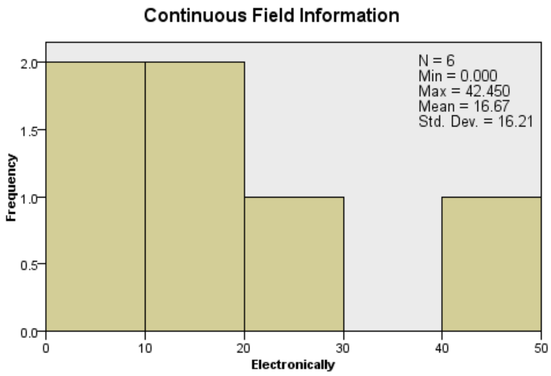
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	10.000
Standard Error	4.770
Standardized Test Statistic	-.105
Asymptotic Sig. (2-sided test)	.917





Sheet 5, Question 9:

An official inquiry would produce better outcomes if there was no fear of prosecution?

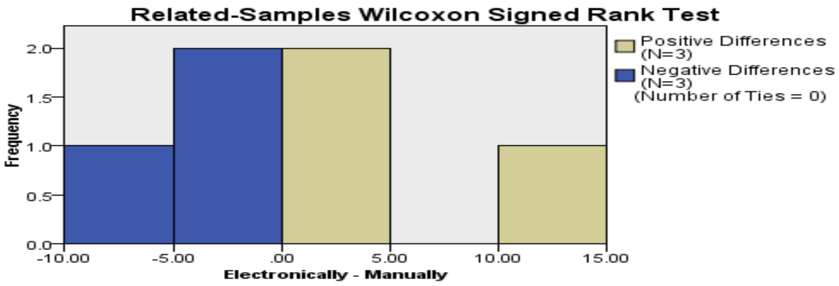
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.116	-6.667	7.721

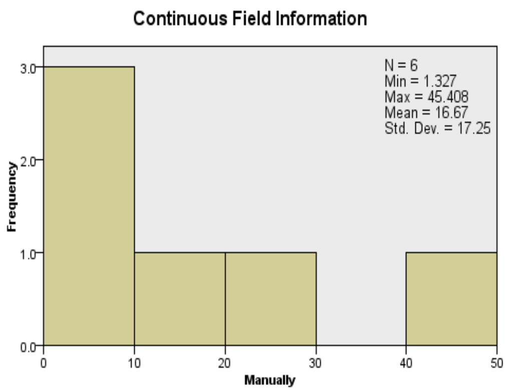
Hypothesis Test Summary

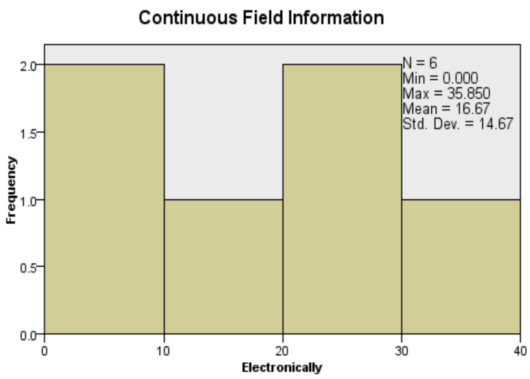
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	10.000
Standard Error	4.770
Standardized Test Statistic	-.105
Asymptotic Sig. (2-sided test)	.917





Sheet 6, Question 1:

FIFO working increases stress levels and poor health?

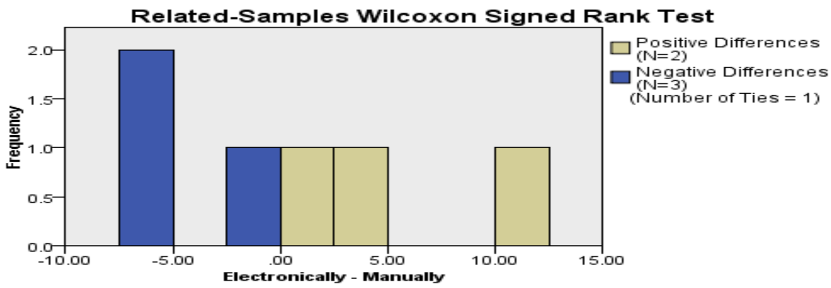
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.519	-6.133	6.652

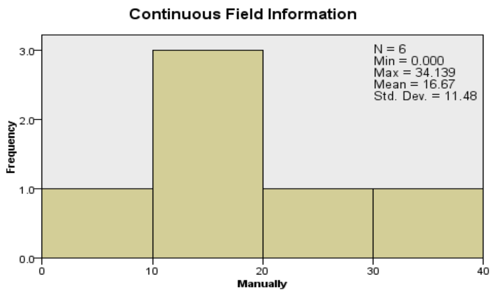
Hypothesis Test Summary

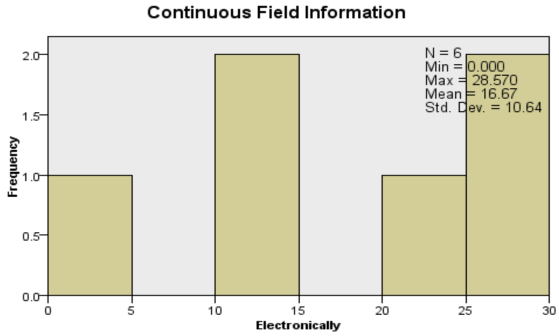
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.893	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	7.000
Standard Error	3.708
Standardized Test Statistic	-.135
Asymptotic Sig. (2-sided test)	.893





Sheet 6, Question 2:

FIFO operations are contributing to poor quality relationships and leading to increased break-up and divorce?

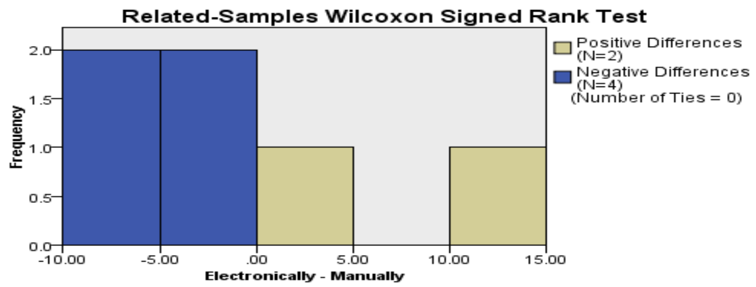
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.292	-6.974	8.711

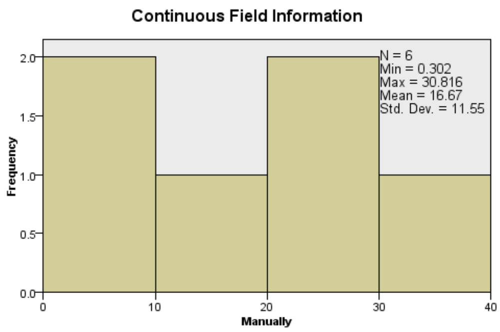
Hypothesis Test Summary

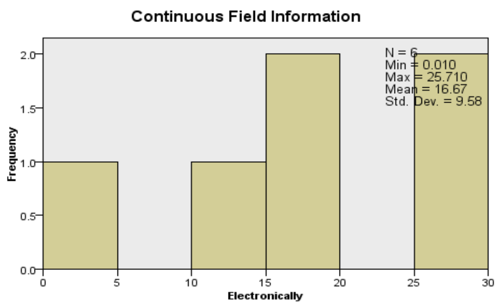
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.753	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	9.000
Standard Error	4.770
Standardized Test Statistic	-.314
Asymptotic Sig. (2-sided test)	.753





Sheet 6, Question 3:

FIFO operations cause family disruptions and stress?

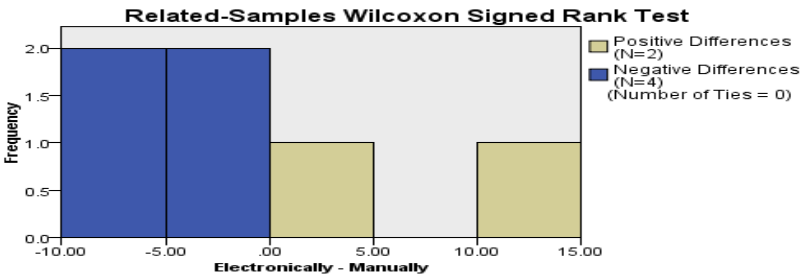
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-1.354	-6.229	7.583

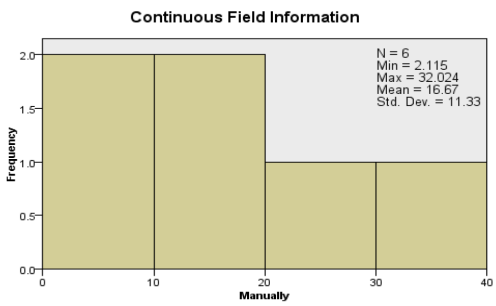
Hypothesis Test Summary

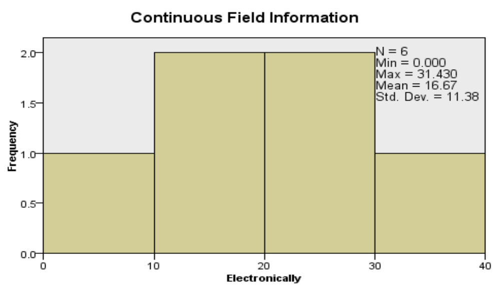
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.753	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	9.000
Standard Error	4.770
Standardized Test Statistic	-.314
Asymptotic Sig. (2-sided test)	.753





Sheet 6, Question 4:

FIFO workers have reduced social and community interaction and feelings of loneliness and isolation?

Confidence Interval Summary

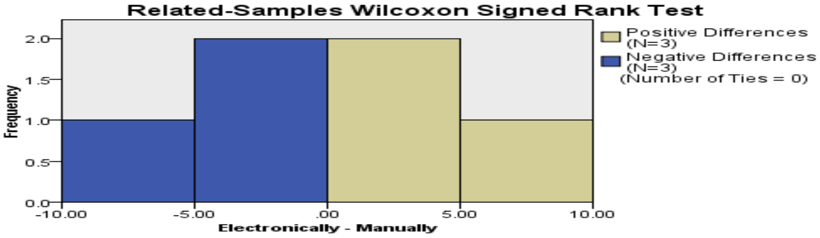
Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.049	-5.961	6.225

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

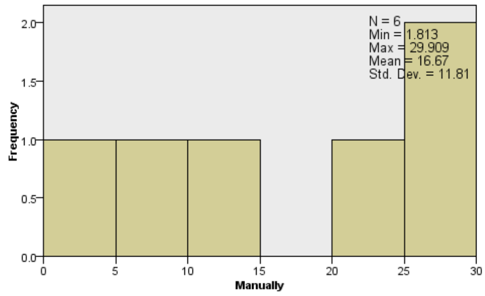
Asymptotic significances are displayed. The significance level is .05.

Related-Samples Wilcoxon Signed Rank Test

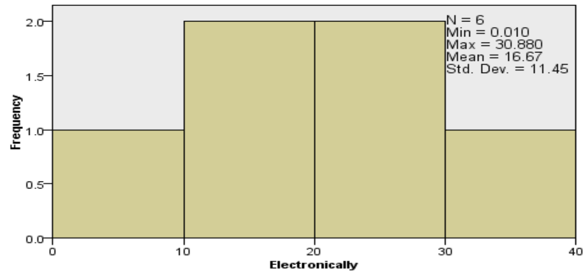


Total N	6
Test Statistic	10.000
Standard Error	4.770
Standardized Test Statistic	-.105
Asymptotic Sig. (2-sided test)	.917

Continuous Field Information



Continuous Field Information



Sheet 6, Question 5:

FIFO working improves financial circumstances from higher wages and lower living costs?

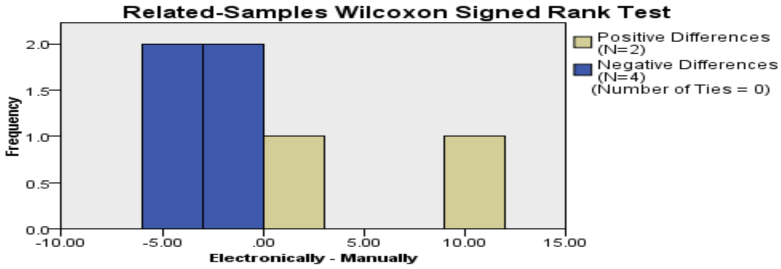
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.846	-4.814	6.445

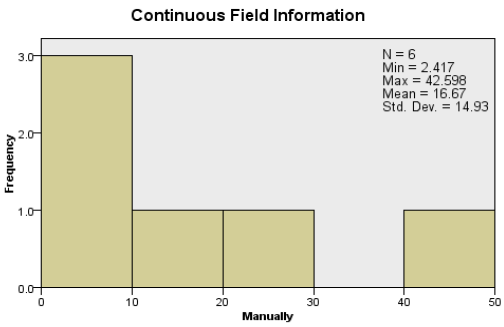
Hypothesis Test Summary

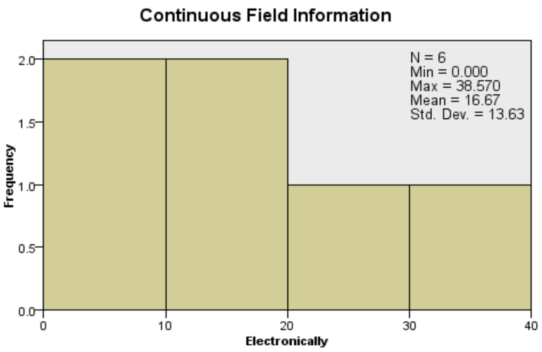
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.753	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	9.000
Standard Error	4.770
Standardized Test Statistic	-.314
Asymptotic Sig. (2-sided test)	.753





Sheet 6, Question 6:

FIFO operations allow workers to make lifestyle choices for themselves and their families?

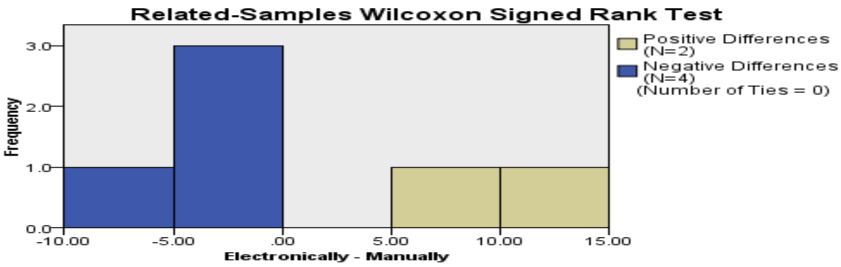
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	-.473	-7.296	8.741

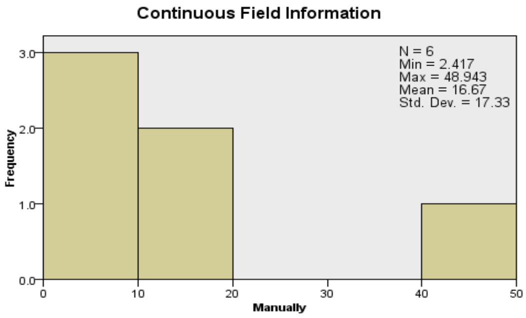
Hypothesis Test Summary

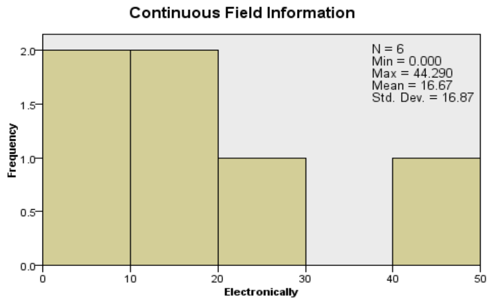
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	10.000
Standard Error	4.770
Standardized Test Statistic	-.105
Asymptotic Sig. (2-sided test)	.917





Sheet 6, Question 7:

FIFO operations allow uninterrupted blocks of time to enable workers to spend better quality time with their partners and families?

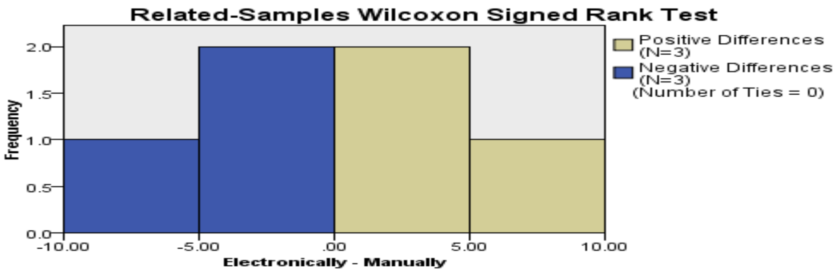
Confidence Interval Summary

Confidence Interval Type	Parameter	Estimate	95% Confidence Interval	
			Lower	Upper
Related-Samples Hodges-Lehman Median Difference	Median of the difference between Manually and Electronically.	.272	-4.839	6.254

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Manually and Electronically equals 0.	Related-Samples Wilcoxon Signed Rank Test	.917	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	6
Test Statistic	11.000
Standard Error	4.770
Standardized Test Statistic	.105
Asymptotic Sig. (2-sided test)	.917