Department of Civil Engineering

Australian Industrial and Construction Injuries, Diseases and Fatalities; and Recommendations for Safety Practices

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.
This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Signature: ....

Date: 28/04/2015

Disclaimer

Data used in this thesis is from National Coroners Information System (NCIS) and it is based on the Access Agreement between NCIS (as the database source of data), Victorian Institute of Forensic Medicine (as the source organisation of that data) and Curtin University through the Department of Civil Engineering. According to clause 20.1 of this Access Agreement 'Neither VIFM nor any Participating Jurisdiction from which Data originated warrants that the data is accurate or reliable and the Authorised Organisation agrees that VIFM and any participating Jurisdiction shall be in no way liable for any loss, damage or injury suffered by it or any other person or corporation consequent upon the existence of any errors in the Data'. If any data is used from this thesis, written permission from VIFM is required.

Abstract

The construction and building industry is one of the most dangerous industries worldwide. A review of the literature indicates a direct correlation between lack of safety culture and the occurrence of accidents within this industry. The Australian construction industry is predominantly made up of small businesses and it has been suggested by some researches that such businesses lack compliance with Occupational Health and Safety (OHS) laws in comparison with larger size businesses. Construction makes up a significant part of the Australian economy thus having a profound influence on the living standard of the nation as a whole. The occurrence of accidents, injuries, diseases and fatalities are amongst the highest in Australian construction industry (relative to other industries). From 2003/04 to 2009/10, a total of 3013 workers, commuters and bystanders in Australia lost their lives as a result of work-related activities. This equates to an average of 430 each year. In the same period, the construction industry accounted for 181 worker fatalities – an average of 26 a year. There are new and emerging challenges to OHS that will require revised responses with a holistic system approach. Hence, the aim of this research was to review and investigate fatalities, injuries and diseases in Industrial and Construction industries in Australia in order to make recommendations for safer practices. The focus was on OHS, construction industry and Western Australia. The hypotheses generated from the analysis of the data from Australian Industrial and Construction fatalities from year 2000 to 2010 using data from National Coronial Information System (NCIS) and Australian construction industry's fatality data from 2003-2004 to 2009-2010 from Safe Work Australia indicated that:

- Construction sites had the second highest number of work-place fatalities after factory/plant locations;
- The highest number of fatalities relating to workers born in other countries occurred in the first 5 years of their stay in Australia;
- Workers born in other countries worked to an older age compared to those born in Australia; and
- Data from NCIS showed that winter and month of July had the highest number of fatalities in Industrial or Construction industries.
- Data from Safe Work Australia indicated that the summer season had the highest number of work-related fatalities in construction industry.

As a result of this research, nine OHS management system models have been recommended which are formed from a cluster of factors and from many different disciplines to be used as an assessment tool, to prevent accidents, injuries, diseases and fatalities in construction or related industries.

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Publications

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Dejahang, M., and Vimonsatit, V., (2015): *Australian Industrial and Construction Fatalities: Data from National Coronial Information System (NCIS) - Part 1 (Age, and Foreign-Born Workers) "under review".*

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Chapter 1: Introduction

1.1 Background

According to Parliament Senate Committee and Campbell, about 50 fatalities are occurring in Australian construction industry every year (Fleming et al., 2006). The injuries in this industry are also estimated at being 50% more in comparison to other industries (Cole, cited in Fleming et al., 2006) and the fatality rates are estimated at being ‘three times the national workplace average’ (Fleming et al., 2006).Even though there has been some improvements during the Safety Strategy 2002-2012 in occupational health and safety, however every year on average 250 workers die in Australia as a result of their injuries sustained at work (Safe Work Australia, 2012). It has been also estimated that every year about 2000 workers die from work-related illnesses in Australia (Safe Work Australia, 2012).

Constructions accidents in Japan are up to 30-40%,in Ireland 50% and in UK 25%are higher compared to all other industries (Bomel, cited in Rowlinson, 2004). In 2000/2001, 114 workers were killed in UK’s construction industry being ‘over five times the all industry average’ (HSE, cited in Rowlinson, 2004).In European Union (EU) construction industry is composed of 10% of the working population however it accounts for 30% of the fatal industrial accidents. In USA, 20% of fatal accidents occur in this industry which is composed of only 5% of the working population (MacKenzie, Gibb and Bouchlaghem, cited in Rowlinson, 2004).

The estimates based on 1998 statistics shows that every year there are about 2 million work-related fatalities, 160 million people in the world suffer from work-related diseases. The cost estimates are about 270 million each year. It has been estimated that every year 12000 children (child labour) lose their lives while working as a result of accidents. These figures are underestimated in view of the fact that ‘many occupational deaths and injuries are never reported even when statistics do exist’ (ILO, 2003).

Industrial and construction industries have a significant role in the economy of Australia or any other countries and have a profound influence on the living standard of the nation as a whole. According to Department of Employment and Workplace

Relations (cited in Fleming et al., 2006) in 2003-04, building and construction sectors valued at about $50 billion to Australian economy and it has been estimated that the improvements in these sectors can generate an extra $2.3 billion per annum into Australian economy and ‘a 1% decrease in the cost of living for all Australians’.

The changes in the world economy and progresses made in technology have been having a great impact on work-places and the working condition of workers in recent years. This effect is even greater in construction industry being known as one of the most hazardous industries due to its dynamic situation of construction sites, diversity of work and its unique environment.

According to ABS (2011-12) the structure of construction businesses includes:

- Small businesses:
  - Range of employment : 0 – 19
  - Employed persons: 62.1% of the total workforce
  - Accounted for: 97.7% of all construction businesses and
  - Total income: 49%of the total workforce
- Medium size businesses
  - Range of employment: 20-199
  - Employed persons: 19.3%
- Large size businesses
  - Range of employment: 200
  - Employed persons: 18.6%
  - Accounted for: 0.1% of all construction businesses and
  - Total income: 27.3% (ABS, 2011-12).

Construction industry is the forth priority action area set by Safe Work Australia by year 2022 after Agriculture, Road transport and Manufacturing.

Given this background the attempt has been made to propose effective strategies to unravel these problems. The models developed in this research are to cover a cluster of factors from many different disciplines. The success or failure of such models strongly depends on the stakeholders such as government organisations, employers, managers (above all civil engineers), health and safety personnel, consultants, OHS committee members, supervisors, the work-force, work-forces' representatives and their genuine dedication to OHS.

1.2 Aim and objectives of the research

The aim of the research is to investigate Australian Industrial and Construction fatalities, injuries, diseases and to identify the most significant contributory factors and the cost associated with them. It is also to make recommendations for safety practices. The specific goals of the thesis are as follows:

1- Review and determine the Australian Industrial and Construction fatalities, injuries and diseases with specific reference to:
   - Occupational Health and Safety in Australia;
   - Construction industry in Australia, and
   - Related matters to Western Australia, these include: WorkSafe Western Australia, work-related fatalities by industry, occupation, and construction industry.

2- Analysis of Australian Industrial or Construction fatalities from year 2000 to 2010. Using data from National Coronial Information System (NCIS). NCIS is known as the most reliable source of work-related fatality data in Australia. This research intends to:
   - Statistically analyse some of the variables from NCIS databases, these include : Age and Gender, Marital Status, Season, Month of the year, Employment status, Case Type completion, Location and Activity at the time of incident;
   - To identify issues of concern in relation to variables analysed;
   - To examine the accuracy of data collected;
   - To review some case studies from NCIS databases.

3- To investigate and evaluate the most significant factors affecting Industrial and Construction industries' poor performance and further make recommendations for safety practices which could contribute in reduction or elimination of industrial and construction accidents. These recommendations include:

- Civil Engineers and OHS education;
- Construction workers and OHS education;
- Further specific recommendations, and
- Development of OHS models

1.3 Significance

The significance of this research and development of OHS Models is to address the need for stakeholders (e.g. OHS professionals, employers, engineers etc.) to have an assessment tool which can help to reveal factors contributing to the occurrence of accidents, injuries, diseases and fatalities in Industrial and Construction Industries in Australia.

These models will enable to connect all contributory factors for poor performance of construction industry or any other industry and contributes into assessment of the correct number of work-related injuries and fatalities in any Australian industry. Many different disciplines had to be studied during the process of this research. OHS Models are developed by integrating the fundamental aspects of the areas of concern. The models are suitable for any industries and can also be used as frameworks to be introduced in tertiary education in many disciplines, particularly in Civil Engineering.

1.4 Structure of the Thesis

The rest of this research thesis is composed of 8 Chapters. It should be noted that it has been necessary to holistically review the literature and all disciplines in relation to work-related fatalities, injuries and diseases in Industrial or Construction industries in Australia to reveal existing contributory factors (Chapters 2 to 4) before approaching to chapters consists of methodology and the results (Chapters 5 and 6).

In Chapter 2, the historical development of occupational health and safety is reviewed followed by the Australian OHS national policies. Furthermore priority industries and disorders are identified.

In Chapter 3 accident causation theories and models are introduced. Epidemiological theory described will be used in analysing the data.

The scope of Chapter 4 is to review the literature on the causes and cost estimates of traumatic industrial work-place injuries, fatalities and diseases in Australia with specific reference to Western Australia and construction industry in Australia.

Chapter 5 demonstrates the methodology used for analysing work-related fatalities in Australia for Industrial and Construction work- places (data from NCIS).

In Chapter 6, some of the variables for work-related fatalities from NCIS will be analysed for Industrial and Construction industries from 2000 (January 2001 for Queensland) to 2010. These variables include: Age and Gender, Marital Status, Season, month of the year, Employment status, Case Type completion, Location and Activity at the time of incident.

As a result of this research some recommendations for work-place safety practices are provided in Chapter 7.

Finally chapter 8 summarizes the contribution of this research and concludes this research along with some recommendations for future studies.

Chapter 2: Literature Review

2.1 Introduction

Despite the advances achieved in relation to occupational health and safety (OHS) in developed countries, fatalities, illnesses and injuries are high and cause for concern, particularly in industries such as construction, road transport and mining. On the other hand the challenges in developing and third world countries are even greater. In view of Quinlan, Bohle, and Lamm (2010, p. 2) ‘Any presumption that OHS will gradually improve in both developed and developing countries is naïve. Further, just as the nature of work undergoes change within both developed and developing countries, so do the health hazards associated with work. There are emerging or new challenges to OHS that will require new or revised responses’.

In view of Winsor, Gardner, and Trethewy (2001, pp 67-77) ‘Australian workplace of the 21st century will look different from those of the past. The advantages of greater flexibility, unity, efficiency and innovation will occur as systems are developed which encourage people to interact more positively with each other and as rapidly changing technology become more effectively used’.

It should be noted that the breaches of basic legislative requirements are common in developed countries such as Australia, United States and Canada. In some industries OHS standards remain appallingly low in practice. The examples of these industries in Australia are home-based and garage factory. The significant number of these workers is female with low pay, long working hours and with little or no OHS safeguard (Quinlan et al, 2010).

The positive changes in the world economy and progress in technology has been having a great impact on the working condition of workers. Collection and analysis of data has revealed many issues, concerns and dangers to workers and their health (Rantanen, 1987-9).

OHS has been recognised by the public and industries and has come a long way during the last 30 years. However the occupational related injuries, diseases, mortalities neither recorded accurately nor has been given attention by politicians or the media compared to some other concerns such as, road accidents, climate change and violent crimes(Quinlan et al, 2010).

2.2 Historical development of occupational health and safety

OHS has been practically rooted, developed and advanced from Britain. A team of enquiry under chairmanship of Lord Alfred Robens was set up in 1970 in Britain to prevail over the shortcomings of the existing OHS legislation. The Health and *Safety at Work Act of 1974* in the UK was shaped as a result of Robens' report presented to British parliament in 1972 (Robens, 1972). Robens report was adopted by many countries. The United States established its own legislative reforms with *Occupational Safety and Health Act of 1970.* Notable achievements by the United Kingdom and the United States were the establishment of detailed standards, its inspection, enforcement, training, education and research. It should be noted that employee involvement in United States was very limited compared to United Kingdom (Robens, 1972).

The key figures who contributed to the development of OHS prior to the nineteenth century were (Taylor and Ester, 1999):

- Georgius Agricola (1494-1555), Author of the book of Things Metallic
- Theophrastus Bombastus Van Hohenheim, Paracelusus (1493-1541), who made the first contribution towards toxicology.
- Bernardino Ramazzini (1633-1714) known as the father of Occupational health, wrote a book on diseases of trades, A Diatribe on disease of workers.
- Percivall Pott (1776) fined the link between an occupation and the Cancer causing compounds, RAH's (polynuclear aromatic hydrocarbons).
- Anthony Ashley cooper (1801-85) improved working condition and working hours for many workplaces.
- Dr Thomas Percival (1740-1804) reported on working conditions of young workers in textile mills.
- Robert Owen (1771-1858) good working condition was observed in his textile mills
- Sir Robert Peel sr. (1788-1850) was the pioneer of the factory legislation.

- Michael Sadler, M.P. (1780-1835) supported changes in the laws concerning the occupational health in the parliament.
- Dr Charles Thackrah (1795-1833) wrote the first book on occupational health on 1832.
- Dr William Farr (1807-83) analysed birth and death statistics in relation to occupational health.
- Dr Edward Headlam Greenbow (1814-88) studied the health effects of lead dust and fumes.
- Dr John Artidge (1822-99) analysed the statistics on the potter diseases.
- Dr Thomas Legge (1863-1932) was the first medical inspector sent to factories to investigate the issues concerning health of workers.
- Dr Alice Hamilton (1869-1970) studied the effect of lead on workers health.
- F. F. Erisman (1842-1915) made vast amount of contribution towards occupational health and safety in Russia.
- Donald Hunter (1898-1978) wrote a book on disease of occupations.
- Luigi Parmeggiani editor of the Encyclopedia of Occupational Health and Safety.

2.2.1 Developments of OHS in Australia

The original OHS in all Australian states and territories was adapted from the English Factory Acts of the 19th century (1833-1894) (Taylor and Easter, 1999). By 1970 all Australian states implemented the British form of OHS laws and regulations, mainly the 1878 Factories Act and later on the 1901 Act. Since 1970 all Australian states have reached a minimum standard for OHS and a wide-range of inspection powers were given to inspectorates (NRCOHSR, 2002).

The Factory Act style of OHS legislation was reformed in 1974, by Robens committee. This reform had overcome the weaknesses of the traditional approach of having too many laws and too many authorities and very little involvement in OHS by workers and unions (NRCOHSR, 2002).Robens Report was based on two principle objectives the first one was the ‘creation of a more unified and integrated system’ bringing statutory general duties for all parties (employers, employees, self-employed, occupiers, designers, manufacturers and suppliers) under the standard regulations and codes of practice. A new administrative power (prosecution of corporate officers and employers) was given to OHS inspectorates. The second objective of Robens' report was 'self-regulation'. This consisted of involvement of management with workers or their OHS representatives in promotion of safety and health at workplaces and with greater collaboration between OHS inspectorate and employee representatives (NRCOHSR, 2002).

The Robens-style legislation was nearly adopted by all Australian States and Territories during 1980s'. The Occupational Safety and Health Act 1984 was introduced in Western Australia placing duties on employers self employed persons, manufacturers, designers, importers and suppliers (McGowan, 2005).National Occupational Health and Safety Commission was established in the mid 1980s with representatives from employers, employee bodies, the Australian Chamber of Commerce and Industry, the Australian Council of Trade Unions as well as the commonwealth state and territory governments 'its operational arm is Safe Work Australia, based in Canberra' (McGowan, 2005).

Prior to 1990, the Australian regulations formed from many regulations. This was reformed towards a national uniformity of standards in regulation and codes of practice during the 1990s. By the end of 1996 all Australian jurisdictions adopted these standards. However the national uniformity process was incomplete by Howard government coming into power in 1996 (NOHSC was abolished) (NRCOHSR, 2002).

A lot of power has been given to inspectorates in Australia. These powers include right of entry, inspection, removal of equipment, materials or samples, photography and production of documents. 'In 2004 WorkSafe Western Australia inspectors issued 11,000 improvement notices, 900 prohibitions notices and had 55 prosecution cases' (McGowan, 2005).

2.2.2 Evolution of OHS in Australia

Majority of Australian OHS inspectorates have been given a quite broad power, to enforce laws, and to prosecute employers in violation of the legislation (penalty is the fine).It is the provision of Australian OHS statutes that workers representatives to be present in workplace committees to be engaged in OHS matters. In most of the jurisdictions, power given to workers representative is a lot, however in Western Australia, Queensland and Tasmania the power given to inspectorates is very limited (NRCOHSR, 2002).

Emmett (1999) describes occupational health and safety as a dynamic issue in every society. Emmett has classified the evolution of OHS in Australia to three phases from 1890s to around 1999:

- The ‘classical’ phase, from the late 1890s to the early 1980s
- The ‘modern traditional’ phase, from about 1985 to 1991
- The ‘performance’ phase, from about 1992 to around 1999.

The Classical phase:

The OHS in this period was similar to the nineteenth century OHS adopted in Europe and twentieth century of United State. Since there is a very limited statistics, it is very hard to assess the success of OHS in this era, however it can be said that OHS in this period was managed in an ‘ad hoc’ manner and it cannot be seen as successful.

The Modern Traditional phase:

This era was the beginning of the implementation of the OHS procedures borrowed from Europe and United states. The election of the labor government had a very positive impact on the progress of OHS in Australia. A broad OHS legislation (similar to British OHS) was introduced in all Australian states and territories. The legislation established duties of care for employers, employees, suppliers, manufacturers, designers and installers. Health and safety committees were formed with involvement of union, management and worker’s representatives. National Occupational Health and Safety Commission (NOHSC) were established in 1985 being fourteen years behind from United States. NOHSC was consisted of representatives from each of the following:

- Eight states and territories;
- Australian Chamber of Commerce and Industry;
- Australian Council of Trade Unions;
- Commonwealth ministers for Industrial Relations and for Health;
- An independent part-time chairman;
- Chief executive officers.

The important achievements by NOHSC were the establishment of advisory national standards, informative products, educational materials, training and research, improvement in workers compensation and rehabilitation, changes in regulations and establishment of a national register to record mesothelioma cases using the pathology results.

Other notable achievements were formation of National Data Set (NDS), a uniform coding classification used for workers compensation systems, allowing national workers compensation data to be published. Use of coroners' records highlighted the actual number of fatalities (more than 500 per year) from occupational incidents compared to the number of fatalities published by workers compensation data published every year. In this era it was realised that a better understanding of OHS by managers, workers and the general public was a main part of microeconomic reform which could contribute in lower business costs and increased in productivity. It was also realised that Australia needed a uniform standards towards OHS, similar to the one adopted in European community.

The Performance Phase:

The performance phase unlike the classical and modern-traditional phases which was borrowed from other countries, now was taking its own way to improve OHS in Australia. At this stage there was an increasing amount of rules, guidelines and regulation, however there was not any evidence of indicating any improvement in OHS. The new approach towards better OHS at workplaces was realization of injuries; diseases and death were not an inevitable consequence of work. This was the beginning of government to give power to inspectorates to enforce rules and regulation and to audit OHS systems at workplaces.

NOHSC improved OHS in many areas such as:

- Regulatory reform
- Promotion of best practice and improved industry performance
- Research and higher education
- Workers compensation
- Quantifying the economic importance of Occupational health and safety and exchange of ideas with big businesses and the public.

In conclusion Emmett points out that Australia has made great achievements in OHS however the success or failure of practitioners' efforts depends on the way OHS is communicated between government and the public. In the following sections evolution of OHS in Australia is further reviewed.

2.2.2.1 Safe Work Australia

Safe Work Australia was established on 1st of July 2009 and became operational on 1st of November 2009 by Safe Work Australia Act 2008 and it was founded by the commonwealth and state/territory governments. The main responsibilities of Safe Work Australia are to improve OHS and workers' compensation arrangements in Australia. This responsibility previously was supported by Australian Safety and Compensation Council (ASCC) from October 2005 to March 2009 and before that by National Occupational Health and Safety Commission (NOHSC) from December 1985 to December 2005. Short and long term national strategies by Safe Work Australia are:

- Reduction of risks and its impact at work;
- Improving competency of stakeholder in effective management of OHS;
- Effective preventative measure to control occupational diseases;
- Elimination of hazards at design stage, and further
- Reinforce the capacity of government to control OHS outcome.

Safety in design principals of Construction and Safe Design of Structures are set by Codes of Practice and work practices in Australia are prescribed by Safe Work Australia. The five most important key elements for safe design set by Safe Work Australia include of five principals: principal 1- people with control, principal 2- the life cycle, principal 3- risk management, principal 4- knowledge and capability, principal 5- information transfer. Safe Work Australia has identified the occupational traumatic injury risks as 'body stressing; falls, trips and slips of a person; being hit by moving objects; and hitting objects with a part of the body'. These mechanisms are accounting for 90 percent of the injuries.

2.2.2.2 WorkSafe Western Australia

The positive achievements by WorkSafe Western Australia provides free guidance notes, codes of practice, educational pamphlets available to everyone and free telephone advice in relation to occupational safety matters to businesses. Think Safe Small Business Assistance Program for businesses with less than 20 employees are provided with a complimentary safety assessment by OHS professional consultants.

In 2001 there were 126,000 small businesses in Western Australia which represented just over 96% of all businesses in this state. Another positive achievement by WorkSafe Western Australia was proposed model for Safety Management Work Safe Plan to be used by organisations to base their OHS on that. Organisations that meet all requirements of this safety management plan can be awarded Platinum, Gold or Silver Award Certificates, depending on achievements of safety management in their workplace. Other achievements by WorkSafe Western Australia include, SafetyLine website to educate people in relation to OHS, ThinkSafe Club for primary school students, WorkSafe Smart Move Program for high school students, SafetyLine Institute for Technical and Further Education students (McGowan, 2005).

2.3 Australian OHS National Policies

According to Safe Work Australia (2012), the current situation of ‘continuing high rates’ of work-related fatalities, injuries and diseases occurring every year is a big challenge for government, employers, workers and the community in Australia. Workplaces that practice high standard of OHS, not only themselves benefit in many ways (e.g., prevent fatalities, injuries and diseases, wining other contracts, workers’ morale, higher productivity), it also economy of the country benefits and the community. Above all it affects the workers and their families in many positive ways.

Even though there has been a great deal of progress in OHS in last few decades in Australia, however there is still a long way to go before ideal situation is achieved in reduction of work-related fatalities, injuries and diseases. The Australian Work Health and Safety Strategy 2012–2022 is built on the National OHS Strategy 2002-2012 to further improve OHS and to protect workers from death, injuries and disease in Australia. The principles of this strategy are the workers and their rights to work in a safe, well-designed working environment. ‘This is consistent with the United Nations’ Universal Declaration of Human Rights and is reflected in duties of care established in all Australian work health and safety legislation’ (Safe Work

Australia, 2012–2022). These strategies are briefly reviewed in the following sections.

2.3.1 OHS National Policy 2002-2012

In 2009 Safe Work Australia was nominated as an autonomous legal body to develop national policy relating to OHS and workers' compensation and to support the National OHS Strategy 2002–2012' (Safe Work Australia, 2012). This task was initially managed by National Occupational Health and Safety Commission (NOHSC) and prior to Safe Work Australia by the Australian Safety and Compensation Council (ASCC). This strategy was approved in 2002 by all states/territory governments and 'the Australian Chamber of Commerce and Industry (ACCI) and the Australian Council of Trade Unions (ACTU)'.At present the OHS performance in Australia is measured through this 'National Strategy'. The monitoring and measuring of OHS performance over time shows the dedication and expectation of governments to improve workers health and safety while at work and target towards a work-place 'free from death, injury and disease'. This strategy has set priority areas concerning OHS in Australia and its concerns are that all stakeholders (employers, workers and community) at national level to work 'cooperatively' and show dedication towards the targets set by this strategy. Short and long term targets were set by this National OHS Strategy 2. It was also suggested that from time to time this National Strategy be evaluated and adjusted according to work-place OHS priorities. The major objectives set by Safe Work Australia, to achieve goals put in place by National OHS Strategy 2002-2012, were:

- By harmonization of work health safety legislation laws among all states/territories to achieve the same protection;
- To raise understanding and significance of 'OHS policies and programs' by means of awards (e.g. National Safe Work Australia Week) and
- Improving workers 'compensation data, collection and analysis and research across government to inform policy and regulatory frameworks, which improve decision making within government' (Safe Work Australia, 2012).

Five priority OHS areas were identified for improvement and targeted for cultural changes which are listed below:

- 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 government to influence OHS outcomes (Safe Work Australia, 2012).

Other areas of concern recommended by stakeholders were eight occupational diseases listed below:

- Musculoskeletal disorders
- Mental disorders
- Noise-induced hearing loss
- Infectious and parasitic diseases
- Respiratory disease
- Contact dermatitis
- Cardiovascular disease, and
- Occupational cancer (Safe Work Australia, 2012).

Initially National OHS Strategy 2002-2012 targeted four industries with their high record of incidents to improve their OHS. These industries include ‘building and construction, transport and storage, manufacturing, and health and community services’. After the first review of the strategy in 2005 more industries were included because of their poor record of OHS; these industries included agriculture, forestry and fisheries.

The targets set by National Strategy were to reduce ‘the incidents of work-related fatalities’ by 10% until end of June 2007 and a further10% by the end of June 2012. The reduction of work-related injuries was targeted by 20% until end of June 2007, and a further 20% by the end of June 2012. The National Strategy was reviewed in 2004-05 and the Workplace Relations Minister authorised to target the ‘lowest rate of work-related traumatic fatalities in the world by 2009'. The National OHS Strategy 2002-2012 targets has been summarised in Figure 2.1.

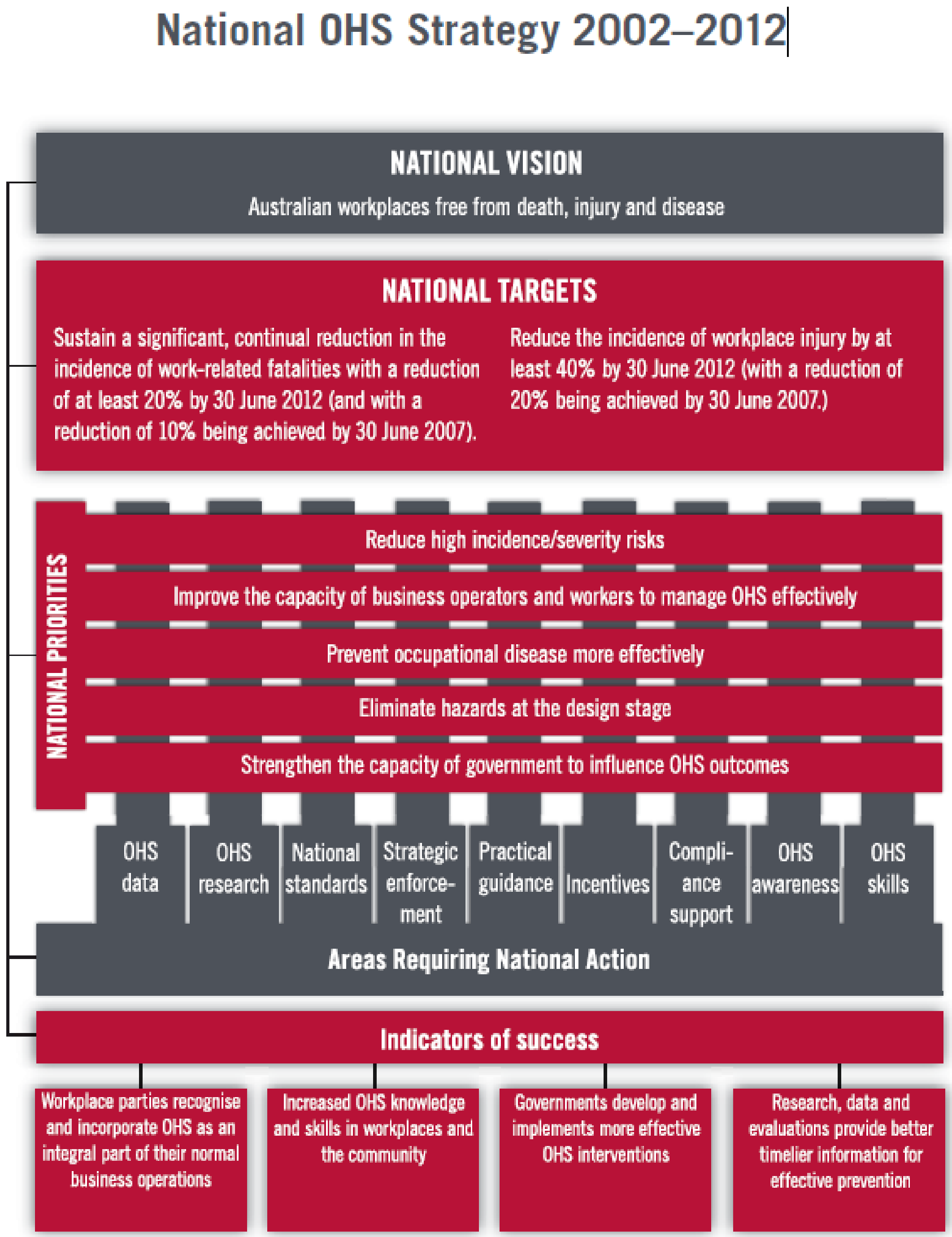


Figure 2.1: National OHS Strategy 2002-2012

Source: Safe Work Australia (2012)

2.3.2 Australian Work Health and Safety Strategy 2012–2022

According to Work Health and Safety Strategy (2012–2022) the consequence of work-place accidents causing death, injury or disease mostly affects workers and their families and employers as well as the Australian economy. The vision of Work Health and Safety Strategy (2012–2022) is to promote a healthy and safe workplace for workers. To achieve these goals four outcomes are targeted with seven area of concern. The four outcomes are:

- Reduced incidence of work-related death, injury and illness;
- Reduced exposure to hazards and risks;
- Improved hazard controls;
- Improved work health and safety infrastructure

These mechanisms are shown in Figure 2.2 (Work Health and Safety Strategy, 2012–2022).

Figure 2.2: Healthy, safe and productive working lives

Source: Safe Work Australia

The seven action areas and strategic outcomes to be achieved by 2022 (Safe Work Australia, 2012):

- Health and safety by design: elimination or minimization of hazards and risks associated with the design of structures, equipments and substances before they are introduced to the workplace. In addition the work processes and systems of work that protects workers health and well being and prevents them from injuries, ill health and death.
- Supply chains and networks (provide goods to businesses): supply chains and networks participants to understand OHS policies and procedures in relation to their work practices.
- Health and safety capabilities: everyone in the workplace must have the appropriate knowledge and training in OHS, related to their work activities. OHS personnel, inspectors and safety regulators to have proper education and competency in OHS to effectively carry out their work. One important aspect of national activity is 'Work health and safety skills development is integrated effectively into relevant education and training programs'. This section will be further expanded by the researcher in the following chapters, as it might be the key to success of OHS and saving the lives of workers.
- Leadership and culture: communities, organisations and their leaders to promote 'safety culture' within their organisation and improve OHS and give priority to health and safety during planning and decision making.
- Research and evaluation: 'research and evaluation are targeted to provide the evidence to prioritise and progress areas of national interest'.
- Government: government policies to consider OHS during all aspects of decision makings improve OHS by using 'their investment and purchasing power' and further promote and demonstrate a positive attitude towards OHS.
- Responsive and effective regulatory framework: To review and monitor the effectiveness of legislations, policies and regulations. A positive and constructive relationship among regulators and others involved in OHS (Safe Work Australia, 2012–2022).

The new targets were set by the strategy to achieve by the year 2022 those are:

- Reduction of work-related fatalities as a result of injuries by 20%;
- Reduction in incidence rate of workers' compensation claims and for musculoskeletal disorders of one or more weeks off work by minimum of 30%.

The focus of this strategy is to governments' regulators, industries, unions and relevant organisations to work together to improve OHS in Australia and accomplish the targets set by this strategy. (Safe Work Australia, 2012–2022).

2.4 Priority industries and disorders

In 2012 seven industries with high rates/number of injuries and fatalities were identified 'as national priorities for prevention activities' these industries include:

- Agriculture;
- Road transport;
- Manufacturing;
- Construction;
- Accommodation and food services;
- Public administration and safety;
- Health care and social assistance. (Work Health and Safety Strategy, 2012–2022).

The challenge of the strategy is to find the root of the injuries, fatalities and the ill health caused to workers and seeks solutions to prevent them. In the first five years among all industries, the focus Australia wide is on two industries, to reduce their high numbers of fatalities these are agriculture and freight transport industries.

The priority areas in relation to work-related disorders were identifies to be the focus of the strategy in the first five years these are:

- 'Musculoskeletal disorders
- Mental disorders
- Cancers (including skin cancer)
- Asthma
- Contact dermatitis, and
- Noise-induced hearing losses.

These areas of concern were chosen because their effect and consequences to workers were severe, high number of workers affected and there are known preventative solutions for them (Work Health and Safety Strategy, 2012–2022).

2.5 Conclusion

Despite all the efforts and improvements made during the Safety Strategy 2002-2012 in OHS, however every year on average 250 workers die in Australia as a result of their injuries sustained at work. Occupational diseases problem is one area that is hard to assess, how many work-related disease fatalities occur each year, because there is not one data source to collect such a data. However it has been estimated that about 2000 workers die from illnesses which are work-related each year in Australia (Safe Work Australia, 2012).

In 2008-09 the cost of work-related injuries and diseases to Australian economy was calculated by Safe Work Australia as being $60.6 billion (‘4.8 per cent of the Australian Gross Domestic Product’). The national actions to be taken in accomplishing the targets set by Australian Strategy 2012-22 will be collaboratively formed among the stakeholders. This strategy will be reviewed in 2017.

Chapter3: Accident causation theories and models

3.1 Introduction

In Chapters 3 and 4 an attempt has been made to review the literature and cover the following related areas: accident causation theories and models, causes of workplace injuries, global occupational fatalities, Australian work-related traumatic injury fatalities and construction industry. In this chapter some of the accident causation theories will be reviewed.

There are many accident causation theories which have evolved from the Domino theory of the 1930's to present time. The review of these theories reveals that accident causation is very complex and there are many contributing factors such as management-related factors, environmental, physical and mental condition of the worker. Accident causation theories have different approaches towards why accidents happen and most theories have their limitations to be able to identify all causes and to be able to develop preventive, corrective and control strategies. Many models of accident causation have been formed as a result of the investigation of root causes of occupational injuries and fatalities. However in recent years the entire workplace system has been the attention of researchers as well as the governments. The three areas of disciplines such as psychology, safety engineering and ergonomics have influenced the outcome of contributory factors towards occupational injuries and fatalities (Quinlan et al, 2010).

The major objectives of ergonomists and safety engineers are to design for a safe working environment and removal of possible sources of injury (Quinlan et al, 2010).It might be concluded that there is no one specific theory which will satisfy all accident phenomenon in different workplace environment.

3.2 Domino theory

The accident causation theory known as the Domino theory of accident causation was introduced by Heinrich (1959). Heinrich proposed his theory which is operationalised in ten statements known as 'Axioms of Industrial Safety' (Dhillon, 2003). The axioms of industrial safety are the sequence of factors causing accident/injury. Other important factors are managements' and supervisors' responsibilities for taking appropriate corrective measures towards safety. Other axioms highlights the unsafe acts of people and/or mechanical or physical hazards, the direct and indirect cost of an accident and finally this is one of the practical accident prevention methodologies having common strategies with productivity and quality approaches (Dhillon, 2003). Furthermore Heinrich's theory explains the sequence of the events leading to an accident/injury in terms of five factors:

- Ancestry and social environment;
- Fault by the person;
- The unsafe act and/or mechanical or physical hazard;
- The accident event;
- Injury.

Heinrich's Domino accident theory puts the blame mainly on people's negative characteristics, ancestry and social environment.

3.3 Accident proneness theory

Accident proneness theory has been broadly discussed in the literature of accident studies. This theory states that some workers (people) are more likely to bring upon themselves accidents than others and this can be attributed to their personal characteristics. This theory also claims that all population is expected to the same risk and accidents happen because of the differences in the accountability utterly due to the personal characteristics of the people (Smillie and Ayoub, 1976). There are some studies which support or are against this theory. According to Raouf (2013), this theory is not accepted and it may only apply to a very small percentage of accidents with no statistical significance.

3.4 Biased liability theory

The Biased liability theory's view is that once a worker has an accident, his chances of being involved in subsequent accidents are either increased or decreased compared to other workers. The contribution of this theory in accident prevention is not acceptable (Raouf, 2013).

3.5 Pure chance theory

The Pure chance theory considers that all workers are exposed equally to the same risk of being involved in an accident and there is no distinct pattern in the events leading up to an accident. This accident theory purely relies on Heinrich's view of accidents are act of god (Raouf, 2013) and as a result the preventative measures would not prevent them from happening.

3.6 Multiple causation models

Petersen's (1971) view of accidents happening were targeted at contributing factors (causes and sub-causes) pooled together to cause the accident. The contributing factors for this model could either be behavioral or environmental. The behavioral factors relates to the worker, such as physical factors (physical work capacity, temporary state: alcohol, drug, fatigue, lack of training and skill). Environmental factor could be related to climate, season, and workplace characteristics (policies, procedures and management's attitude towards safety).

3.7 Human factors theory of accident causation

The human factors theory of accident causation assumes that workers' or human's error are the main cause of accidents. According to Dhillon (2003) this theory attributes three specific factors leading to accidents caused by human error:

- Overload;
- Inappropriate response/incompatibility;
- Inappropriate activity.

Human error caused by overload is imbalance between the capacity of a person (natural ability, state of mind, training, fatigue, stress and physical condition) and the work load imposed on the worker. The work load factors are: environmental (noise, distraction, etc.), internal factors (emotional stress/worry, personal issues) and situational factors (improper instruction, risk level). Inappropriate response /incompatibility of a person could be for example detecting a hazardous situation and not correcting it or ignoring safety issues. Incompatibility of a person with standards and work procedures may lead to accidents. Inappropriate activities could be a misjudgment of the degree of a risk or performing a task without having a proper training (Dhillon, 2003).

3.8 Occupational medicine and epidemiology

Epidemiology is a branch of medical science and is defined as ‘the study of the distribution and determinants of disease in human population’ (Christie, cited in Quinlan et al, 2010, p. 84). This brings about the relationship between epidemiology and OHS. The principles of epidemiology are based on set of rules, methods of research design and data analysis revealing the ‘causal relationship between work factors and illness’ or in relation to other variables. The limitation of epidemiology is that the facts concerning, what causes the health problems does not lead to solutions or guidance on intervention or prevention of health problem issues Quinlan et al (2010, p. 90).

Epidemiological research is mainly concerned with identification and evaluation of physical and chemical agents that either have immediate or cumulative health effect. Occupational epidemiology has a major contribution towards ‘identifying and measuring health risks with application of quantitative methods in the twentieth century’ (Stellman, cited in Quinlan et al, 2010, p. 145). The difficulties facing the historical studies such as cohort or case control are the limited access to worker’s medical records or their destruction by employers (Betts and Rushton, cited in Quinlan et al, 2010, p. 226).The main concern of the occupational medicine is the identification of occupational diseases, certain hazardous material, their production and processes.

‘In relation to occupational medicine/epidemiology it was noted that this discipline has played a critical role historically in bringing recognition to the diseases associated with particular types of industry and the hazardous substances used by workers in them’ (Quinlan et al, 2010, p. 274).

3.9 Epidemiological theory

The epidemiological approach accounts for all possible contributing factors (if initially recorded correctly and precisely for further analysis). The shortcoming of epidemiological approach is that it is generally descriptive and it lacks any analytical power. This can overcome with modeling and simulation (Smillie and Ayoub, 1976).According to Tranter (2004), the aim of epidemiological studies is to identify the association between the causes and effects (e.g. accidents, diseases).Epidemiological studies has been categorised to be:

- Descriptive: investigates the incidence of an illness or other wellbeing of a particular population in relation to their demographic status (e.g. 'age, gender, race, occupation, socioeconomic status, geographic location of the population').
- Experimental.
- Analytical: analytical epidemiology examines the relationship between an outcome and its cause (e.g. occupational diseases). This involves identifying and measuring risk factors in relation to attributes such as: age, race, sex, genetic, biomechanics, physiological characteristics, socioeconomic status, occupation, residency, environmental and individual behavioral attitude.

The epidemiology has been originated from the study of disease and illness epidemics (Surry, 1974). According to Gorden (2005, cited in Surry, 1974), accidents happen as a result of a complex relation between the characteristics of the host (the victim), the agent (what caused the injury) and the environment. The epidemiological approach considers many relevant factors in relation to the host (e.g. age, sex, etc) agent (potential hazard) and the environment (temperature, noise) (Mc Farland, cited in Surry, 1974). Another shortcoming of epidemiological model is that it lacks in analysing why accident happens (Surry, 1974).However Mc Farland (cited in Surry, 1974) points out that, the result obtained from epidemiological analysis can be used to determine why accident happened.

3.10 Swiss Cheese Model of Accident Causation

The Swiss cheese theory of accident causation was suggested by Dante Orlandella and James T Reason from university of Manchester (Figure 3.1). The layers of cheese are representing the defenses (e.g. OHS management system, environment, human factor etc.) between hazards and accidents. The holes in the layers are weaknesses in the system and if these flaws are aligned accident occurs. This model is used for risk identification and risk management in many disciplines such as engineering, aviation and the healthcare (Wikipedia, 2014).

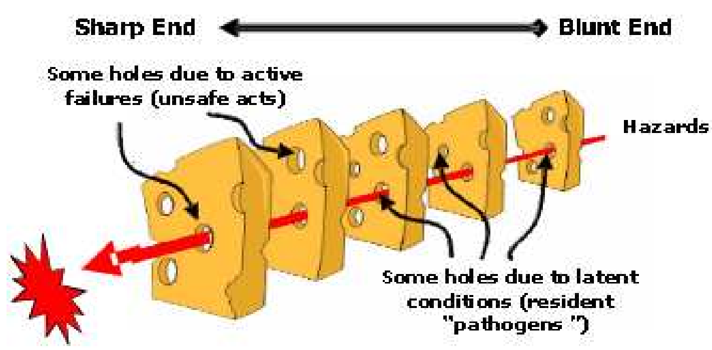


Figure 3.1: Swiss cheese Model of Accident Causation (Reason 1997)

3.11 Conclusion

Many injury causation theories and research methods have been introduced during the past few decades. According to Dwyer (1983) most theories examines limited sets of accident causation and Quinlan et al (2010) points out that most management Systems are authoritarian and financial incentive. Theories such as Behavior-based Safety (BBS) has been criticized for mostly focusing on individuals and ignoring other issues such as work organisation or management practices for workplace injuries (Hopkins, cited in Quinlan et al, 2010).

The review of some of the accident causation theories revealed that each theory has some limitations. The Domino theory was one of the common theories used to investigate accident causations, however this theory was 'strongly criticised by the safety professionals' as being too simple to be able to cover all aspects of a complex accident situation (Petersen, 1982).The accident proneness theory's statement of some people are more likely to incur accidents than others is true, however it is not the only factor to cause the accident and many contributing factors has been ignored. The same applies to the biased liability theory being very ambiguous to its contribution to the accident causation theories. The main weakness of epidemiological approach is that it is generally descriptive and it lacks any predictive power. To overcome this is by computer simulation, modeling and analysis in safety. The pure chance theory is based on that the accidents are act of god, if this means that they are unavoidable then it might be true, however to a very small percentage (e.g. 2%). According to both Human Factor and Multiple Causation Models, the majority of accidents are preventable considering factors such as management system, human factor and environment.

Chapter 4: Causes of Workplace Injuries, Illnesses and Fatalities

4.1 Introduction

The main causes of workplace injuries and illnesses have been classified in to two key areas of concern. One, ‘blaming the victim’, traces the causes on the personal, behavioral characteristics of the worker and ‘blaming the system’, which fiends the causes on wide areas such as organisational, the other technological, environment and social aspects of the work (Hopkins, 1995, pp 1-15).

As a result of globalization, industrialized nations and large enterprises that export their dangerous jobs to developing and other countries for financial gains, morally and ethically they must also introduce and follow OHS in these workplaces. According to ILO (2003), the health and safety legislation is poorly (e.g. poor inspection and reporting systems) managed or not properly followed in most of the developing countries. As a result, the workplace accidents, injuries, diseases and fatalities are underestimated in these countries. World population is on increase, resources are becoming limited and competition is on increase for workers to keep their job. This is one of the main reasons to cause stress to workers which may lead to alcohol and drug abuse also causing accidents and illness at work.

Globally high risk industries identified by ILO (2003), include agriculture, mining, construction, fishing, ship breaking and informal sector (casual employment). According to ILO (2003), about half of the workforce in the world is from informal sector. This sector has very poor working condition and OHS and issues concerning workers’ right are ‘non-existence’. As a result of globalization, increase in world population, limited resources and competition for working population to keep their jobs, mental stress is on increase in industrialized nations. At the same time export of dangerous jobs to other countries for financial gains of some enterprises is causing workplace injuries, fatalities and diseases on increase in those countries. In the following sections the causes and cost estimates of traumatic industrial work-place injuries, fatalities and diseases in Australia with specific reference to Western Australia and the construction industry have been reviewed.

4.2 Different views on the causes of workplace injuries

Hopkins (1995) has classified, the blaming the victim, into four and, the blaming the system, approach to three types. Just a few of these has been reviewed, which will be presented next.

‘Accident Proneness’: assuming that the personal characteristics (age, sex, intelligence and personality) of the workers mainly contribute to their injury or illness. He added that there is a correlation between injury statistics and individual characteristics of the workers. However Hopkins points out that ‘screening out workers prone to injury or illness is a discriminatory policy which runs the risk of seriously disadvantaging sections of the workforce, such discrimination is now largely illegal’ (Johnson cited in Hopkins, 1995).

‘The Ignorance/Carelessness theme’: the injury or illness of the worker is as a result of their ignorance or carelessness. Lord Robens established the significant reason for accidents happening at work being because of the apathy or carelessness of the workers (Gunningham and Creighton, cited in Hopkins, 1995). Lord Robin also added that other contributory factors in relation to workers ignorance are: not following correct safety procedures, violation of safety regulations and their awareness of safety practices.

‘The culture of masculinity’: implies to workers’ attitude towards safety, forced to think to follow safety acts is regarded as ‘effeminate’ and think they might be ‘labeled as cowered by their work mates’(Fitzpatrick , cited in Hopkins, 1995). Education and training can break the cycle of this attitude towards safety.

Malingering: ‘the most dramatic blame the victim’ which suggests many of injury/illness of the workers is sham or over stated to take day off or for claiming workers compensation. This kind of thinking will not help to reduce the real number of injuries.

Blaming the system: approach puts the blame on system failure: the philosophy of system failure investigations are based on the, ‘no fault’, ‘no blame’ on individual or the accountability of the organisation. However it points out the direct causes as well as ‘surrounding systems’ which the accident happened.

Company violation of safety regulations: unlike the system failure companies do have legal liabilities in case of violation of safety regulations. Production Imperatives: many accidents such as losing a finger or a limb happen during machine breakdown which management put pressure on workers to take a rout of a shortcut to 'restore' normal production.

In conclusion Hopkins concludes that it is 'more useful to attribute health and safety problems' to systems of the organisation (being responsible for the injury/illness of the workers) and the work environment than blaming the works.

Mathews (1997) looked at the organisational best practice, by linking the high standard of OHS to improved productivity, competitiveness (not to be looked at as another cost), and improved work quality. Companies with high standard of OHS management system have proven to 'operate in parallel with enterprise productivity and quality management systems'. According to Bird and Germin (1990) traditionally safety was seen as an extra expense for the business, however at present many managers see safety as an investment for the business as well as humane side of it. Bird and Germin viewed the loss control, one of the important and fundamental aspects of the job of every manager in any organisation. To achieve an effective loss control:

- It is the manager's responsibly to implement OHS effectively to protect the health and safety of the workforce.
- Managing safety means cost control and
- Safety and loss control improves management system (improved output and profitability) of any organisation.

Deming and some other management experts had a point of view that about only 15% of the problems of any company is possible to be controlled by the employees and 85% by the management. However it is implausible that any one OHS management scheme will suit all enterprises. (Emmett and Hickling, 1995).In the following sections some areas of concern in relation to causes of workplace injuries will be reviewed.

4.2.1 Risk taking

According to Lark (1991), physical risk taking at workplace may put the well being of the personnel and the corporate in danger. In contrast to Larks opinion on risk taking Konner (1990, cited in Lark, 1991) believing that risk taking ‘is part of being alive’. However in view of Krause and Hodson, (1990) ‘Workplace risk taking is a vital concern that requires appropriate intervention’ one intervention could be behavior – based safety management. This intervention is implemented by means of formal policy statement, indicating that management does strongly takes a stand that physical risk taking is not acceptable. The second important intervention is the establishment of a record keeping system by collaboration between managers, supervisors and workers to record ‘risk-taking behaviors’ accidents, incidents, near miss and dangerous behavior. This information should be analysed and discussed by employees at organisational level ‘a list is made of things that personnel do (or could do) that might result in injury or illnesses’.

4.2.2 Organisational and psychosocial working environment

It is known that workplace hazards are classified as physical, chemical and biological, however in past twenty years other aspects of the work organisation has been brought in to attention by psychologists. This is known as psychosocial work environment this area of psychology is concern between the work environment and well being of the workforce. The recent studies has recognised that the outcome of OHS is directly depends on the relationship between the workers demographic states (e.g. gender, age, ethnicity and foreign workers) and social processes. According to Caruso et al (cited in Quinlan et al. 2010, p. 21) the relationship between workplace characteristics and OHS could be attributed to factors such as:

- Size of the organisation, its assets, employment security and the characteristics of the industry;
- Application of training, induction, provision for leave, facility for childcare and ‘sexual harassment program’;
- The commitment of management towards OHS, supervisory and disciplinary programs;

- Task work procedures, relationship between man and machine and new technologies;
- ‘payment, rewards and incentive systems’
- Working hours and shift work;
- Staffing, workloads, production, service delivery pressures;
- Demographic status, work experience, ‘language skills, literacy and training’;
- Role of union;
- Using subcontractors and outsourcing.

Work organisation can also have adverse health effects on workers; this is an area that more research needs to be done. However in areas such as shift work, overtime and extended working hours has been a lot of studies done which has revealed its links to an ‘array’ of health issues (Caruso et, cited in Quinlan et al. 2010, p. 21).

It has only been in recent years that the International Agency for Research on cancer has labeled shift work ‘as probable (2A) carcinogens It should be noted that shift work or irregular hours can also affect the health and well being of the families of the workers (Miller and Han, cited in Quinlan et al. 2010, p. 27). It should also be recognised that unemployment, informal work (any ‘work not subject to regulatory controls’), under age labour and the deprived living condition (‘found in many poor countries’) are all subject to ill health and well being of the workforce (Barten et al.; Giatti et al.; Benach and Muntaner, cited in Quinlan et al. 2010, p. 27).According to Quinlan et al (2010, p. 29) the advances in mechanization changes in ‘labour-saving forms of manufacturing, off shoring to developing countries’ which has been occurred in the past fifty years in industrialized countries has changed the form of the workforce and created new form of work-related hazards.

4.2.3 Industrial form of work organisation

There is a direct relationship between industries’ organisational work arrangements and OHS. There has been a broad research in relation to adverse health affect of some work arrangements such as downsizing and job insecurities (Quinlan et al., 2001; Quinlan and Bohle, cited in Quinlan et al. 2010). The adverse health effects could be physical, psychological, poor ‘work-life balance’, violence and bullying

(Quinlan and Bohle, cited in Quinlan et al. 2010, p. 33).Some of the factors influencing the work organisation:

- Downsizing can affect work load due to decrease in staffing, multi-tasking, increased hours and even unpaid overtime;
- Decrease in full-time permanent positions and increase in the use of subcontractors, part-time, short-term, fixed-term and agency workers. This has lead to increase and 'growth of self-employed, micro businesses and small business employers'. Part-time and temporary work is linked with 'multiple job-holding' (Louie et al., cited in Quinlan et al. 2010, p. 33).
- An increase in home-based work due to increase in subcontracting.

The survey under Australia at work in 2007 by Wanrooy et al, cited in Quinlan et al. 2010, p. 33) indicates that 61.1 % of the employees were permanent, 18.8% were casual employees and 5.2% of the workforce worked under the fixed-term contracts. There is an international evidence of many studies indicating that subcontracting and related arrangements have significant effect on health and well being of the workers (Quinlan and Bohel, cited in Quinlan et al. 2010). These may be due to competition, workload and extended hours. It has been estimated that around 15 to 20% of the working population of the advanced countries are engaged with shift or night work. Further in some industries the eight hour working has been replaced by twelve hours. This can be a cause for fatigue and one of the main concerns of OHS. In addition the health effects of the shift-work and ageing workforce 'will multiply for both individual and the community at large' (Dawson, 1996, cited in Quinlan et al. 2010, p. 34). The final point to be made is 'a shift in the locus of industrial relations towards the enterprise or workplace level as well as a decline in union density and collective bargaining/negotiation' (Heiler, Quinlan, cited in Quinlan et al. 2010, p. 35).

4.2.4 Diversity of the workforce

In addition to the effect of the work organisation on OHS is the workforce and its diversities. There has been a great increase in the number of diseases such as vibration-induced injury, musculoskeletal disorders, asthma and cardiovascular diseases and obesity in the workforce may all be contributed to the work environment or work arrangements (e.g. shift work or extended working hours) (Quinlan et al, 2010, p. 35).

The main changes which have occurred in the past twenty years are, rise in female numbers in the workforce, aging population and multiplicity in ethnicity of the working population (Quinlan et al, 2010). In many countries and Australia the aging population is emerging due to continued low fertility and increased life expectancy. According to ABS (cited in Quinlan et al. 2010, p. 38) the median age in Australia has increased by ‘5.8 years’ in the last twenty years. The ageing workforce has major implications for ‘labour supply, labour under-utilisation, productivity and health’ (Wegman and McGee; Productivity Commission, cited in Quinlan et al. 2010, p. 38). Age related issues affecting the OHS have been already recognised, indicating that male workers have more serious injuries which take longer to recuperate (Rogers and Wiatrowski, cited in Quinlan et al. 2010).

According to ABS (cited in Quinlan et al. 2010, p. 40), the older workers are mainly self-employed working either part-time or on short-term basis. The younger workers below age of 25 are working on temporary or part time bases. In 2004 this group of workers accounted for ‘62%’ of men working population worked for less than eight hours per week. Evaluation of 108 studies by Salminen (cited in Quinlan et al. 2010, p. 40) indicates that younger workers are more prone to work-related injuries, however their injuries are less fatal compared to older workers. Another issue of concern about young workers is their job ‘churning’ (moving from job to job) ‘and undermined induction/training, supervision/OHS management and regulatory regimes’ (Quinlan et al. 2010, p. 40).

Shorter job status has been established to be a major OHS risk issue for younger workers (McCall and Horwitz, cited in Quinlan et al. 2010). In addition there is evidence that very young and children are engaged in paid employment (New South Wales Commission and Young People, cited in Quinlan et al. 2010), there is a lack of research in this area. The recent study has revealed that ‘short job-tenure’ is a risk factor for all workforces; however the risk is more for older workers (Breslin and Smith, cited in Quinlan et al. 2010).

4.2.5 Ethnicity, foreign-born workers and OHS

This is an area that needs careful study and analysis of existing data. Studies of population-based indicate that foreign-born workers are at a greater risk of injury (Quinlan et al. 2010, p. 43). Interaction between ethnicity and OHS is a very complex issue. Foreign-born workers are formed from a diverse groups of workers such as permanent migrant with different background this includes Australian and New Zealander workers being able to move on a permanent or temporary bases between the two countries, refuges (whom applications have been approved to stay and work), illegal workers, 'temporary resident foreign workers', backpacker tourists (in English speaking countries) this applies to workers either having or not having work permit. Another group is foreign student on student visa which they apply for residency. Both of illegal and temporary workers are becoming very popular in developed countries. The temporary resident foreign workers play an important role in formation of the workforce of many developed countries such as Western Europe, North America, Australia, New Zealand and other countries. A recent study of injury data in New Zealand 'indicates that non-Europeans have a higher incident rate of injury than Europeans' (Bohle et al., cited in Quinlan et al, 2010, p. 41).

Amongst non-Europeans, the indigenous (Maori) workers have higher rate of injury compared to the rest of the workforce in New Zealand, this is almost twice of the labour market average injuries (Bohle et al., cited in Quinlan et al. 2010). Serious injuries are higher among immigrant workers in UK and North America (particularly Latino workers) (Centers for Disease Control; Irwin Mitchell and the Centre for Corporate Accountability, cited in Quinlan et al. 2010).

O'Conner et al (cited in Quinlan et al. 2010, p. 43) in their study of 'health and safety training among young Latino construction workers in US' found that the training of some hazardous tasks were poor. This especially applied to workers with poor English communication abilities. They also pointed out that lack of English skills 'should not be exaggerated' to the omission of workers right to receive training, induction and supervision. Other issues are for example, high workload, inadequate union involvement and extensive regulatory non compliance (Bohle and Quinlan, cited in Quinlan et al. 2010, p. 43).

‘Elaborate networks of middleman’, labour gangers, migration agents and ethnic businesses specialising in the exploitation of fellow countrymen may construct a reality very different from the formal rights and entitlements these workers may appear to process’ (Jones et al., cited in Quinlan et al. 2010, p. 42).

‘Migrant or ethnic minority group status may exacerbate the vulnerability of workers already in vulnerable jobs with little if any union representation and where noncompliance with OHS and workers’ compensation regulation is common if not the norm’. It should be noted that ‘…statistics on employment by ethnicity are lacking and, as already noted, many studies ignore this connection’(Guthrie and Quinlan; Toh, cited in Quinlan et al. 2010, p. 44). There is a need to identify that group of ethnic minority group who are vulnerable to exploitation and may not report safety problems or be aware of their rights and entitlements. Illegal immigrants, foreign-born temporary residents who either is not allowed to engaged in any paid work or allowed to work a limited hours or guest workers who can only stay in the country on the bases of their employment status. Evidence indicates that these group of workers facing some difficulties (Guthrie and Quinlan; Toh, cited in Quinlan et al. 2010). Guest workers in Australia are facing many problems with their employment status. This group of workers is not having the same rights or wages as other workers. Since their visa status depends on their employment therefore it limits their rights to complain. Other issues concerning ethnicity and OHS are the size, body shape and height of the workers (anthropometric principles) and changes (flexible/adjustable) required taking in to account in design of equipment and machinery (Quinlan et al. 2010).General health and lifestyles of the workforce are other issues influencing OHS, evidence shown that obesity may be a contributing factor to work-related injuries.

4.2.6 Labour hire

According to Wikipedia ‘Since early 90’s’ many workplaces have reduced their employment and they use workers from ‘labour hire organisations’, when the demand is high (Labour hire, Wikipedia, 2014).

According to the trade union, workers from labour hire could be disadvantaged in two ways. One is the unfair dismissal, since the work is on the bases of casual work in case of unfair dismissal, the labour hire will not use the word ‘terminated’ however they will not give any work to the worker to avoid the law concerning that the worker has been dismissed unfairly. The second issue is concerning workplace health and safety. According to NSW Industrial Commission ‘….a labour hire company is required by the OHS Act to take positive steps to ensure that the premises to which its employees are sent to work do not present risks to health and safety’. The labour hire agencies are responsible to make sure that their employees receiving adequate training, and supervision and sufficient measure are taken for their health and safety at the workplace that they have been sent to (Labour hire, Wikipedia, 2014).

4.2.7 Mental health

The first media release report on mental health was released by Safe Work Australia on 8th of April 2013. This report is based on the analysis of the cost of workers’ compensation claims associated with work-related mental health from 2008-09 to 2010-11. The report compares the rate of work-related mental health claims for males and females in different industries (‘public and private sector workers’) and occupations (Safe Work Australia, 2013).

Workers suffering from work-related mental health are absent from work for long period of time and are mainly the most costly form of workers’ compensation claim. It has been estimated that Australian businesses are losing more than $10 billion each year as a result of absenteeism. In this report, the chair Ann Sherry AO of Safe Work Australia expresses her concern about work-related mental stress and its severe and negative impact on workers, their families and employers. The report has also identified that, the rate of compensation claims are the highest among workers with ‘high levels of responsibilities’ the examples are ‘train drivers and assistance, police officers, ambulance officers and paramedics’ (Safe Work Australia, 2013).

The highest number of claims is made by women being bullied or harassed. The compensation claims among women is three times higher than men. With reference to Table 4.1in 2003-04 and 2004-05 combined the number of claims made by woman was 87 compared to 40 by men. Among all industries the highest number of claims is as a result of ‘work pressure’. Amongst all occupations the professionals are making the highest claims for mental stress (one third of mental stress claims are related to work pressures).

The older workers claims are mainly due to high work demands whereas younger age workers' claims are mainly due to workplace violence. It is also estimated that this group of workers (under age of 25) also comprise of 'fifth of all work-related injuries experienced by Australian workers' (Safe Work Australia, 2013).In 2003-04 and 2004-05 most of the mental stress compensation claims (about two-thirds) were attributed to five industries. Health and community services comprised of 21%, Education 19%, personal and other services 11%, Government administration and defense 9% and Retail trade comprised of 9%. Further details on the data are presented in Table B1 in Appendix B. In 2011-12 the percentage of all notification by mechanism of incident, the mental stress (16%) was the third highest of claims after being hit by moving objects (21%) and vehicle incidents and other (18%). These data can be seen in Table B2 in Appendix B.

According to media release of 10th of October 2013, by Safe Work Australia, it has been estimated that five percent of all work-related injuries are related to mental stress.

4.3 Global occupational injuries, diseases, disabilities and fatalities

According to ILO workplace injuries, diseases, disabilities and fatalities are a worldwide issue and most of them are preventable by achieving and implementing a high standard of OHS. The estimates based on 1998 statistics shows that, every year there are about 2 million work-related fatalities, '160 million people' in the world suffer from work-related diseases. The cost estimates are about 270 million each year. It has been estimated that every year 12, 000 children (child labour) lose their lives while working as a result of accidents. These figures are underestimated in view of the fact that 'many occupational deaths and injuries are never reported. Even when statistics do exist' (ILO, 2003). The estimates of causes of two million work-related fatalities have been summarised by ILO in Figure 4.1.

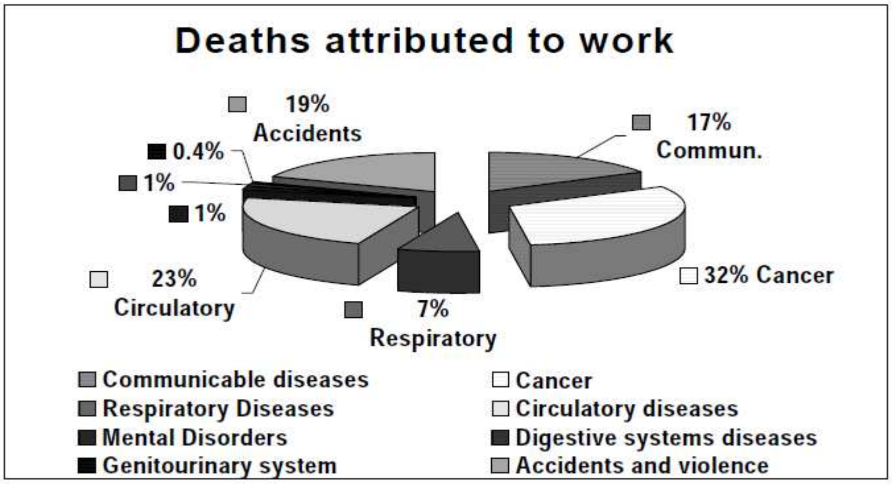


Figure 4.1: Main causes of occupational fatalities worldwide (ILO 2003)

With reference to Figure 4.1, there are four major different causes which contribute to work-related fatalities around the world. One is cancer (32%) and the main contributing factors are: asbestos, carcinogenic chemicals and their processes, ionizing radiation, radioactive materials, radon and ultra violate radiations. Other contributing factors include: carcinogenic dusts, silica, tobacco smoke at work-place and 'diesel engine exhaust' (ILO, 2003). The second highest killer of workers is recognised to be by circulatory diseases (23%) and these are cardiovascular and cerebrovascular diseases. The contributory work related factors to cause cardiovascular diseases are attributed to shift and night work, excessive work, 'long hours of work (including death by overwork, sometimes known as karoshi), noise, 'environmental tobacco smoke at work' and chemicals (e.g. 'carbon disulphide, nitroglycerin, lead, cobalt, carbon monoxide (foundries, traffic controllers), combustion products, arsenic, antimony'). Some other contributory factors cause job strain, hypertension and increase the level of 'stress hormones'; these are because of high level of work demand or repetitive work activities. 'Cerebrovascular diseases are mainly as a result of shift and long hours of work and 'environmental tobacco smoke at work' (ILO, 2003).

The occupational accidents (19%) are the third highest cause of occupational fatalities in the world. The contributory factors are: lack of proper government policies, procedures, enforcement, consultative system and 'poor tripartite cooperation'. Other contributory factors are attributed to the lack of safety culture ('effective training and education system at all levels'), 'lack of research and proper statistics for priority settings' and occupational health and safety management systems at the enterprise level (ILO, 2003).

Communicable diseases (17%) are the fourth highest cause of work-related fatalities in the world. The main causes are 'malaria, viral and bacterial diseases, schistosomiasis, tse-tse flies, zoonosis ...'the contributory factors are lack of knowledge and awareness of infections and 'parasitic diseases' (e.g. poor hygiene, quality of drinking water and sanitation). Work-related cancer and circulatory diseases may likely to take place rather late in working life or sometime even just after retirement (ILO, 2003) therefore it is difficult to be attributed to work-place disease fatalities (underreported).

4.3.1 Global distribution of occupational accidents and diseases

The trends and estimates of the work-related fatalities as a result of work-place accidents are not evenly distributed in the whole world. Further details on the data are presented in Table B3 in Appendix B. According to ILO (2003), for example, the rate of work-related cancer and the respiratory diseases are the highest in China. The cause is attributed to excessive use of asbestos, poor OHS in the mining industry and 'passive smoking' (inhalation of smoke emitted from smoking by others than the person smoking the tobacco) at workplace. The research in recent years has also attributed 2.8% of the lung cancers to passive smoking as a health hazard to non smokers exposed to the tobacco smoke. Workplace passive smoking accounted for 1.1% of the death from chronic pulmonary disease, 4.5% for asthma, ischemic heart disease accounted for 3.4% and cerebrovascular stroke was 9.4% of the death. These estimates are based on 1998 statistics (ILO, 2003).

Work related accidents are also on an increase in China and are the biggest in Asia and islands. 'India and Sub-Saharan Africa' have a high rate of occupational communicable diseases. OHS performance is also very poor in Latin America and the Caribbean ('cancer and circulatory diseases lead the mortality') (ILO, 2003).Work-related fatalities even vary among European countries some having twice the rate compared to others. The rate might be four times higher in some of the Middle Eastern and Asian countries compared to industrialized countries with high standard of OHS. Although the trend of occupational injuries is decreasing in industrialized countries, however stress as a result of overwork is increasing (ILO, 2003).

4.3.2 Industrialised countries targeting workplace zero accident

A large percentage of all work-place accidents in the world are preventable if all countries adapt the known advanced ‘accident prevention strategies and practices’ that already exists and easily obtainable. Some industrialised countries are targeting work-place zero accidents and as a result the rate of accidents are decreasing in this countries (ILO, 2003). The trend of work-related fatalities, accidents and diseases are decreasing in the ‘industrialized countries’. However in the ‘developing and newly industrializing’ countries the trend is either stable or increasing further. The ration of work-related fatalities compared to injuries were carried out in United State and Finland showing that for every work-related fatalities there are more than 1000 injuries. This ratio is 1: 1200 in Germany (ILO, 2003).

There are some factors behind the difference in accidents occurring in industrialized countries and other countries. The main reason is the improvements made in OHS and safety culture in industrialised countries ‘but so has the export of dangerous jobs. Much of the world’s most hazardous work is no longer performed in the older-established industrial countries’ (ILO, 2003).

The recent changes which have been made to work organisations as a result of globalization (e.g. free trade among countries, new technology) and also due to the fact that large enterprises are outsourcing and subcontracting most of their jobs, this situation has created a high number of small businesses. These changes can benefit some nations in the reduction of the rate of accidents, injuries, diseases and fatalities and at the same time have a negative effect in other parts of the world.’ Much of the steady reduction in the number of work-related accidents in the industrialized countries has been mainly due to workforce cuts in high-risk sectors’ (ILO, 2003). However the rate of injuries in high-risk workplaces in these counties is still high. The example is the injuries caused to logging workers in ‘mountain areas of the US State of North Carolina’.

It has already been established that construction industry has one of the highest rate of accidents worldwide and this rate is even higher in developing countries. The fatal injury rate among these logging workers is 15 times more that fatality rate of those in construction industry in developing countries. Another factor in reduction of work-related fatality rate in industrialized countries is the improvement in the first aid care, speedy action by emergency transportation of injured person to hospital (ILO, 2003). The status of work-place accidents especially in construction industry of some of the industrialized countries has been briefly reviewed in the following sections.

4.3.2.1 United Kingdom

The construction industry is the biggest industry in UK with estimated two million workers (HSE, cited in Fleming et al., 2006). Despite the proactive initiatives (significant volumes of research) to improve safety at work taken by UK in comparison to Australia, European countries and US, still every day one work-related death and 600 injuries are reported. At the same time absenteeism as a result of work related injuries are estimated as high as ‘three quarters of a million people’ every year (HSE, cited in Fleming et al., 2006).

Progress and level of achievements in UK’s OHS standards, trend of injuries, were assessed by Paton (cited in Fleming et al., 2006), to be unsatisfactory as a result of high levels of injuries. However Paton in his article the ‘measure of Success’ accepted the positive initiatives and enforcement measure put in place by the government during the 10 year invigorating health and safety policies. A significant number of initiatives and campaigns have been put in place by HSE to highlight some hazards such as ‘ladder safety through Ladders Week’ (Paton, cited in Fleming et al., 2006) and providing free safety recommendations and assistance for ‘construction projects’. Paton concludes that a key factor and a fundamental point for a ‘successful safety campaign’ is ‘enforcement’.

The Construction Design and Management Regulations 2015 (CDM) put in place by HSE covers ‘management of health, safety and welfare when carrying out construction projects’ in UK (HSE, 2015). The tasks and responsibilities under CDM 2015 apply to clients (organisations or individuals), domestic clients (individuals carrying construction work on their own), principal designers, designers, principal contractors, contractors and workers.

Recommendations were made by HSE (cited in Fleming et al., 2006) known as Five Steps to Success in management of health and safety and the improvement of an explicit safety policy. These steps are briefly outlined as follows:

Step 1- Clarification of responsibilities by;

- Documentation of safety standards, assignment of responsibilities for staff's involvement in workplace safety e.g. 'training, recruitment and advisory support', effective teamwork, supervision and to follow instructions.

Step 2- Assignment of responsibilities for staffs in promoting and encouraging health and safety culture through four key words;

- competence, control, cooperation, and communication

Step 3- Setting targets for implementation of performance and instruction of standards towards a positive safety culture by for example:

- Hazards identification, risk assessment and control measures are set and monitored for their effectiveness and;
- Safety standards have to be 'measurable, achievable and realistic';

Step 4- Development of a system to be able to recognize a;

- *Problem before it occurs(Cole, cited in Fleming et al., 2006)*

Step 5- Suggesting organisations to audit (internal and external audits) their system and: Learn from past experiences (Fleming et al., 2006).

4.3.2.2 United States

The National Institute for Occupational Safety and Health (NIOSH) is the United States organization operating under Department of Health and Human Services. NIOSH is the operating resource for providing information, education, training, recommendations and research in relation to health and safety. In addition other functions of NIOSH are in development of OHS standards (NIOSH, cited in Fleming et al., 2006).

In relation to construction industry, the responsible organisation is the Occupational Safety and Health Administration (OSHA). OSHA in US has the power to enforce the labour regulations and to employ inspectorate to visit construction sites for their compliance with OHS regulations. In addition, OSHA has been educating construction workers in many ways (e.g. programs, ‘training grants’) as well as providing guidance ‘resources for high-risk or remotely located construction workers’ (CPWR, cited in Fleming et al., 2006).

According to CPWR (cited in Fleming et al., 2006) and with reference to ‘the US employee advocacy group denominated the Centre to Protect Workers (CPWR)’ through their ‘Construction Chart Book’ (developed by CPWR) it indicates that due to lack of resources the construction site inspection by OHSA has been decreasing. In addition according to the data from ‘US Census Bureau’ there is only ‘one safety inspector’ for well above 3, 000 sites for all industries. Other issues of concerns are related to lack of resources are:

- The inspections by OSHA is mainly carried out in sites which is supported by union than non union sites (estimated at %10);
- The inspections were mostly carried out in big enterprises worksites compared to small and medium size workplaces;
- There has been a significant increase in penalties for non-compliance as a result of decline in worksite inspections by OSHA, CPWR (2002, 1, cited in Fleming et al., 2006).

CPWR has their own website regarding ‘occupational hazards on construction sites’ in a comprehensive and up to date database, eLCOSH easy to use containing relevant legislations, regulations and OHS materials concerning workers in construction industry ‘this type of system could potentially prevent overlapping of information available to the public’ (Fleming et al., 2006).

There have been 774 work-related fatalities as a result of injuries sustained to workers in construction industry of US in 2010. This accounted for 17% of all work-related fatalities among all industries in U.S., being the highest in this year (CDC, 2014). The contribution of the U.S. construction industry estimated as $511.6 billion in 2010 (The Construction Chart Book, 2013).There are similarities between

Australian's health and safety statistics with U.S. and Europe; however it is double of the United Kingdom (Wild, cited in Fleming et al., 2006).

4.3.2.3 New Zealand

The government of New Zealand recommended that the legislation, regulations and safety guidelines in construction industry were 10 years old and needed to be amended and brought up to date. The guidelines mainly are targeting the employees and they are obtainable as a list, accompanied by related regulations in OHS Handbook. It was recommended by the government that inspectorate to refer to this handbook while inspecting the workplace. This reform took place in 1995 based on the New Zealand's National Health and Safety Employment Act of 1992 (Fleming et al., 2006).

The guidelines in health and safety standards were further improved in construction industry by an independent organisation (Site Safe) in 1999 known as Construction Safety Management Guide: Best Practice Guidelines in the Management of Health and Safety in Construction (Site Safe, cited in Fleming et al., 2006). The focus of this guide was to better clarify the roles and tasks of stakeholders in construction industry. These guidelines were supported by government and private companies (Fleming et al., 2006).

4.3.2.4 Canada

Canadian Centre for Occupational Health & Safety (CCOHS) was established in 1978 by Canadian government. CCOHS is a nonprofit organisation and it is governed by delegates from government, employers and laborers. The objectives of CCOHS are to support working population of Canada by promoting well-being ('physical, psychosocial and mental health'), providing training and education in OHS (CCOHS, 2014). This is a consultative centre to provide resources relevant to safety and health such as legislations, standards and regulations to construction and other industries to support in the reductions of work-related fatalities and injuries and protect working population from diseases. CCOHS provides guidance by consultants through an 'inquiry service' by means of telephone, email or in person' (CCOHS, 2004, cited in Fleming et al., 2006).

CCOHS publishes a complimentary bi-monthly newsletter by e-mail for current and up-to-date workplace health and safety topics to ‘create a healthy workplace’ (CCOHS, 2014). This newsletter is ‘unique to Canada’ (Fleming et al., 2006). An up-to-date statistics shows that in 20 years from 1993 to 2012, the total of 18, 039 (an average of 902 fatalities each year) people have been killed due to work-related accidents. The number of work-related fatalities in 2011 was comprised of 919 and in 2012 comprised of 977 representing an average of more than 2.7 deaths every single day. Since 1991 the federal government of Canada has recognised the April 28^{th} as a ‘National Day of Mourning’ to commemorate work-related fatalities and injuries in Canada. This is also to encourage all stakeholders to prevent future tragedies. On this day the Canadian flag is elevated half mast on Parliament Hill (CCOHS: newsletter, 2014).

4.4 Australian Work-Related Traumatic Injury Fatalities

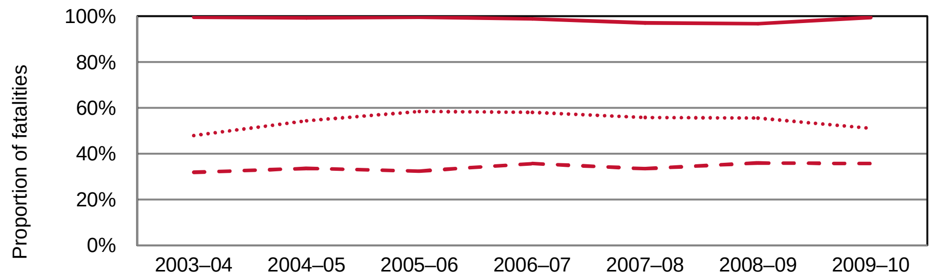
Safe Work Australia has been reporting work-related injury fatalities in Australia since 2003-04. ‘Because there is no single national data collection system that identifies all work-related injury fatalities, the exact number of people who die in any year as a result of work-related injuries in Australia is difficult to establish’(Safe Work Australia, 2012).

In the following sections an attempt has been made to review Australian work-related traumatic injury fatalities by, industry (in particular construction industry), occupation, and mechanism of incident with specific reference to state/territories of Australia and Western Australia in particular. In addition the following sections has also been briefly covered: workers’ compensation, review of the OHS performance and costs estimates of work-related injuries, illnesses, fatalities and diseases in year 2008-09 in Australia.

4.4.1 Work-related traumatic injury fatalities Australia 2003-04 to 2009-10

Safe Work Australia collects data from three different sources, the National Data Set for compensation based statistics (NDS), the Notified Fatalities Collection (NFC) and National Coronial Information System (NCIS). The investigation of incidents for rail, marine, and aviation are carried out by the Australian Transport Safety Bureau.

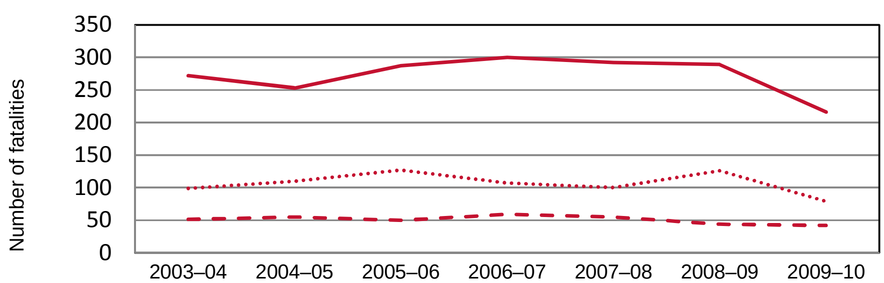
Each of these data sets having their own strengths and weaknesses and the coverage of fatality data by each of these data set is shown in Figure 4.2, which indicates that NCIS is the most reliable source of work-related traumatic injury fatalities in Australia with 99% accuracy.



	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10
NCIS	100%	99%	100%	99%	97%	97%	99%
NDS	48%	54%	58%	58%	56%	56%	51%
NFC	32%	33%	32%	36%	33%	36%	36%

Figure 4.2: Work-related fatalities: Dataset contribution, 2003–04 to 2009–10 (Safe Work Australia, 2012).

The Work-related traumatic injury fatalities Australia 2003-04 to 2009-10 was completed in March 2012. As the relevance of this document to this research some important sections, will be reviewed in detail in the following sections. This report by Safe Work Australia identifies work- related fatalities in Australia under 3 different categories. The numbers of fatalities are classified as worker, commuter and bystander as shown in Figure 4.3.



	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10
Worker	272	253	287	300	292	289	216
Commuter	99	110	127	107	100	126	79
Bystander	51	55	50	59	55	44	42

Figure 4.3: Work-related injury fatalities: worker type, Australia, 2003–04 to 2009–1010 (Safe Work Australia, 2012).

According to Safe Work Australia in 2009-10, there were 337 work-related traumatic injuries in Australia. Of those cases 216 (64%) of the fatalities were comprised of worker, and the remaining fatalities comprised of 79 (23%) commuters and 42 (12%) bystanders. This being the lowest number of worker fatalities since the series started, however there is an indication of 7% increase in worker fatalities in 2010-11(Safe Work Australia, 2012). Worker fatality (Injury fatality) includes: injuries occurred ‘in the course of work activity’. These series identifies the characteristics of the worker fatalities by:

- Sex, age group, occupation and industry;
- Involvement of vehicles;
- State/territory of death, mechanism of incident;
- Working with trucks and
- Working on farms.

The work-related injury fatalities, in the seven years from 2003-04 to 2009-10 have reached a total of 3013 workers, commuters and bystanders in all industries. This accounts for an average of 430injury fatalities each year as shown in Figure 4.4 (Safe Work Australia, 2012).

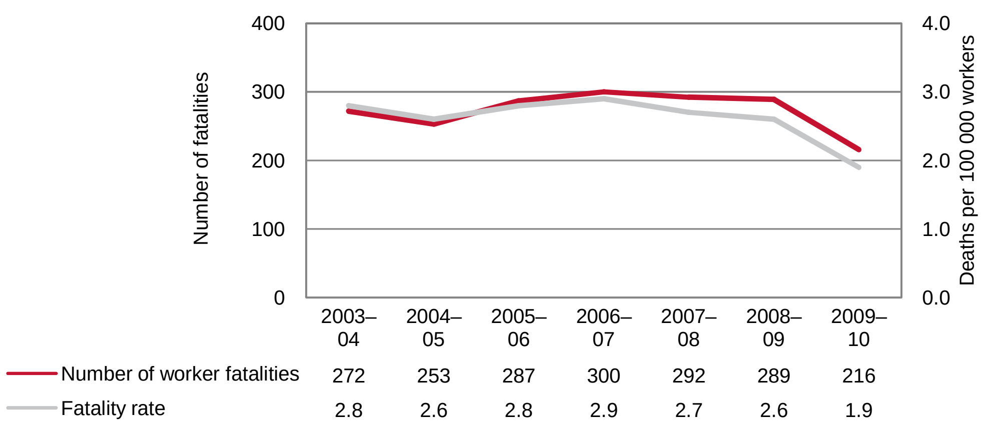


Figure 4.4: Worker fatalities: number of deaths, Australia, 2003–04 to 2009–10 (Safe Work Australia, 2012).

The number of worker fatalities by industry of employer is the highest in Agriculture, forestry& fishing. Construction industry is ranked number three having the highest number of worker fatality after Transport, postal and warehousing and

Agriculture, forestry and fishing (seven years combined). Worker fatalities totaled to 181 in construction industry with average of 26 each year from 2003-04 to 2009-10. Further details on the data are presented in Figure B.1 and Table B4 in Appendix B.

4.4.2 The Australian Work-related fatalities by state/territory of death

The highest number of worker fatalities from 2003–04 to 2009–10have occurred in New South Wales (total = 578, average of 83/year), followed by Queensland (total = 461, average of 66/year), Victoria (total = 392, average of 56/year), Western Australia(total = 229, average of 33/year), South Australia (total = 113, average of 16/year), Tasmania (total = 73, average of 10/year), Northern Territory (total = 53, average of 8/year), and Australian Capital Territory had total of 10 work-related fatalities. Further details on the data are presented in Table B5 and Table B6 in Appendix B.

4.4.3 The Australian Work-related fatalities by Mechanism of incident

In 2009-10, there have been 100 (46%) worker fatalities as a result of vehicle incidents. Most of these fatalities (73) occurred on public roads (traffic incident) and 27 of the fatalities occurred on worksites. In this year truck drivers and truck passengers composed of 51. These data can be seen in Table B7 in Appendix B. The truck drivers compared to other vehicle driver status had the highest (with exception of other industries) number of worker fatalities since the series started. Other mechanism of injuries with high number of fatalities was falls from height (24) and being hit by moving object (23). These three mechanism of incidents accounted respectively for 46%, 12% and 11% of all workers fatalities for the seven year period. These data can be seen in Table B8 and Figures B.2 and B.3 in Appendix B

The total of 310 (16%) of all worker fatalities in this series were among farm workers, which 37 (17%) occurred in 2009-10. An alarming 90 (29%) of these fatalities were among age group 65andover. ‘This is nearly three times higher than the proportion of all worker fatalities’. According to this data it is evident that there is a higher ‘risk of death in older workers on farms’. Further details on the data are presented in Figure B.4 in Appendix B.

Most of the incidents on farms (2/3) causing death of worker were involved vehicles, mostly tractors (83), as result of roll over, travelling on uneven ground or along embankments. Other type of vehicles involved in incidents causing worker fatalities. These data can be seen in Figure B. 5 in Appendix B.

Commuter fatalities include: fatalities occurred in the course of work duty (travelling to or from work) or during a work break. The commuter fatalities are characterized by:

- Age group, occupation, industry of the employer and;
- Type of vehicle involved.

There has been 748 commuter fatalities since the series started up and to 2009-10. Year 2005-06 recorded the highest number of fatalities (127) followed by 2008-09, the total of 126. Further details on the data are presented in Figure B.6 in Appendix B. The characteristics of the commuter fatalities in relation to age group and gender, occupation and industry of the employer are shown in Figure B.7, Table B9 and Table B10 in Appendix B.

The male and age group less than 25 had the highest number of commuter fatalities and this pattern has continued and decreased every year from 2003-04 to 2009-10.

The commuter fatalities in construction industry comprised of 80 compared to 26 for mining industry for the seven series. Jurisdictions that offer workers compensation to commuters who are travelling to or from work are: The ACT and Seacare, NSW and QLD with some limitations, NT only workers on foot or pushbike and Comcare up until March 2007.

In Western Australia and Tasmania commuter fatalities are not covered by workers compensation and in Victoria and South Australia those workers are only covered if there is a significant connection between employment and the incident which caused death (Safe Work Australia, 2012).

Bystander fatality: ‘as a result of someone else’s work activity’. Bystanders are characterised by:

- Age group;
- Location of incident;

- Mechanism of incident.

Total of 356 bystanders died over the seven series, which 40% were female and the highest number of bystanders were under 15 years of age (29% of the total). The number of bystander fatalities under age of 15were 36% (15) in 2009-10. The next highest number of bystander fatalities over the seven series was age 65 and over (17%) (Safe Work Australia, 2012).Further details on these data are presented in Table B11 and Table B12 in Appendix B. According to Safe Work Australia (2012), the bystander fatalities are the 'undercount' of the true figures over the seven years series, since the coronial records, not in general provide detailed information to be able to attribute a death to someone else's work activity. This specially applies to vehicle incidents. The deaths in vehicle incidents are only counted as bystanders fatality, when the 'driver of the work vehicle to be at fault'. Bystander fatalities are not compensable through the workers' compensation system. Therefore bystander's fatalities in these series must be looked at with caution.

4.4.4 Work-related fatalities Western Australia 2000-01 to 2012-13

WorkSafe a division of the Department of Commerce with the cooperation of WorkCover in Western Australia has been publishing work-related fatalities in Western Australia since 1988-89 which is coincided with upcoming in to operation of Occupational Safety and Health Act 1984. As a result of this Act; WorkSafe is responsible for all work-related fatalities (including employees and self-employed) other than those in the mine sites (State of the Work Environment, 2013). WorkSafe obtains work-related fatalities in relation to mining industry in Western Australia from the Department of Mines and Petroleum. The mining fatalities 'fall within the jurisdiction of the Mines Safety and Inspection Act 1994'.These series are titled as State of the Work Environment (SOWE). According to WorkSafe these series are 'to promote awareness of occupational safety and health in Western Australia'. Work-related fatalities which are not included in this data are:

- Commonwealth Government workers, workers who are covered by Comcare and defense personnel;
- Occupational diseases;
- Work-related road traffic accidents (note: covered by WorkCover) ;

- Work-related fatalities as a result of heart disease (note: heart attack fatalities are covered by WorkCover) only included if are directly as a result of the work activity performed at the time of death (State of the Work Environment, 2013)

According to the most up-to-date publication of State of the Work Environment,(2013), there has been a decrease in the number of work-related fatality rates ‘since the Occupational Safety and Health Act 1984 (the Act) came into effect in 1988-89 (State of the Work Environment, 2013). With reference to Figure B.8in Appendix B, the highest number of fatalities per million workers was the highest in 2007-08 and the lowest in 2009-10.Since 2000-01 to 2012-13, in 13 years there has been 254 work-related fatalities and 240 events causing death in Western Australia as shown in Table 4.1.

Table 4.1: Work-related fatalities in W.A.: 2000-2001 to 2012-2013 (State of the Work Environment, 2013).

Year	*Number of fatalities*	*Per Million Workers*	*Number of fatal events*
2000-01	21	22.4	17
2001-02	18	18.6	18
2002-03	23	23.4	22
2003-04	20	20.6	19
2004-05	22	21.7	22
2005-06	12	11.3	12
2006-07	25	23	24
2007-08	27	24	24
2008-09	21	18	18
2009-10	9	7.7	9
2010-11	21	17.2	21
2011-12	17	13.5	16
2012-13	18	13.7	18
13yr Total	**254**		**240**

The majority of these fatalities (174) from 2000-01 to 2012-13 occurred in Western Australia’s country region compared to 80 in metropolitan region. Further details on the data are presented in Figure B.9 in Appendix B.

4.4.5 Work-related fatalities by industry, Western Australia 2000-01 to 2012-13

The work-related fatalities are classified in the industry which employer is engaged (not the subdivisions) and that is the industry of the workers working at the time of fatal incident. The highest number of traumatic work-related fatalities in Western Australia from 2006-07 to 2012-13 for the period of seven years occurred in Agriculture, Forestry and Fishing (23.9%) followed by construction (16.7%) and Mining Industry (13%) (State of the Work Environment, 2013). These data can be seen in Figure B. 10 and Table B13 in Appendix B.

The breakdown of priority areas of concern by WorkSafe across all industries in relation to the work-related fatalities from 2006-07 to 2012-13, data are presented in Table B14 in Appendix B. The highest number of fatalities occurred as a result of falls from height and mobile plant (including tractors). These areas are targeted by WorkSafe for enforcement and compliance to reduce the number of accidents, injuries and fatalities in workplaces and promote safe systems of work (State of the Work Environment, 2013).

4.4.6 Work-related fatalities by occupation, Western Australia 2000-01 to 2012-13

The highest number of traumatic work-related fatalities in the major occupations was Machinery Operators and Drivers and Labourers each accounting for 23.6% of the fatalities. According to ABS Labour Force estimates in 2012-2013 the major occupations, Machinery Operators and Drivers in Western Australia had the lowest number of workers (about 106,000) and labourers accounted for 138,000 of the workers and 6 fatalities being the fifth highest. The highest proportion of truck drivers' fatalities occurred in the Road Transport accounting for 10 (58.8%) of the deaths followed by Metal Ore Mining subdivisions accounting for 4 (23.5%) of the total fatalities. 'Truck drivers are the minor occupation group of highest fatality risk' in Western Australia (State of the Work Environment, 2013).

However there has been some reduction in the number of truck driver's fatalities since 2008-09.Further details on the data are presented in Figure B.11 and Figure B. 12 in Appendix B.

4.5 Workers’ compensation

The workers’ compensation and rehabilitation scheme was introduced in Australia and other industrialized countries in late nineteenth and early twenties century. These achievements and preventive legislation ‘was the result of many years of political struggle on the part of workers, union and other interested parties’ (Quinlan et al, 2010). ‘This positive approach to protect workers, in case of injuries, became the requirement by the employers to take workers’ compensation insurance with either recognized private insurers or government agencies (Plumband, Cowell, Cited in Quinlan et al, 2010).

According to Quinlan et al (2010) the workers’ compensation in Australia is a state and national ‘responsibility’ and each state and territory has their own legislation and different organizational way of reporting. This adds up to ten different worker’s compensation in all Australian jurisdictions. Although the main concern of the workers’ compensation legislation in Australia is to prevent workers from injury and disease, however the main objectives of the scheme are:

- Providing medical care and financial support for injured workers and their dependents;
- Ensuring employers to take financial responsibilities towards workers being injured or having diseases which are related to their workplace;
- Encouraging injured workers to rehabilitation and their return to work;
- Encouraging employers to take preventive measures more seriously.

In addition to above, all the jurisdiction cover the same basic benefits such as: costs of medical expenses, short and long term compensation, replacing the lost income, lump sum payments and death benefits (Quinlan et al, 2010).

Safe Work Australia reviews and analysis work related serious claims accepted as workers’ compensation in Australia under the series, ‘Compendium of Workers Compensation Statistics Australia’ every year. These series are the indication of work related injuries and diseases of employees whose claims have been accepted as worker’ compensation under serious claims with correspondent to variables such as ‘industry, occupation, age and sex’. In 2008-09 (Safe Work Australia, 2011), the industries with highest number of serious claims were manufacturing, health and community services, construction and retail trade. Male workers had the highest number of serious claims in two of the industries: manufacturing 22% (females 8%) and construction 17% (females 1%). However in two of the industries which females had the highest number of serious claims were health and community services comprised of 30% (males 4%) and in the retail trade comprised of 15% (male 8%). (Safe Work Australia, 2011).These data can be seen in Table B15 in Appendix B.

The comparison between males and females in relation to serious claims by occupation indicates that males had the highest number in three of the occupations Labourers& related workers (23%, females 18%), Tradespersons & related workers (27%, females 4%), Intermediate production & transport workers (25%, females 5%). However females had the highest percentage of serious claims in five of the occupations. Intermediate clerical, sales & service workers (27%, males 5%), Professionals (20%, males 7%), Associate professionals (10%, males 6%), Elementary clerical, sales & service workers (13%, males 5%), advanced clerical & service workers (2%, males 0%).Further details on the data are presented in Table B16 in Appendix B. With reference to Figure B.13 in Appendix B, it shows that the incident rate of serious claims by sex and age, males comprised of 20.7% in age group 55-59 years and females comprised of 13.3% in the age group of 50-54 years.

4.6 Review of the OHS performance in Australia

The review of the OHS performance in Australia shows that the 'incident rate of serious injury and disease claims' has reduced from 14.5/1000 employees to 13.0/1000 from 2006-07 to 2009-10. In the same period, the number of compensated fatalities had also decreases from 290 to 215 (26%). The target of 40% reduction in the claims for injuries and musculoskeletal disorders, until end of June 2012 was only achieved by 28%. South Australia was the only jurisdiction achieving 41% and Australian Capital Territory and Seacare had an increase in their workers' compensation claims in this period. There has been 47% decrease in fatality claims from injury and musculoskeletal disorders from 2002-03 to 1010-11 (Safe Work Australia, 2012).

From (2000-01 to 2002-03) to 2008-09, the reduction in the rate of claims among priority industries was only higher than the average of Australia (22%) by construction industry being 24% followed by other industries: the manufacturing and transport and storage (21%), health and community services (19%), the agriculture, forestry and fishing industries all had the least decrease (11%). According to Safe Work Australia (Occupational Disease Indicators, April 2010), there has been declining trends in five of the eight concerning disease groups from 2000-01 to 2006-07: ‘musculoskeletal disorders; mental disorders; infectious and parasitic diseases; contact dermatitis; and cardiovascular diseases’. There is not any clear indication of increase or decrease in the other three priority disease groups ‘noise-induced hearing loss; respiratory diseases; and occupational cancers’ (Safe Work Australia, 2012). It should be noted that these figures are based on worker’s compensation data, therefore they are not the complete indication of work-related injuries, diseases and fatalities in Australia since only employees are covered by workers’ compensation. The estimate of the cost of workers’ compensation schemes in one year (2010-11) added up to $7 448 million (Safe Work Australia, 2012).

Other improvements were that in 2010-11, there were 2% increase to (from 75% to 77%) workers who suffered injury or disease returning to work. In this year there were 57 600 notices, 397 legal actions taken by work health and safety authorities against businesses in Australia and in addition $15.5 million ‘in fines were handed out by the courts’ (Safe Work Australia, 2012).

The extent, level, amount, duration, rehabilitation, administration and structure of worker’s compensation in Australia ‘remain a political’ issue in Australia. One great limitation of workers compensation, worldwide is the lack and acknowledgment of occupational diseases. This is attributed to the lack of knowledge (‘etiology of many diseases’) and research in this area (Quinlan et al, 2010).

According to Fifteenth Edition of Comparative Performance Monitoring (CPM) report by Safe Work Australia (2013), the lowest number of ‘work-related compensated injury fatalities’ has been reported since 2002. The rate of return to work of workers after injury has also been decrease by 2 percent compared to previous year. However there is a significant difference in average rate of injuries and fatalities between all industries and industries such as transport and storage, manufacturing, construction, agriculture, forestry and fishing. Finally in spite of the reality that workers’ compensation is to protect workers and their family from loss of income in case of injury, disability and death this ‘do not include compensation for emotional suffering’ (Quinlan et al, 2010). Above all is what kind of compensation can replace a mother or father role for children who have to grow up without them. Indeed literature lacks to mention this very important aspect of moral and financial aspect of OHS.

4.7 Costs estimates of work-related injuries, illnesses, fatalities and diseases Australia (2008-09)

The effect and cost of work-related injuries, illnesses, fatalities and disease fatalities are mostly on workers and their families and further on employers and the community. A comprehensive study was carried out by Safe Work Australia (2008-09) to measure the cost of work-related injury and illness. This study was based on the methodology developed, applied and endorsed by NOHSC in 2004. This methodology used by NOHSC was based on the 1995 report by Industrial Commission (cited in Safe Work Australia 2008-09) report which was further modified after it was reviewed by two independent parties: Access Economics (2004, cited in Safe Work Australia 2008-09) and Allen Consulting Group (2003). This methodology measures total work-related incidents using an incident approach (‘incident approach measures new cases occurring during the reference year’) meaning with incident approach the economic cost of disease are followed to the future and therefore, even cases that are not longer in workers compensation system (e.g. received a lump sum) which still incurring medical and other costs in that year are included in this study (Safe Work Australia, 2008-09).

The total number of work-related injury and illnesses and incidents’ data were obtained from workers’ compensation claims with supplement of Work Related Injury Survey (WRIS), Safe Work Australia estimates of injury fatalities (Safe Work Australia, cited in Safe Work Australia 2008-09), disease fatalities (ABS, cited in Safe Work Australia 2008-09) and NDS. The WRIS (ABS Catalogue, Work-related Injury Survey, 2010) is complete data coverage of all work-related non-fatal and non-compensated incidents. The incidents that their contribution was minor to the total cost of work-related injury/disease were removed from WRIS data, such as if only part of a shift was lost, with no absenteeism from work, ‘lasting incapacity’ or the injury did not cause any lost time. Therefore WRIS is also underestimation of the total work-related incidents in this year (Safe Work Australia, 2008-09).

NDS data is the estimate of the number of work-related injuries and diseases which occurred in 2008-09. The data provided by NDS is ‘the total number of accepted new compensation claims submitted to workers’ compensation jurisdictions during the 2008–09 financial years’. Accepted compensation claims data are ‘categorised by severity, duration of absence, nature (injury/disease) and jurisdiction’. Since many work-related injuries/disease caused to self-employed or workers who were not compensated for their injuries (e.g. short period of absence) are not included in NDS data, therefore this data is underestimation of all incidents occurred in 2008-09 and it is very significantly underestimated in construction and agriculture industries (Safe Work Australia, 2008-09).

Work-related injury and illness costs are either direct or indirect; for example the direct costs to employers are such as workers’ compensation either paid by the employer or from ‘workers’ compensation jurisdictions’ (Safe Work Australia, 2008-09) and the example of indirect costs is productivity loss. These costs direct or indirect (e.g. loss or decreased income, loss of quality of life) depending on the severity of the injury, work arrangements of the worker the costs on workers and the community is very difficult to be measured. However this study made the best effort to measure these costs by categorising them in to different steps. The step one was the cost ‘borne by the key economic agents’ (employers, workers and the community). These intangible costs are summarised in Table B17in Appendix B. The total costs includes ‘the sum of production disturbance costs (PDC), human capital costs (HKC), medical costs (MEDC), administrative costs (ADMINC), transfer costs (TRANC) and other costs (OTHERC)’ (Safe Work Australia, 2008-09).The severity of work-related injury and illness was categorised in to five levels: short absence, long absence, partial incapacity, full incapacity and fatality. Further details on the data are presented in Table B18 in Appendix B.

The approach (known as ‘ex-post’) used by this methodology was to measure the total costs of work-related injury and disease borne by the key economic agents, including the expected costs which might occur in the future added into the reference year (using present values). ‘This approach is known as the lifetime cost approach’ (Safe Work Australia, 2008-09).

By reference to Table B19 in Appendix Band as a result of this estimation using the data from NDS and WRIS (‘by nature and duration’) by Safe Work Australia there were 611 300 non-fatal work-related injuries and diseases in 2008-09. Those workers who received workers’ compensation composed of 325 500 and those workers who did not receive workers compensation composed of 287 900 (Safe Work Australia, 2008-09).

There is a lack of data in relation to work-related diseases. This also applies to the data from workers’ compensation and ‘ABS surveys of the workforce’. However some diseases have been proven to be related to workplace exposures such as ‘neoplasm (cancers and tumors), asthma and other respiratory diseases and heart disease’. In 2008-09, 61 000 morbidities were estimated as a result of workplace exposures. Asthma (3 000), Neoplasm (5 000), respiratory disease (23 000) and the highest number were composed of heart disease (30 000). ‘The estimates are based on a number of studies of population attributable fractions for workplace exposure’ listed beneath the. Further details on the data are presented in Table B20 in Appendix B.

The Table B.21 and Figure B.14presented in Appendix B, show the average indirect cost of each work-related injury and disease borne by the key economic agents in 2008-09. The highest average costs is borne by the worker, in case of injury $46 090 and $163 530 in case of disease. In case of full incapacity the average cost of each injury is $ 1 582 680 to the community being the highest cost followed by $1 438 420 to the worker. In case of disease the highest average cost is borne by the worker $ 1 213 290 and to the community this cost is $835 990 (Safe Work Australia, 2008-09).

The estimated total cost of work-related injury and disease in 2008-09, borne by the worker, employer and the community is added up to $60.6 billion (each incident’s average cost $99,100). The total cost of injuries was 30.7 billion (each incident’s average cost $69,700). The cost of diseases totalled to 29.9 billion (each incident’s average cost 175,200) (Safe Work Australia, 2008-09). These data can be seen in

Table B22 in Appendix B.The total cost of incidents byseverity categories are shown in Figure B.14in Appendix B, indicates that most of the financial burden is on workers (Safe Work Australia, 2008-09).

With reference to Table B22in Appendix B, the cost of workers' compensation is added to the cost to the community rather than the cost to the employer (Safe Work Australia, 2008-09).

4.7.1 Costs of work-related incidents by Australian jurisdictions

The highest estimated indicative ('The differences in treatment of full incapacity claims between jurisdictions') of total cost of work-related injuries and diseases in 2008-09, were borne by New South Wales adding up to 20 300 million dollars of which 11 100 million dollars were as a result of injuries and 9 200 million dollars as a result of diseases followed by Queensland (total cost of 13 900 million dollars), Victoria (total cost of 13 100 million dollars) and Western Australia (total cost of 5 700 million dollars) had the fourth highest cost of work-related injuries and diseases in 2008-09.

4.7.2 Costs of work-related incidents by Australian industries

The total costs and 'estimated unit costs' of work-place injuries and diseases borne by different industries in 2008-09 are shown in Table B24 in Appendix B. 'These figures are based on differences in the number and distribution of claims and average weekly earnings between each industry division'. The highest estimated indicative total costs of injuries and diseases are borne by Manufacturing ($8, 600 million), followed by Health and Community Services ($7, 000million), Construction industry had the third highest costs ($6, 400 million). These three industries accounted for close to 40% of the total cost of work-related injuries and diseases in 2008-09.

4.8 Injuries and Fatalities in Australian Construction Industry

Building and construction industry is one of the most dangerous industries in the world and in Australia. Australian construction firms are mostly formed from small businesses, however it has been suggested by some researches that small construction businesses in Australia lack in issues, risks and compliance with laws concerning OHS, compared to larger size businesses (Holmes, Mayhew, cited in, Rowlinson, 2004).According to Parliament Senate Committee and Campbell (cited in Fleming et al., 2006), about 50 fatalities are occurring in Australian construction industry every year. The injuries in this industry are also estimated at being 50% more in comparison to other industries (Cole, cited in Fleming et al., 2006) and the fatality rates are estimated at being ‘three times the national workplace average’(Fleming et al., 2006).Despite the fact and existence of codes of practice for removal, licensing and training of asbestos, the enforcement of regulations ‘by union organizers and site safety delegates is still an issue on many refurbishment and demolition jobs in Australia. Too often, contractors will risk exposing their workers and the general public to asbestos dust rather than pay the costs of removing it properly’ (Fraser, 2007).Among all Australian states only ACT and NSW have some control on residential properties containing asbestos in their structures. According to legislation in ACT owners must provide the detail of asbestos in their property to any person which might be affected by asbestos dust. At the same time owners or builders must provide details of asbestos removal from any property before their application is approved. This positive approach towards asbestos removal is only taken place by some local councils in NSW, requiring homeowners to remove asbestos (‘make their properties safe’) from their property before their application is approved for any development (Fraser, 2007).

According to Fraser (2007), the safety in construction industry is ‘jeopardized by an Australian government bent on removing union influence’. Workers could be receiving fines of up to $22,000 if they go on strike at building sites and stop the work process and not being able to prove that their health and safety was at risk. Fraser adds that even though there have been some improvements in health and safety regulations in recent years the work-related injuries and fatalities are still alarming and ‘there is a long way to go before significant change will be achieved’.

In view of union in construction industry and the Construction Forestry Mining and Energy Union (CFMEU) there must be tougher penalties for employers in construction industry who cause death to their workers through their recklessness or negligence. ‘The introduction of industrial manslaughter legislation to jail employers who kill’ was supported by workers; however this law was only enacted by government of Australian Capital Territory (Fraser, 2007). According to this legislation, employers are responsible for independent contractors and workers from labour-hire agencies to comply with OHS. ‘An offender can be imprisoned for up to 25 years’ (Fraser, 2007). In 2004-05 a new health and safety legislation was introduced in NSW, Vic and WA with some differences in each state. In Victoria the offence is if employer ‘knowingly exposes a person to the risk of serious injury or death’. In NSW if it is proven that employer through negligence has caused employee’s death could be sentenced for up to five years in prison. According to this legislation company directors in WA could be jailed up to two years if it is proven that they caused severe injury or fatality through ‘gross negligence’ (Fraser, 2007).

‘Other notable legislative changes made in Victoria are obligation of designers towards safety. In Victoria and Western Australia, provisions have been made which requires: safety consultation with workers, safety representative’s with safety training and establishment of safety committees. In addition under the Act in Western Australia labor-hire companies and their employees’ (Fraser, 2007).
Victorian legislation gives power to union members to enter any site suspecting any breaches of OHS legislation. However they cannot stop or rectify the breach if that workplace does not have a nominated safety representative (Fraser, 2007).

Studies have shown that up to 90 percent of work-related fatalities in construction industry are preventable by implementation of appropriate control measures. The root causes of construction accidents are attributed to the size of the organisation, management commitment to OHS; structure and ethnicity of the workforce, enforcement and inspection by government.

There are many health issue problems in construction industry such as decompression sickness, tendonitis of hand or forearm; inflammation of skin and mucous membrane, gas poisoning, asbestos-related diseases and contact dermatitis (Rowlinson, 2004).Other health issues are: vibration white finger, skin cancer, carpal tunnel syndrome, Reynaud’s disease, decalcification of the bones and job stress. (Rowlinson, 2004). As a result of the Royal Commission, a nationally uniform OHS code of practice in construction industry was identified as a high priority and legislative changes were proposed by Commonwealth Government to improve the working practices in building and construction industries. There is a diverse feeling among stakeholders in implementation of nationally uniform OHS code of practice (Fleming et al., 2006).

In the following sections the key issues concerning construction industry will be reviewed.

4.8.1 Causes of construction accidents

According to Holt (2001) the literature about safety in construction industry indicates that, maybe there is not much cared or done to improve the working condition and human suffering in this industry. Holt adds that UK's record in construction safety management among European countries is a good example that much has been done and achieved. Holt outlines some of the unsafe acts, unsafe conditions, secondary causes of accidents and social pressures in construction industry. Some of these are outlined below:

Unsafe acts are: working without authority, failure to warn others of danger, leaving equipment in a dangerous condition, using equipment at the wrong speed, disconnecting safety devices such as guards, using defective equipment, using equipment the wrong way or for the wrong task, failure to use or wear personal protective equipment, bad loading of vehicles, failure to lift loads correctly, being in an unauthorized place, unauthorized servicing and maintaining of moving equipment, horseplay, smoking in prohibited areas and drinking alcohol or taking drugs.

Unsafe conditions include: inadequate or missing guards to moving machine parts, missing platform guardrails, defective tools and equipment, inadequate fire warning systems, fire hazards, ineffective housekeeping, hazardous atmospheric conditions, excessive noise and poor lighting.

Secondary causes of accidents: are related to management system pressures, financial restrictions, lack of commitment, lack of policy, lack of standards, lack of knowledge and information, limited training and selection for tasks, poor quality control systems resulting from the above.

Social pressure include: group attitudes, trade customs, industry tradition, society attitudes to risk-taking, acceptable behavior in the workplace, and commercial/financial pressure between contractors.

Although the manual labour has significantly decreased in newly evolved industries however this does not apply to industries such as construction (Bridges, 2003). According to Landeweerd, Urlings, Dejong, Nijhuis and Bouter (1990) ‘having a job in construction industry is a risky way of passing the working day’. This study by Landeweerd etal. (1990) classified the determinants of accidents/injuries in construction industry in to three groups these are:

Macro level factors: these factors are generally related to socio-economic/construction industry specific the contracting system (for example the harmonization between the principal contractor and subcontractors) and the mobility of the work force.

Meso level factors: such as project factors (e.g. selection of employees and project planning).

Micro level factors: these factors are in relation to the working sits and the work load, teamwork and attitude of workers and their individual characteristics such as enthusiasm, approach and understanding of the work they are engaged with. One of the micro level factors in occurrence of accidents/injuries has been attributed to ‘safety behavior of construction workers’ (Bullinga et al. 1987, cited in Landeweerd et al, 1990). The relationship between construction worker’s attitude and safety actions taken by them (‘risk taking tendency’) is a variable factor which has to be identified (Urlings et al, 1988).

There is a direct relationship between individual’s characteristics and their safety awareness of risk taking (Lennerlof cited in Landeweerd et al, 1990).In this study many issues were discussed in relation to construction workers and their perception of risk taking, the examples are: there is a dispute between their recklessness, tendency to take risks or their self-indulgent activities like social drinking and attending parties. The question being: is this false prejudice? Landeweerd et al. (1990) in this study concluded that there are some limitations and bias present in this theory and there is a need for more studies and the comparison between construction and other occupational groups are needed to prove the validity of the kind of theories considering other factors such as role of the organisation.

With reference to studies by Fleming et al. (2006) under the title of ‘Safer Construction: From Concept to Completion’, the most important causes of construction accidents are attributed to the diversity of the work involved, the environment, man (human factor), and machine. Some of the recommendations made by this study for ‘best practice frameworks for construction OHS’ is briefly summarized in the following sections and in addition with reference to other studies where applicable:

‘Best Practice Frameworks’: The effectiveness of Occupational Health and safety is achieved by collaboration between all parties involved from design stage to maintenance and demolition stage. At the planning stage the OHS objectives, risks and their preventative measures, the provision of personal protective equipment, safety conscious contractors selected and finally five principles are embedded to complement OHS. These five principles include: transparency, rationality, accountability, targets and outcomes, consistency and cost benefit proportionality (Fleming et al., 2006).

‘Government Regulations’: The review of studies reveals that government regulations best is utilized when safety is planned for design and construction, safety information for construction accidents and their preventative methods. Other areas of concern are selection of safety engineers, environmental health and safety plan and fines for non-compliance (Fleming et al., 2006).

‘Contractor Selection Criteria’: Contractor selection during tenders is mainly based on ‘principles of cheapest price/lowest cost’. In addition safety costs are not considered by main parties, the tenders and contracts. This review highlights the important areas to be considered during selection process such as consideration of health and safety through all stages of the construction from environmental, social, economical and sustainability. The contractors and subcontractors who clearly outline their ‘contractual responsibilities’ and guidelines towards how to control hazards at the construction sites are best serving towards safety. Employers must assess the contractor’s safety performance (their past good record in safety) through their written safety plan document which identifies the: safety standards, hazards, risks (level of risks: medium to high), preventative measures and safety training procedures. At the bidding stage the contractor’s safety plan must be assessed and reviewed by the construction team before work has resumed at the work site. In addition the safety plan must clearly identify who is responsible to implement, monitor and manage safety. The safety plan needs to be assessed at different stages of the project for its effectiveness (Fleming et al., 2006).

‘Designing for safety’: Construction design is the most crucial part of any construction project to implement safety. At this stage the designers must work and collaborate by the construction project team such as clients, supervisors, stakeholders

(e.g. clients, architects, electrical engineers, builders, maintenance personnel) to identify safety concern issues (e.g. hazard identification, risk assessment) and further provide solutions for preventative measures. Designers and employers are encouraged to attend site visits for inspection and record faults and make their recommendation in the 'safety log book'. At the design stage safety must be considered for the following areas before work starts:

- Site remediation and method;
- Provision of amenities/services;
- Site security/access;
- Excavation;
- Adequate ground condition and type of control mediums (e.g. batters, trench boxes, shoring);
- Silica content;
- Machinery types best equipped to mitigate dust; and
- Stable structures during deconstruction or reconstruction (Fleming et al., 2006).

Designers incorporating OHS in their designs is strongly depends on their theoretical safety knowledge, industry experience, competency and experience in OHS. Other concerns are making designs for safety tools and strategies easily available including increasing OHS education in tertiary subjects and organising refresher training courses for designers. Safety performance of any organisation is strongly dedicated to the involvement of the top management towards OHS (Fleming et al., 2006).

'Computer based Safety Applications': Development of an 'electronic safety database' for the duration of the construction phases will provide prompt communication and up-to-date information in relation to project safety and other (e.g. comments, alterations, monitoring of the work processes) matters(Fleming et al., 2006).

'Provision and use of Safety Equipment': The use of personal protective equipments must be the last resort, when all other protective means are considered. It is important that potential and limitations of PPEs are known to users and regular checks and maintenance of PPE equipments are kept up-to-date (Fleming et al., 2006).

Some of the PPEs such as safety glasses, gloves or masks obstruct working conditions, therefore workers avoid using them, and this might become a reason that they might ignore other safety procedures (Quinlan et al, 2010, p. 119).It should be noted that PPE does not get rid of the hazard or give a complete protection to workers. The fact that their use causes inconvenience or their protection is limited must be considered, the examples are helmet only protects workers from light weight objects. Some studies in Australia has shown that women who wear safety footwear have problems such as ‘hot inflexible soles impeded specific work tasks’ and also the steel cap also put pressure on their toes. Belts worn for lifting has shown that do not provide any protection for back injuries; Earmuffs or plugs impede communication; the benefits of using PPE such as helmet, safety shoes and high-visibility vests have been specially shown in some industries like construction. Heat and chemical resistance clothing has been shown to be very effective in case of fire and chemical accidents. PPEs are expensive and some workplaces may neglect their proper use ignoring quality, maintenance and their selection (Quinlan et al, 2010, p. 517).

4.8.2 National standard for construction work (NOHSC): 1016 (2005)

Construction industry is one of the most dangerous industries in Australia and in the world and construction workers are twice more likely to be killed at work compared to other industries. It has been estimated that about 49 construction and building workers has lost their lives as a result of their work activities since 1997-98 in Australia (NOHSC, 1016 (2005).

The goal of National Standards are affirmed by the NOHSC with reference to S. 38 (1) of the National Occupational Health and Safety commission Act 1985. This standard sets responsibilities for all involved (e.g. clients, designers, managers etc.). The aim of this standard is to protect all involved from injury and disease in construction work and by allocating responsibilities for all persons to identify hazards, risks and make an attempt to eliminate or reduce them. ‘This national standard does not supersede obligations under relevant legislation of the states and territories and the Australian Government’. Controlling risk: Controlling of the risks can be achieved by either elimination or minimization. This can be achieved by the following considerations:

- Substitution or less risky condition;
- Hazard Isolation;
- Minimization of the risk by engineering means;
- Application of administrative means (e.g. safe work practices);
- Use of personal protective equipment.

In view of the Australian government and NOHSC the uniformity in the regulation of Occupational health and safety throughout Australia will positively affect the economy. The NOHSC recognises that construction industry is among the high priority industries in Australia with high rate of fatalities and injuries. In November 2003, NOHSC was nominated by the Workplace Relations Ministers' Council to develop national standards for construction work. A Construction Reference Group was formed by NOHSC from representatives from all states and territories of Australia as follows:

- The Commonwealth;
- The Housing Industry Association;
- The Master Builder' Association;
- The Construction Industry;
- Forestry;
- Mining and Energy;
- Union and
- The NOHSC office.

NOHSC by the help of this group established the National Standards for Construction work. In addition to this Standard, was the establishment of National Codes of practice for the prevention of falls in construction work tilt-up and precast concrete construction work and occupational health and safety induction training for construction work. 'The NOHSC National Standard for construction work draws together best practice from Australian states and territory OHS authorities into a framework that will promote, for the first time, a nationally uniform approach to the management of OHS in the building and construction industry'(NOHSC, 1016 (2005).

4.8.3 Building and construction industry in Australia and the Cole Royal Commission

The nature of construction and building industry, dynamic situation of the worksites, environmental issues, climatic conditions and different industries working next to each other are just a small number of the many other factors facing this industry which contributes in OHS failures.

According to Department of Employment and Workplace Relations (2005, cited in Fleming et al., 2006) in 2003-04, building and construction sectors valued at about $50 billion to Australian economy at the same time these sectors employs more than 775 000 people. It has been estimated that the improvements in these sectors can generate an extra $2.3 billion per annum into Australian economy and ‘a 1% decrease in the cost of living for all Australians’(Fleming et al., 2006).In addition to above financial and employment benefits are fatalities, accidents, injuries, compensation claims, illnesses and worker’s disabilities caused by their work-activities.

In 2001 the Commissioner Terrence Cole was appointed by Australian government to make inquiry in to the matters of concern in relation to Australia’s building and construction industry (Cole, 2002). This report was completed in 24th of February 2003 and it was ‘tabled in Parliament on 26 and 27 of March 2003’ (Commonwealth of Australia, 2001).

This inquiry was established to investigate the ‘claims of malpractice and misconduct in the Australian building and construction sector’ and to ‘address the flaws that have resulted in OHS failures’. The findings of the Cole Royal Commission include the following:

- Ineffectiveness of current workplace relations laws;
- 400 different illegal actions were identified by individuals, unions and employers;
- Probability of 20 breaches of the Federal and State Acts;
- ‘Government regulatory bodies retained inadequate structures to enforce both legislative and universal behavior standards’ (Fleming et al., 2006).

The flaws in the building and construction sectors identified by this report and other studies include structural, cultural, behavioral, attitudinal and inherent disregards towards authority and policies. Regardless of the past failures and attempts to change 'the conduct and the culture of the building and construction industry', 212 recommendations were made by the commission to improve the poor performance of OHS in Australian construction industry. These recommendations were made to improve 'safety, taxation, law compliance, industrial law enforcement and employee entitlement protection' (Fleming et al., 2006).

4.8.4 Australian construction industry and workers' compensation

Construction industry (with 71% proportion of employees in industry and incident rate of 21.8) was one of the priority industries with high risk of incident rates and high workers' compensation claims in 2008-09 after agriculture, forestry and fishing(with 49% proportion of employees in industry and incident rate of 25.2), transport and storage(with 88% proportion of employees in industry and incident rate of 25.0) and manufacturing (with 94% proportion of employees in industry and incident rate of 23.4). The proportion of employees in construction industry (71% being 2/3 of the all workers covered for workers compensation) is the lowest after agriculture, forestry and fishing. This could be one of the many reasons that injuries are much higher in construction industry considering that in 2008-09, 11% ('this equates to 40 serious claims per day') of all serious workers' compensation claims were made by construction industry (Safe Work Australia, 2011). Further details on the data are presented in Table B25 in Appendix B.

The range of incident rate of serious claims per 1000 employees among the males were between 20.1 (age group 15-24 years) and 33.6 (65 years and over).Females comprised of 12% of the total employees and they constituted 3% of the serious claims in the construction industry. The highest rate of incidents among woman employees were 7.1 in age group 15-24 years and the lowest incident rate was 3.4 in 55-64 age group. Among all age groups females had a lower rate of incident rate than male employees. This difference of incident rate of serious claims between males and females employees is attributed to the nature of the work they undertake in this industry. 'In fact, only 3% of female construction workers were employed as Tradespersons & related workers and 4% as Labourers& related workers, the occupation groups lodging the largest numbers of serious claims' (Safe Work Australia, 2011). These data can be seen in Figure B.15 in Appendix B.

Common causes and types of serious claims for injuries and diseases in construction industry: The main causes of serious workers' compensation claims in 2008-09 in construction industry were attributed to' Muscular stress while lifting, carrying or putting down objects (17%), Falls from a height (13%), Muscular stress while handling objects other than lifting, carrying or putting down (13%) and falls on the same level (12%). The fall from a height, over one-quarter (28%) were from ladders, 15% from Buildings&other structures, and 11% from Scaffolding'. Based on the record, 77% of the serious claims were as a result of injuries, whereas 38% comprised of Sprains, strains of joints and adjacent muscles and 12% comprised of open wounds. The claims for diseases comprised of 11% for diseases of the musculoskeletal system and connective tissue,6% dorsopathies (disorders of the spinal vertebrae and intervertebral discs, 4%disorders of muscle, tendons and other soft tissues, 6% deafness (mainly in the concreting services). There were 25 claims for Neoplasms (cancers and benign tumors), which 11 was due to skin cancers and 8 of the claims were for mesothelioma.

4.8.5 Fatalities in construction industry Western Australia 2006-2007to 2012-13

The fatality data's in Construction industry from 2006-2007 to 2012-2013 includes all subdivisions' of this industry (Building Construction; Heavy and Civil Engineering Construction; and Construction Services) covering 'construction, additions, alterations, reconstruction, installation and maintenance and repairs of buildings and other structures including demolition or wrecking and land preparation'. For this period there were 138 work-related fatalities in all industries in Western Australia including 8 (34.7%) self-employed. The construction industry had the highest number of work-related fatalities 23 (16.7%) after Agriculture, Forestry and Fishing (33 fatalities) with average of 3.3 for the six year period (State of the Work Environment, 2013). The highest number of fatalities in this period occurred in Construction Services (15) being 65% of all deaths followed by construction (6) and Building Construction (2) (State of the Work Environment, 2013). Further details on the data are presented in Table B26 and Figure B.16 in Appendix B.

In this period the age group 35-44 had the highest number (6) of work-related fatalities, followed by age groups 25-34 (5), 45-54 (4), 65-69 (3), 20-24 (2) 19 and younger, 55-59 and 70 and over all had one death The age group 35-44with highest number of fatalities in this period had no fatalities in the lost two years in the series. These data can be seen in Figure B.17 in Appendix B.

4.8.6 Mechanism of incidents construction industry 2006-2007 to 2012-2013

The majority of common mechanism of incidents in construction industry in the seven years period from 2006-2007 to 2012-2013 were falls from height which comprised of 8 fatalities and by being hit by moving objects 6. All 14 fatalities were male employees from occupations ‘glazier, traffic controller and a pre-apprentice electrician’ (State of the Work Environment, 2013).Further details on the data are presented in Table B27 in Appendix B.

4.9 Conclusion

Work-related fatalities, injuries and disease are a worldwide problem. Despite the fact that the statistics are underestimation of the true figure, however it is still very high and a cause for concern. Cancer has been identified as a major cause of work-related fatalities and contributory factors has been identified as asbestos, carcinogenic chemicals and their processes, ionizing radiation, radioactive materials, radon and ultra violate radiations. Other contributing factors include: carcinogenic dusts, silica, tobacco smoke at work-place and diesel engine exhaust.

Shift and night work, long working hours and environmental tobacco smoke at work, excessive work, high level of work demand or repetitive work activities, noise, chemicals and job strain are the main cause of cardiovascular, cerebrovascular and hypertension diseases. These diseases likely to take place rather late in working life or sometime even just after retirement, therefore it is difficult to be attributed to work-place disease fatalities. Other areas of concern in some parts of the world are malaria, viral and bacterial diseases, schistosomiasis, tse-tse flies, poor hygiene, quality of drinking water and sanitation.

In Australia from, 2003-04 to 2009-10, a total of 3013workers, commuters and bystanders in all industries lost their lives as a result of their work. This is an average of 430 each year. In the same period construction industry has accounted for 181 worker fatalities with an average of 26 each year. There is a concern about older farm workers; the fatality rate among this group of workers is nearly three times higher than the proportion of all worker fatalities' in Australia.

In Western Australia from 2000-01 to 2012-13, in the 13 years there have been 254 work-related fatalities. A total of 174 of these fatalities occurred in country region compared to 80 in metropolitan region. The highest number of work-related fatalities has been as a result of falls from height and mobile plant. Considering the exclusions in these datas' and their effect on these figures is the indication of underestimation of work-related fatalities in Australia. These exclusions in Western Australia include Commonwealth Government workers, workers who are covered by Comcare and defense personnel and exclusion of occupational diseases, work-related road traffic accidents (note: covered by WorkCover), Work-related fatalities as a result of heart disease (note: heart attack fatalities are covered by WorkCover) only included if are directly as a result of the work activity performed at the time of death. The cost of work-related fatalities, injuries, diseases and workers' compensation is so high on Australian government and society as a whole, however workers and their families' suffering is beyond any estimation. The trend of work-related fatalities, accidents and diseases are decreasing in the industrialized countries, however in third world and developing countries a lot more is needed to be done to achieve an improved standard of OHS.

Chapter 5: Research Methodology; and

Chapter 6: Data Analysis and Discussion

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Chapter 7: Recommendations for Work-place Safety Practices

7.1 Introduction

Construction industry has been recognised as one of the most dangerous industries and it is not going to be improved until all stakeholders from employers to workers are well educated about OHS, as Rowlinson (2004) call it, a holistic whole system approach. It is only in this way there will be a framework for a uniform respond to OHS matters and a safer working environment for the workforce. Work-related injuries, diseases, disabilities and fatalities can happen to all stakeholders including engineers, company directors, supervisors and workers. As a result of this research some recommendations have been made. These recommendations apply to all stakeholders these are:

1. Civil Engineers and OHS Education;
2. Construction workers' education;
3. Further recommendations and
4. OHS and safety models

7.2 Civil Engineers and OHS Education

From January 2012, the Tertiary Education Quality and Standard Agency (TEQSA) 'will register and evaluate the performance of higher education providers against the new Higher Education Framework (TEQSA, 2012). The Standards Framework comprises five domains: Provider Standards, Quality Standards, Teaching and learning Standards, Information Standards and Research Standards (TEQSA, 2012). The Provider Standards and Qualification Standards are collectively the Threshold Standards which all providers must meet in order to enter and remain within Australia's higher education system (TEQSA, 2012)' **(**Wallis, 2012, p18).

'It is timely that inclusion of OHS and safe design in TAFE and university construction, architecture and design and engineering qualifications take place because from 1 January 2012 the new national Work Health and Safety legislation is in place in New South Wales, Queensland, the Australian Capital Territory, the Commonwealth and the Northern territory, and the legislators of the remaining states are seriously considering introduction of the model Work Health and Safety legislation'**(**Wallis, 2012, p21).

Inclusion of OHS and safe design in engineering subjects with specific reference to civil and structural engineering qualifications in Australia were studied by RMIT University through the school of property, construction and project management **(**Wallis, 2012). The findings of this study highlights that OHS is poorly embedded in universities' engineering qualifications compared to TAFE qualifications. From a sample of 238 universities only 41 (17.23%) and in TAFE institutions 279 out of 331 (84%) were included OHS in their units. The university qualifications included in this study were construction, project management, property, architecture and design and civil and structure. However in civil and structural engineering qualifications, the inclusion in to the TAFE units comprised of 4 out of 22 (18%) compared to 18 out of 89(20%) in universities. It was suggested that lecturers, teachers or trainers who deliver and teach OHS should have practical OHS knowledge and experience from industry. It was also 'agreed that it is not a role of the accreditation organisations to stipulate the manner of delivery' **(**Wallis, 2012, p16).

According to Health and Safety Executive (HSE, cited in, Rowlinson, 2004) academic staff must recognize that construction risk management is managing health and safety risks and the teaching of health and safety must be an essential part of construction related courses and programmes. HSE further recommends that construction courses should be audited to include health and safety management in all relevant subjects with the view of being an essential and cross curriculum element.

Civil engineering graduates 'have a role to play in health and safety' since they are engaged in many tasks from construction and project management, design of structures, property development, administrative management consulting to material manufacturing (Smallwood, cited in, Rowlinson, 2004).

According to Krause (cited in Rowlinson, 2004) incidents or accidents 'occur at the end of the health and safety upstream/downstream sequence'. Krause further outlined the factors affecting health and safety as:

- Culture;
  Values, vision, mission, purpose, goals and assumptions.
- Management system;
  Education, training, prequalification of contractors, implementation of a management system, plan for safe work procedures, site design, behavior penalties, responsibility, priorities, attitude, measurement system and resource allocation.
- Exposure;
  Behavior, conditions, plant and equipment, and facilities.
- Incidents.

The research conducted in the USA by Smith and Arnold (cited in, Rowlinson, 2004) outlined the health and safety course content for construction students at Pennsylvania State University. The course content was designed for employees with one to five years experience. The course content included the following:

- 'Pre – project hazard analysis;
- Preparation of accident reports;
- Conducting tool-box talks;
- Participating in project health and safety meetings;
- Performing hazard analysis;
- Recognizing common hazards;
- Conducting health and safety audits; and
- Maintaining material safety data sheet (MSDS) files'.

Krause (cited in Rowlinson, 2004) pointed out that, other areas of concern were experience modification rating (EMR), incident rates and accident costs. A research in relation to construction health and safety curriculum carried out in the USA among college and university students revealed that among all respondents forty-five percent stated that there had one subject entirely dedicated to construction health and safety. Other 55% respondents acknowledged that health and safety was not addressed in a broad-spectrum and generally was covered in other subjects or it was covered in some subjects 'relative to the subject material' (Coble et al., cited in, Rowlinson, 2004).

The result of the research by the European Foundation for the Improvement of Living and Working conditions shows that work-related falls accounted for 35% of the fatalities. Some of these fatalities could have been prevented during the design decisions. It has to be acknowledged that there is a direct relationship between consideration of safety during the design stage and accident causation (Jeffrey and Douglas, cited in Rowlinson, 2004).

Recommendations:

It is recommended that inclusion of OHS syllabus in to engineering courses to be, one on a separate subject covering general OHS areas as presented in this thesis (Appendix A), titled as Recommendations for Workplace Health and Safety Practices (applicable to all engineering disciplines) and second health and safety issues of concern related to each subject (risk assessment and risk management) and as a component of that subject.

7.3 Construction workers and OHS education

Who is by and large affected by HS are the workers and their families. For example construction workers are the ones exposed to potential hazards of their work activities and they are the ones must be involved in protecting themselves by knowing, what kind of hazards are present in their workplace. Workers awareness about hazards present in their workplace can contribute in improving health and safety at their workplace. Therefore workers at all levels must be educated through an approved government institutions before they are engaged in any work at construction sites or any other workplace with high risks. It is only then the workers can identify issues concerning their health and safety and protect themselves from accidents, fatalities and diseases and speak up.

Recommendations

It is suggested government to structure a system (databases) and to require that every working person in Australia to have a Working Identification Number (ID) before they can engage in any work activity. At the start, the attached document to their ID is their personal details (e.g. resume, Medicare number) of the working people. Each time working people change jobs their new resume is added to this databases by their new employer and their resume is updated in this databases. Or alternatively this proposed system to be applied only for construction industry’s workforce or similar industries with high accident rate. Other attachments to this data base should be regular health checkup of workers and their health details (attached to their Medicare number), however this must be confidential and only to be accessible by appropriate departments in case of work-related fatalities, identification of work-related diseases and research purposes. It is also suggested that this ID card to be carried with every working person while at work. This way if any working person has vehicle accident in public roads could be identified as work related by the road accident authorities. It is recommended that, (for example) construction workers’ education and training be organised in layman language by:

1 Attending relevant training courses to the exact work activity they will be engaged and meet the requirement of the course; or
2 Mandatory safety training courses in other languages apart from English for working people having difficulty with English language.

The second training course should be a generic one. Some of the specific areas to be covered are outlined below:

- Workers obligations at work by law and fines for misconduct;
- Demonstration of the cost of accidents to workers, employers and the society as a whole;
- First aid training;
- An overview of chemical, physical and biological hazards at work;
- General overview of work-related diseases;
- Personal protective clothing;
- Basics of ergonomics;
- Nutrition and wellbeing;
- Effect of alcohol and drugs on the body and its effect at work.

The specific safety and health training of the workers must cover all related matters to their specific job activities and further followed up at their workplace organised by their employers as inductions or toll box talks.

7.4 Further Recommendations

1- Regular health check-up for construction workers;
2- Engineering students to have some knowledge about other engineering disciplines especially in relation to health and safety issues and concerns;
3- There is a need for a safety culture model for engineers who have worked in other countries with differences of safety cultural with Australia;
4- Dangers and health effect of alcohol and drug use and their health effect and other related issues should be thought at school by professionals in these areas just before students entering high school;
5- Identification of root causes of work-related stress, depression and mental illness;
6- Use of the same coding system by NCIS and Safe Work Australia for

   a) Industry: according to the Australian and New Zealand Standard Industrial Classification (ANZSIC) 2006 (ABS cat. no. 1292.0);

   b) Injury: in the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM);

   c) Location of incident*:* according to category of ANZSIC 2006;

   d) Occupation: coded to the Australian and New Zealand Standard;

   e) Classification of Occupations (ANZSCO) (ABS cat. no. 1220.0) First edition and if it is not shown at the major group level;

   f) Type of occurrence classification system coding (TOOCS): Version 3.1(Safe Work Australia, 2010-11). At present these coding are used by Safe Work Australia and ABS.

7.5 OHS and safety models

The review of the literature indicates that work-related fatalities in Australia are underestimated. As a result of this research, an attempt have been made to suggest OHS models which could contribute in reduction or elimination of work-related injuries/fatalities and assist in identifying causes of work-place accidents and facilitate in identifying the accurate number of work-related fatalities. These models collectively reveal and contribute to effective interventions in reducing work-place injuries and fatalities. These OHS models include:

- Model 1: Organisational Management;
- Model 2: Management Responsibility;
- Model 3: OHSMS Design;
- Model 4: OHS Framework;
- Model 5: Workplace OHS Committee;
- Model 6: Accident/Incident Investigation Report;
- Model 7: Accident/Incident Report;
- Model 8*:* OHS and Workplace Fatality Data;
- Model 9: Multidisciplinary OHSMS Model.

Models 1 to 7 are further described in Appendix A under Recommendations for Workplace Health and Safety Practices. In the following sections Model 8*:* OHS and workplace injury/fatality Data and Model 9: Multidisciplinary OHSMS Model will be presented.

Model 8, Figure 7.1 proposes an establishment of databases, as have already been presented in Section under construction workers and OHS, recommendations.This model suggests that every work-place (included into this database their policy and procedures) and every working person should register and be included into this database before they are able to engage in any work activity at any workplace. When working people start a new job they should provide their ID number to their new employer after their acceptance of their new employment. Employers to put forward working peoples' resume into this database. This database is to be accessible by:

- State/territories: government organisations;
- Nationally: Safe Work Australia;
- ABS and
- NCIS.

Further work-place injury/fatality, accident/incident investigation report is forwarded to this database by the workplace. It is then the number of work-related injuries and fatalities are recorded correctly. In addition with availability of working peoples details including their medical records and accident/incident investigation report, further studies can identify contributory factors in occurrence of work-place injury/fatalities and further recommendations made to put in place corrective actions. If organisations such as state/territories: government organisations, nationally: Safe Work Australia, NCIS, ABS and work-place all apply the same coding protocol for work-related injuries/fatalities investigation reports, it is then there will be a synchronization between these organisations to accurately assess work-related injuries and fatalities.

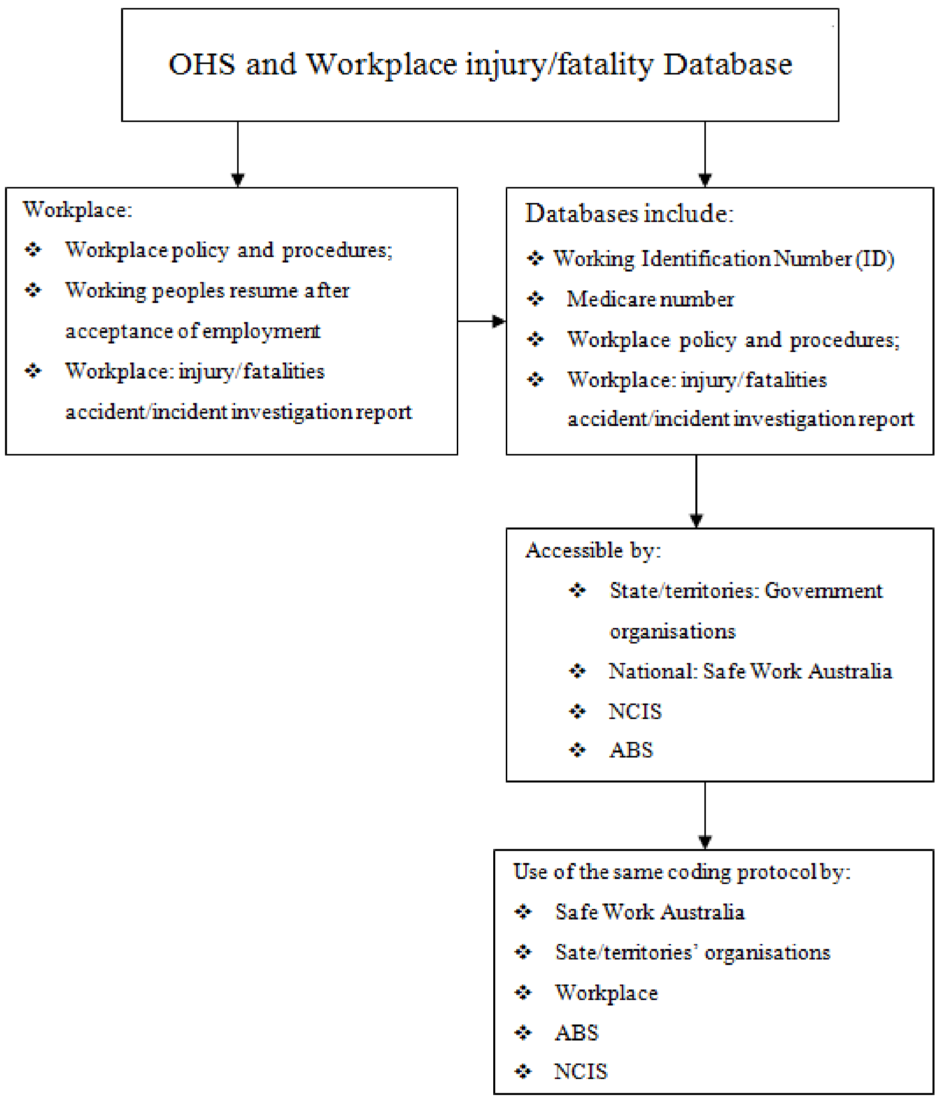

Figure 7.1 Model 8: OHS and work-place Fatality Data

Model 9 Figure 7.2 sums up the 8 models presented in this research under a Multidisciplinary OHSMS Model. This model represents that success or failure of workplace health and safety depends on the relationship between the following factors:

- Employers OHSMS design;
- Work-place:
  - Organisational management;
  - OHS framework;
  - Workplace OHSMS Model;
  - Accident/incident report and the

Worker's factors:

- Age
- Gender
- Height
- Weight
- Vision
- Hearing
- Born in Australia
- Born elsewhere
- Country of birth:
- Years in Australia:
- Education
  - Secondary
  - TAFE
  - Above
- Occupation
- Multi Skilled
- Work Experience
- Tobacco smoking
- Alcohol consumption
- Drug use

In addition, workplace compliance and enforcement of laws are one of the vital factors in OHS to protect workforces' health, safety and wellbeing.

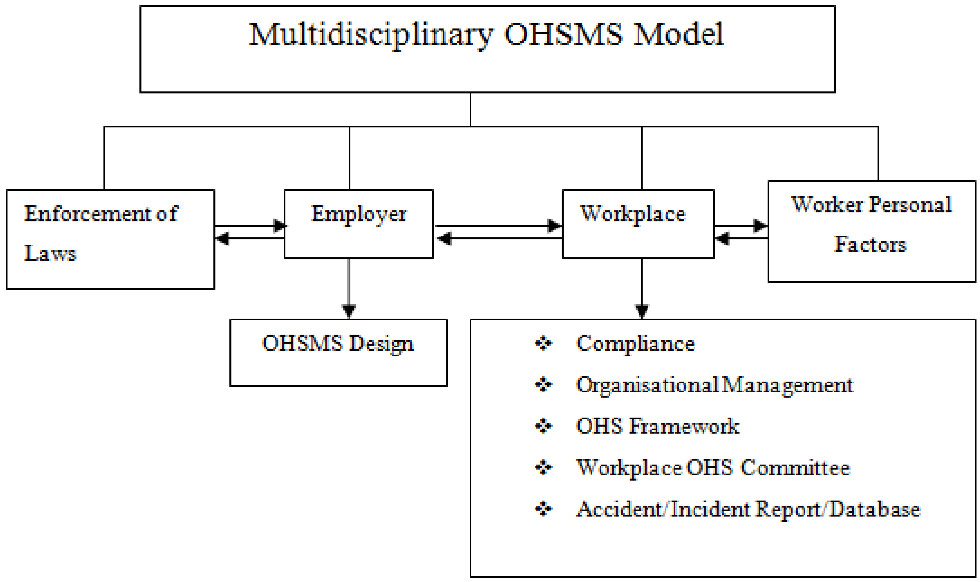

Figure 7.2 Model 9: Multidisciplinary OHSMS Model and Fatality Data

7.6 Conclusion

There is a direct relationship between OHS education and knowledge of employers, designers, managers, engineers and workers and one will not be effective without the other. In addition is government's enforcement of OHS laws, regulations and work-place compliance. Under new model of National Work Health and Safety legislation some of the Australian states/territories are already have implemented the inclusion of OHS in some of the engineering curricula. Western Australia and some other states are yet to introduce the new model of National Work Health and Safety legislation **(**Wallis, 2012).

Review of the literature indicates that OHS planning during design stage is yet to be recognised as an important factor in reducing construction accidents. Inclusion of OHS and safe design in civil engineering curricula is a fundamental step in improving fatalities, injuries and diseases in construction industry. According to Anderson (2002a) one critical issue that has not been acknowledged is the lack of expertise and the knowledge of industry professionals in health and safety. The high rate of construction accidents in the UK has resulted in a call for a tougher legislation. Knowledge and education in health and safety is one of the real levers for long-term progress in health and safety (Crates, Rowlinson, 2004).In view of Crates (Rowlinson, 2004) the teaching of health and safety should not be limited to two hours lectures during a seven years of the undergraduate studies, this is not sufficient for professionalism and competence in health and safety.

Designers are required to receive OHS training and take every step in their planning and design stage to protect workers' health, safety and wellbeing, avoiding the use of dangerous structures, hazardous materials and considering safe system of maintenance procedures (ILO, Rowlinson, 2004).

Chapter 8 Conclusions and Further Work

8.1 Conclusions

This research is intended to review and address the existing problems in industrial and construction industries in Australia with specific focus on OHS, construction industry and Western Australia. The objectives defined in section 1.2 have been all achieved. The main points that have been presented and discussed are as listed below:

a) The industrial work-related fatalities in Australia were reviewed.
b) The cost of work-related fatalities, injuries, diseases and disabilities in Australia were identified and reviewed.
c) The poor performance of construction industry and specific OHS legislations were identified.
d) Construction industries' small businesses and construction services were identified as significant factors in Australian economy. A brief description of these points (a, b, c and d) is included in sections 8.1.1 to 8.1.4.
e) The analysis of work-related fatalities in Industrial and Construction industry of Australia, data from NCIS databases has revealed significant results. A brief description of the major outcome has been included in section 8.2.
f) Further recommendations for work-place safety practices were made. These are briefly reviewed in sections 8.3 to 8.3.2.
g) Finally an attempt has been made to make recommendations for work-place safety practices with development of 9 OHS Models (section 8.4).

The major contribution of this research is included in the following:

8.1.1 Assessment of the work-related fatalities in Australia

Work-related fatalities in Australia are underestimated, since there is no single national data collection system to record all work-related fatalities. Some of these are included as follows:

- Work-related fatalities from diseases, natural deaths, heart attack and stroke are only included if there is a direct relationship between the death and the work activity.
- Work-related traffic incidents (regarded as worker fatality and it means from one workplace to another) are not recorded correctly by NCIS or any other dataset, since these fatalities are recorded by the police and there is inadequate information to attribute the fatality to the work of the person. Commuter's (to or from work) fatalities also not recorded correctly since they are not compensable in all jurisdictions.
- Bystanders fatalities are also undercounted, this is also due to lack of information in NCIS databases.
- Injured worker who dies as a result of problems of medical negligence and suicide are excluded from Safe Work Australia's databases.
- Other areas of concerns that are possible to be underestimated are the number of work-related fatalities as a result of exposure to hazardous substances and exposure to asbestos. Work-related fatalities as a result of exposure to hazardous substances were estimated to 2290 each year.
- Death as a result of cancer was the highest among the work-related fatalities followed by renal, cardiovascular, neurological, and chronic respiratory disease. A small number of fatalities were as a result of exposure to toxic substances however a larger proportion was attributed to person-years of life lost (PYLL). These fatalities are excluded from fatality data.
- Despite the fact and existence of codes of practice for removal, licensing and training of asbestos, the enforcement of regulations are lacking in Australia and generally workers and the public are exposed to asbestos dust on many refurbishment and demolition sites. Among all Australian states only ACT and NSW have some control on residential properties containing asbestos in their structures. According to legislation in ACT owners must provide the detail of asbestos in their property to any person which might be affected by asbestos dust. At the same time owners or builders must provide details of asbestos removal from any property before their application is approved. This positive approach towards asbestos removal is only taken place by some local council in NSW, requiring homeowners to remove asbestos from their property before their application is approved for any development.

8.1.2 Cost of workplace fatalities, injuries, diseases and disabilities

The literature indicates that the direct result of construction accidents, fatalities, injuries, diseases and disabilities are mainly born by workers and their families. The average cost of work-related injury and disease born by the workers, and the community has been estimated as follows:

The cost to the worker includes:

- $46 090 in the case of an injury;
- $163 530 in case of disease.

In case of full incapacity the average cost of each injury is:

- $ 1 582 680 to the community being the highest cost followed by
- $1 438 420 to the worker.

In case of work-related disease the highest average cost is born by the worker:

- $ 1 213 290 and to the community this cost is
- $835 990.

The total cost of injuries estimated for one year (2008-09) totalled to

- 30.7 billion (each incident's average cost $69,700);

The cost of diseases totalled to

- 29.9 billion (each incident's average cost 175,200) (Safe Work Australia, 2008-09).
- The unit cost of work-related injury and illness, by construction industry of workplace, in 2008–09 was estimated to $110,600. The estimated total cost of work-related injury and disease in 2008-09, born by the worker, employer and the community is added up to $60.6 billion (each incident's average cost was $99,100).

Direct costs of workplace accidents:

- Medical bills;
- Increase in insurance premiums;
- Liability costs;
- Property loss.

Indirect costs of workplace accidents;

- Uninsured costs;
- Reduced productivity;
- Costs associated by project delays;

- Replacement costs (e.g. workforce, equipment and facilities);
- Costs of investigation; and
- Administrative time.

Taking into consideration that the number of work-related fatalities in Australia is underestimated the review of the literature indicates when assessing the cost of work-related fatalities the cost to worker's family and the society as a whole does not include the number of dependent children or the spouse. This cost is hardly ever is discussed in the literature. It might be said that this is the highest ethical, moral and financial cost of work-related fatalities to families as well as to the community as a whole to encourage stakeholders to take OHS seriously.

8.1.3 Poor performance of construction industry and OHS legislation

Even though there have been some improvements in health and safety regulations in recent years in Australia, the work-related injuries and fatalities are still alarming. Some of the factors that contribute to poor performance of construction industry in Australia are:

- The lack of influence imposed by Australian government to union on construction sites. However Victorian legislation gives power to union members to enter any site suspecting any breaches of OHS legislation. However they cannot stop or rectify the breach if that workplace does not have a nominated safety representative;
- Lack of tougher penalties for employers in construction industry who cause death to their workers through their recklessness or negligence;
- The introduction of industrial manslaughter legislation was only enacted by government of Australian Capital Territory. According to this legislation the employers who were responsible for the death of any workers could be jailed up to 25 years including independent contractors and workers from labour-hire agencies to comply with OHS;
- Employers are responsible for independent contractors and workers from labour-hire agencies to comply with OHS. The employers who offend can be imprisoned for up to 25 years;

- The barriers to implementation of compliance with OHS regulations in small construction firms mostly lie on the lack of knowledge and training and its associated costs;
- In 2004-05 a new health and safety legislation was introduced in NSW, Vic and WA with some differences in each state. In Victoria the offence is if employer consciously exposes an individual to the risk of severe injury or death. In NSW if it is proven that employer through negligence has caused employee's death could be sentenced for up to five years in prison. According to these legislation company directors in WA could be jailed up to two years if it is proven that they caused severe injury or fatality through gross negligence.

8.1.4 Construction industry, small businesses and construction services

The medium and larger construction firms in Australia are already and strongly dedicated to OHS, however since majority of construction firms are formed from a small business, the focus must be the small businesses. The review of the literature indicates a direct correlation between lack of safety culture and occurrence of accidents in construction industry. The review of literature also indicates that countries taking OHS in construction industry top-down, seriously and allocating a greater emphasis on promoting workers awareness in site safety matters has dramatically decreased their rate of accidents and injuries. Some of the significant points about Australian construction industry are included as follows:

- According to ABS in 2011-12 about 67% (number of businesses: 172,697) of the working persons in construction businesses in Australia were engaged in construction services. In comparison the building construction accounted for 16.8% (number of businesses: 31,297) and heavy and civil engineering construction 16.2%. (number of businesses: 5, 789). In the same period 62.1% of the persons employed were working for small businesses compared to medium size businesses of 19.3% and 18.6% were working in large size businesses. The construction small businesses (range of employment 0 – 19) accounted for: 97.7% of all construction businesses and total income of 49%.

- Other areas of concern in construction industry include: aging population (high risk- chronic diseases associated to aging), shortage of skilled workers, high work demand, stress and fatigue.
- The high rate of respiratory diseases such as asthma and bronchitis are above average in the construction workers compared to other industries. Although the small construction businesses form the majority of construction firms in Australia they have a limited financial and human resources to attribute to health and safety.
- Other concerns in construction industry are construction worker's work habits, lack of awareness about what is the composition of substances, corner cuttings, lack of supervision, enforcement of OHS laws by government, union involvement, financial and time restrictions on organizing scaffolding, choose of the quicker and cheaper way of doing the tasks.

8.2 Industrial and construction industry and fatality data from NCIS

The concluding remarks for analysis of data from NCIS are included in this section.

- From the total of 1025 work-related fatalities data from NCIS, workers born in Australia composed of 49.9%, born elsewhere 5.9% and with a high number of missing values 44.3%.
- WA had the highest number of work-related fatalities in this period for workers born elsewhere (41).
- The result indicates that the highest number of fatalities for workers born elsewhere have occurred in the first 5 years (13) of their stay in Australia.
- In addition results indicate that workers born elsewhere are also working at older age compared to workers born in Australia. Although because of the missing values (above 5%), .the result is not accurate or reliable however this snapshot is a good indication of comparing the two groups. It should be concluded that foreign workers need better work training in their earlier years of their stay in Australia.
- The result indicates that winter and month of July had the highest number of fatalities in Industrial or Construction industries (data from NCIS). However the analysis of data from Safe Work Australia indicates that the summer season had the highest number of work-related fatalities

Other significant results from analysis of NCIS data include:

- The number of natural death for the employed which comprised of 443 and was so close to death due to external causes 519.
- The construction sites had the second highest number of work-place fatalities after factory/plant locations;
- There is not an evidence of a standard and a robust protocol for data collection and data entry for work-related fatalities from each state/territory in NCIS data.
- Other issues of concern from analysing the data from NCIS includes work-related fatalities that occurred in the industrial work-places such as, child not at school, retired/pensioner, student, unemployed, criminal activities, drug taking activities, informal sports and exercise during leisure time, organised sports and exercise during leisure time, general play / leisure activities, resting/sleeping, self-inflicted harm and violent or aggressive activities.

8.3 Recommendations for work-place safety practices

As a result of this research an attempt was made to make recommendations for safety practices which could contribute in reduction or elimination of industrial and construction accidents. These recommendations include:

- Development of a generic Multidisciplinary OHSMS titled as Recommendations for Workplace Health and Safety Practices (Appendix A).
- Engineering qualifications and OHS education.
- Development of an OHS and work-place injury/fatality Data (Model 8) and a Multidisciplinary OHSMS Model (Model 9).

8.3.1 Civil Engineers and OHS Education

The inclusion of OHS in engineering subjects with specific reference to civil and structural engineering qualifications in Australia was studied by RMIT University through the School of Property, Construction and Project Management. Some of the findings of this study include the following:

- OHS is poorly embedded in universities' engineering qualifications compared to TAFE qualifications;
- However in civil and structural engineering qualifications the inclusion in to the TAFE units comprised of 4 out of 22 (18%) compared to 18 out of 89 (20%) in universities;
- Review of the literature indicates that OHS planning during design stage is yet to be recognised as an important factor in reducing construction accidents;
- It was suggested that lecturers, teachers or trainers who deliver and teach OHS should have practical OHS knowledge and experience from industry. It was also agreed that it is not a role of the accreditation organisations to stipulate the manner of delivery.

In UK Joint Board of Moderators (JBM) was established in 1977 to develop and circulate 'guidelines agreed upon by the institutions for the design of Civil Engineering courses for Bachelor and Masters degrees'. Other responsibilities of JBM are to accept 'accreditation of the educational base both for Institution membership and the UK's Chartered Engineers and Incorporated engineer qualifications'. Further the accredited degree courses are published on the JBM Web.

An attempt has been made to make recommendations for the appropriate method of including OHS in to engineering courses, particularly construction and civil engineering courses:

- One on a separate subject covering general OHS areas as presented in this thesis as Recommendations for Workplace Health and Safety Practices.(applicable to all engineering disciplines) and
- Second health and safety issues of concern related to each subject and as a component of that subject including OHS planning during design stage.

8.3.2. Construction workers and OHS education

Training intervention for workers is as important as engineer's education, it saves lives, and it is ethical, moral and consequently has a great impact on the economy of the county. Workers' training must be also done in two ways, one must be generic (e.g. first aid course, personal protective clothing) and second training must include related matters to their specific job activities.

8.4 Development of the OHS models

Finally from the findings of this research an attempt was made to develop nine OHS models. The seven OHS Models are described in details in Appendix A, under Recommendations for Workplace Health and Safety Practices.With reference to Model 8 (OHS and Work-place injury/fatality Data) suggestions have been made, that if every working person is registered into a system which their movement (e.g. from job to job) could be followed up through time (for example like a work-place passport) as a result the number of work-related fatalities including traffic accident fatalities on public roads while at work, family members, volunteers, students on work experience and bystanders are appropriately recorded. As a result this database could greatly assist in revealing contributory factors causing work-place accidents, injuries and fatalities and further assist in corrective actions to take place. Model 9 (Multidisciplinary OHSMS Model), sums up the 8 models presented in this research. This model finally concludes that work-place OHS depends on employer's OHS policy and procedures, workplace OHS systems, worker's characteristics and enforcement of laws.

8.5 Further studies are recommended to investigate:

The major limitations of the data are missing values, it is recommended this data be reviewed and only to be further analysed based on those data without missing values. Further the analysis of the data should go beyond the epidemiological approach by simulation modeling and analysis, this allows the researcher to graphically present the accident trend and further to proceed to computer simulation approach. Additionally the safety analyst can follow the accident event by examining the computer output and further find the potential hazards and make corrective action.

This study has compiled a large amount of construction injury fatality cases from NCIS data. These cases could be further studied to identify the key findings on causation of fatalities and how improvement of fatalities is linked to nine recommendations as suggested in this thesis.

Further studies recommended investigating the high number of natural death in construction industry of Australia using the same data from NCIS.

The major problems facing the small construction businesses include lack of OHS education, training, familiarity with code of practice and regulations and compliance compared to larger enterprises. Considering the manpower and financial circumstances of small businesses compared to larger organisations could be one major problem they facing for their poor performance in OHS. To overcome this problem, the larger organisations could mentor the small businesses by allowing them to participate in their OHS educational training and meetings and further to help them to understand their ethical and legal obligations toward health and safety. This study could make a great contribution for small construction businesses in Australia.

Other areas of research in construction industry includes: construction workplaces' compliance by regulation and further investigate recommendations, improvement notices and prohibition notices produced by government to workplaces; construction accidents, fatalities and injuries during high and lows in the Australian economy (state of the economy); Survey study of construction workers attitudes towards health and safety and their participation in workplace committees; construction work-related diseases; construction workers and personal protective clothing; how standards or exposure measures are achieved? And construction workers wellbeing, suicide, drug and alcohol use and mental health.

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Appendix A:

Recommendations for Workplace Health and Safety Practices

(Developed by the Researcher)

Occupational health and safety relies on the strong relationship between management, workers' personal characteristics, machinery and the environment. To understand workplace hazards and accidents, many factors and the links between them must be considered before any conclusions can be drawn. The effectiveness of an organisation's safety management system depends on the commitment of stakeholders to health and safety, which has a positive impact on the workforce. OHS should be part of a good management, it save lives and increases productivity. The main chapters of this study consists of the holistic review of the literature and related disciplines in relation to work-related fatalities, injuries and diseases in industrial and construction industries in Australia. In addition, an attempt has been made to make recommendations for work-place health and safety practices. Training to increase work-place safety awareness is a key to health and safety outcome. The developed models can be incorporated as part of tertiary education particularly in Civil Engineering. As a result, models for safety procedures have been developed; full details are presented in Appendix A.

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Glossary of Terms

Workplace (WorkSafe Western Australia Commission, 2002, p 29)

'Means a place, whether or not in an aircraft, ship, vehicle, building, or other structure, where employees or self-employed persons work or are likely to be in the course of their work'.

Hazards (Tranter, 2004, p 2)

Hazard is defined in AS/NZS4360: 1999 'as a source or situation with a potential for harm in terms of human injury or ill health, damage to property, environment, or a combination of these'.

Hazard is potential that an event sequence will cause damage or harm.

Risk (Tranter, 2004, p 2)

'Risk is the likelihood or probability that the hazard will cause damage or harm. The degree or the magnitude of the risk is determined by the duration of exposure, most likely outcome from exposure and the frequency of exposure. The combination of frequency, duration and severity of exposure'.

Health (NHMRC, 1973, p 1, cited in Quinlan et al., 2010, p 5)

'According to the World Health Organisation (WHO) and the International Labour Organisation (ILO) in 1950, 'health was defined to be a state of complete physical, mental and social wellbeing and not merely the absence of disease and deformity'.

Occupational injuries (NIOSH, 2004, p xxi, cited in Quinlan et al., 2010, p 5)

'Any injury such as a cut, fracture, sprain, amputation etc. that results from a work-related event or from a single instantaneous exposure in the work environment'.

Occupational illnesses (NIOSH, 2004, p xxi, cited in Quinlan et al., 2010, p 5)

'Any abnormal condition or disorder (other than one resulting from an occupational injury) caused by exposure to factors associated with employment'.

Vibration (Cole, 1982, cited in Bridger, 2003, p321)

'Vibration is defined as the oscillation of a body about a reference position and can be described, like noise, in terms of amplitude, frequency and phase'.

Exposure limits for vibration (Tranter, 2004, p107)

'The exposure limit is a combination of the frequency and duration of exposure. It should be the maximum value that is not exceeded at any time unless special precautions and controls are taken'. The critical value for longitudinal vibration lies between frequencies of 4-8 Hz. For transverse vibration this value is approximately between 1-2 Hz

Human Factors (Dhillon, 2003, p 110)

'This is a body of scientific facts concerning the characteristics of humans. The term embraces all biomedical and psychosocial considerations and in particular includes factors such as personal selections, evaluation of human performance, aids for job performance and life support, and training principles and application in the area of human engineering'.

Ergonomics (Bridger, 2003, p 1)

'Ergonomics is the study of the interaction between people and machines and the factors that affect the interaction. Its purpose is to improve the performance of systems by improving human machine interaction'.

A1: Workplace Health and Safety

Introduction

Workplace health and safety is more concerned with accidents, fatalities and injuries than the effect of hazards on workers' health and wellbeing. According to Quinlan, Bohle, and Lamm (2010) and indeed as the literature indicates, the social and psychological effects of fatalities, physical injuries and work-related illnesses (in particular mental illness and work-related stress) on workers themselves, their immediate family, relatives, 'friends and colleagues is not consistent with the effective management of OHS' (Quinlan et al, 2010, p 64). There is a need for a holistic, multidisciplinary, advanced approach to occupational health and safety management systems (OHSMS) (Quinlan et al, 2010).

Occupational health and safety relies on the fundamental relationship between management, worker, human factors, machinery and the environment. To understand workplace hazards and accidents many factors and the links between them must be considered before conclusions can be drawn (School of Public Health, 2005).The review of the literature carried out by Quinlan et al, (2010) listed the following potential factors: chemical hazards, physical hazards, biological hazards, organisational, psychological and social hazards. In addition, differences in human physiology (biological limits), individual anthropometrics and unique characteristics are also important factors to be considered. For a multidisciplinary OHSMS approach, some of the disciplines of concern are 'occupational medicine, engineering, occupational hygiene, ergonomics, work psychology, sociology, work relations, law and economics' (Quinlan et al., 2010, p 69). 'As with occupational medicine, Australia has tended to lag behind other countries in both training and employment of occupational hygienists' (Quinlan et al., 2010, p 274). These disciplines have made a positive contribution to the improvements made in OHS in recent years. Other important accident prevention and safety factors to be considered include good housekeeping, regular inspection, supervision of the workplace and training (School of Public Health, 2005).

There is an extensive body of literature on all aspects of causal links in the workplace between accidents, injuries, illnesses, fatalities and OHS. It is beyond the scope of this research to investigate any areas or disciplines in detail. However an attempt has been made to explore and bring together effective interventions and to integrate the fundamental aspects of the areas of concern into 7 OHS models these are:

- Model 1: Organisational Management
- Model 2:Management Responsibility
- Model 3: OHSMS Design
- Model 4: OHS Framework
- Model 5: Workplace OHS Committee
- Model 6: Accident/Incident Investigation Model
- Model 7: Accident/Incident Report

In the following sections these models and other areas of concern in OHS will be reviewed.

Organisational management

The effectiveness of an organisation's safety management system depends on the commitment of stakeholders to safety, which creates a positive impact on the workforce. The stakeholders include managers, health and safety personnel, consultants, OHS committee members, supervisors, and employees and employee representatives. However the key personnel in the management of safety are the managers involved in and affected by OHS decision-making. The past few decades have seen a significant change in management styles and the evolution of a number of advanced management theories, such as scientific management, general administrative theories, human resources approach, system approach, and quality management systems. This has come about because of global forces (globalisation, technical innovation and customisation) and competition among enterprises changing the world market (School of Public Health, 2005).If top management shows a strong and effective commitment to safety, it encourages employees to do the same. Organisational management and its components are shown in Figure A.1. OHS is a part of good management, saves lives and increases productivity. The following stages are necessary for an effective implementation of OHSMS leadership Figure A.2:

- Planning stage based on OHS policy
- Organising
- Leading and implementing
- Controlling and review (School of Public Health, 2005).

Organisational Management

Management

- Support OHS on:
  - Moral
  - Humanitarian
  - Ethical issues
- Results:
  - Improved productivity
  - Savings in direct and indirect costs
  - Good reputation
  - Win other contracts

Worker

- Individual limitations (Biological limits)
- Physiological differences (human limitations e.g. strength)
- Psychological
  - Skills
  - Learning ability
  - Performance
  - Capabilities
  - Tolerance of unpleasant situations
  - Lack of motivation
  - Life Stress (e.g. death, divorce)
- Factors affecting aerobic capacity of worker:
  - Age
  - Gender
  - General health
  - Body weight
  - Nutritional status
  - Stress and strain
  - Fatigue
  - Tobacco smoking
  - Alcohol consumption
  - Drug use

Working Environment

- Type of Industry
- OHS policy
- Workplace characteristics
- Company size
- Supervision
- Location
- Hazards
  - Physical
  - Chemical
  - Biological
- Ergonomic Factors
  - Time
  - Month of the year
  - Season
  - Climate
  - Lighting
  - Noise
  - Shift Work

Machine

- Energy sources:
  - Mechanical
  - Electrical
  - Thermal
  - Radiation
- Tools
- Instruments
- Equipment

Social Factors

- Permanent
- Contract
- Festive (if accident occurred in festive season)

Culture

- Role of language
- Culture

Figure A. 1: Model 1: Organisational Management

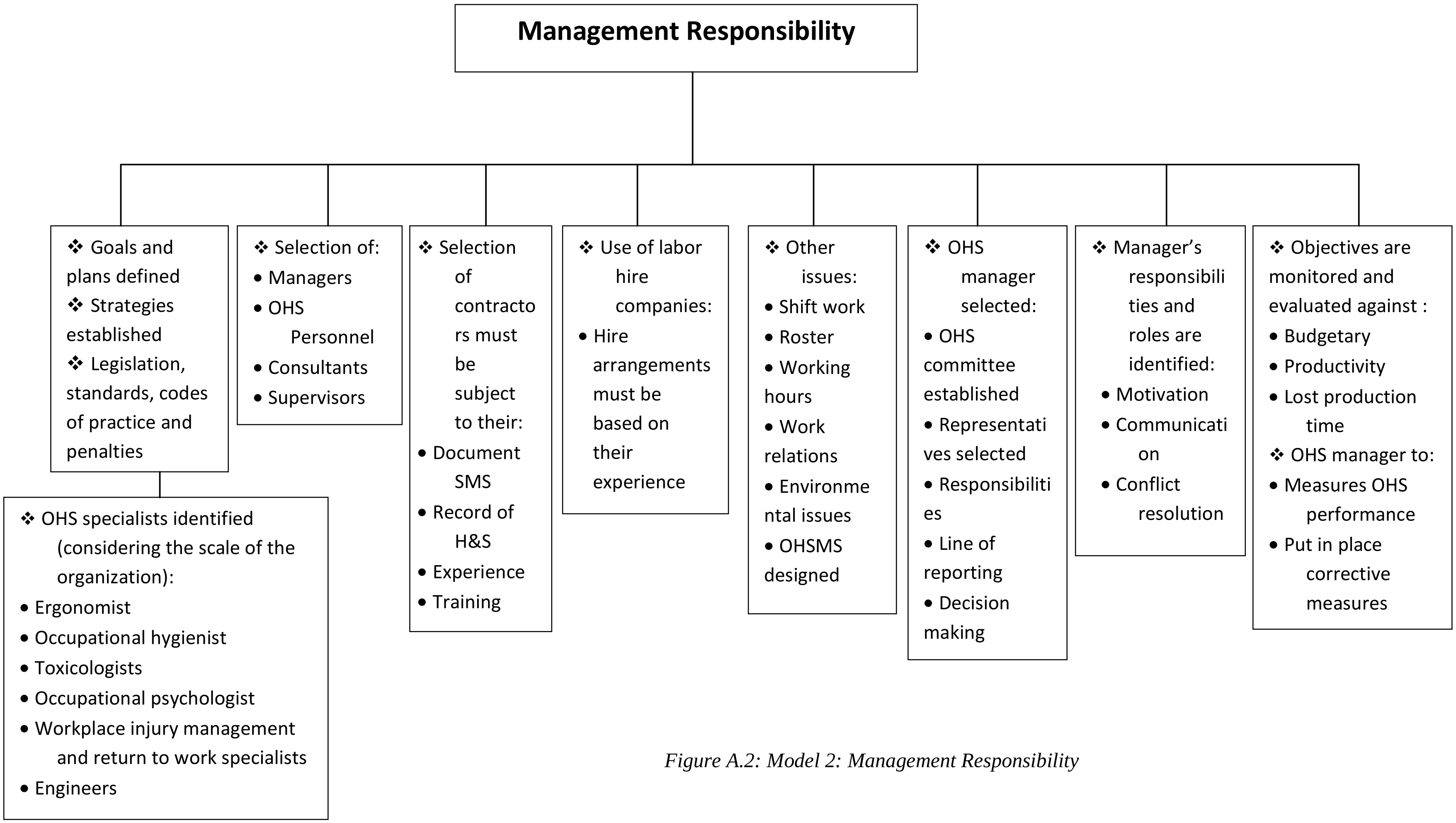


Figure A.2: Model 2: Management Responsibility

The safety management of any organisation should at least cover and identify areas such as safety policy and procedures, (to be available to the workforce) (Corboul and Warren, 1993; Mason, 1993; Roylett et al., 1994; Settenbrino, 1994; Emmett and Hickling, 1995; Viergutz, 1997; Winder et al., 2001). Other areas of concerns include organisational factors (e.g., organisation's attitude towards health and safety), training, human factors, incident and accident reporting, maintenance procedures and emergency procedures (e.g., fire protection, evacuation, alarms) (Quinlan et al, 2010).

In the following sections the fundamental parts of OHSMS such as planning, organising, leading, controlling, design of an OHSMS, hazard identification, risk assessment, hazards elimination and risk management will be briefly reviewed.

Planning stage

For an occupational health and safety management system to be effective, it must be comprehensive and supported by the top management (Winder, Gardner and Trethewy, 2001). It is the responsibility of the management to be involved in promoting safety and setting a good example for the workforce. At this level, responsibilities are assigned and the management defines goals, strategies, standards and plans to coordinate activities to achieve the organisation's objectives for its performance(School of Public Health, 2005).Depending on the scale and type of organisation, either internal or external OHS specialists must be identified and selected. These may include OHS managers, supervisors, ergonomists, occupational hygienists, toxicologists, occupational psychologists, workplace injury management and return-to-work specialists. Engineers with knowledge of OHS are a great asset for any enterprise. Selection of contractors and use of labour hire companies and hire arrangements must be based on their record of health and safety and their documented safety management system.

The workforce (e.g., freelance workers) must be selected on the basis of experience in the work involved, and training providing for them to ensure competency. Other issues to be considered are selection of supervisors and their responsibilities, shift work, roster and working hours, work relations, legislation, standards, codes of practice, penalties and environmental issues (School of Public Health, 2005).The evaluation of the hazards, their safeguards against the hazards and their effect on the workforce and the environment should be explored. If management systems are properly setup, then it is possible to minimise hazards (Corboul and Warren, 1993; Mason, 1993; Roylett et al., 1994; Settenbrino, 1994; Emmett and Hickling, 1995; Viergutz, 1997; Winder et al., 2001).

Organising stage

Development of a sound Occupational Health and Safety Management System (OHSMS) and associated safety action plan (SAP) is the first step in achieving the goals set up at the planning stage. At this stage the structure of the organisation is formed in terms of OHS legislation. The OHS manager establishes the OHS committee and its representatives. The tasks, responsibilities, lines of reporting, decision-making and accountabilities are established and the necessary information to accomplish OHS activities provided. The relevant standards, codes of practice, industry standards and practices are identified. The integration of a number of standards should be the foundation by which any organisation achieves a high standard of safety culture (good management) (Corboul and Warren, 1993; Mason, 1993; Roylett et al., 1994; Settenbrino, 1994; Emmett and Hickling, 1995; Viergutz, 1997; Winder et al., 2001).

Leading stage

At this stage, it is the manager’s role to take a leadership approach in motivation, direction, communication and conflict resolution, so that the objectives set at the planning stage can be achieved.

Controlling stage

At this stage, the objectives set at the planning stage are monitored and evaluated against indicators such as budget, productivity and lost production time. The safety manager measures OHS performance against established policies collects facts and puts corrective measures in place.

Design of an occupational health and safety management system model

The design of an OHSMS depends on the type and structure of the organisation, its size, its products, the company philosophy, the system model, organisational effectiveness, authority and responsibility (School of Public Health, 2005).Risk management is the most important part of any organisation and cannot be the responsibility of any one person; it needs the cooperation of all involved, from top management to workers (School of Public Health, 2005).Accordingly, the hazard control function depends on the implementation of risk management standards such as AS/NZS 4360:2004. At the design stage of an OHSMS, the OHS framework and functions are established based on the following:

- Hazard identification
- Risk assessment
- Hazard elimination or control
- Ongoing monitoring, control and performance measures (AS/NZS 4801:2001) Figure A.3 and Figure A.4.

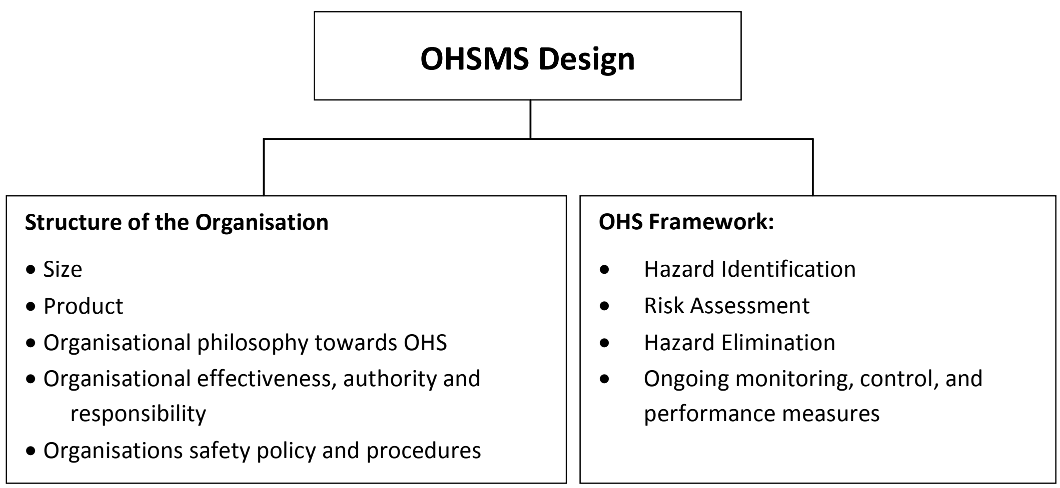


Figure A.3: Model 3: OHSMS Design

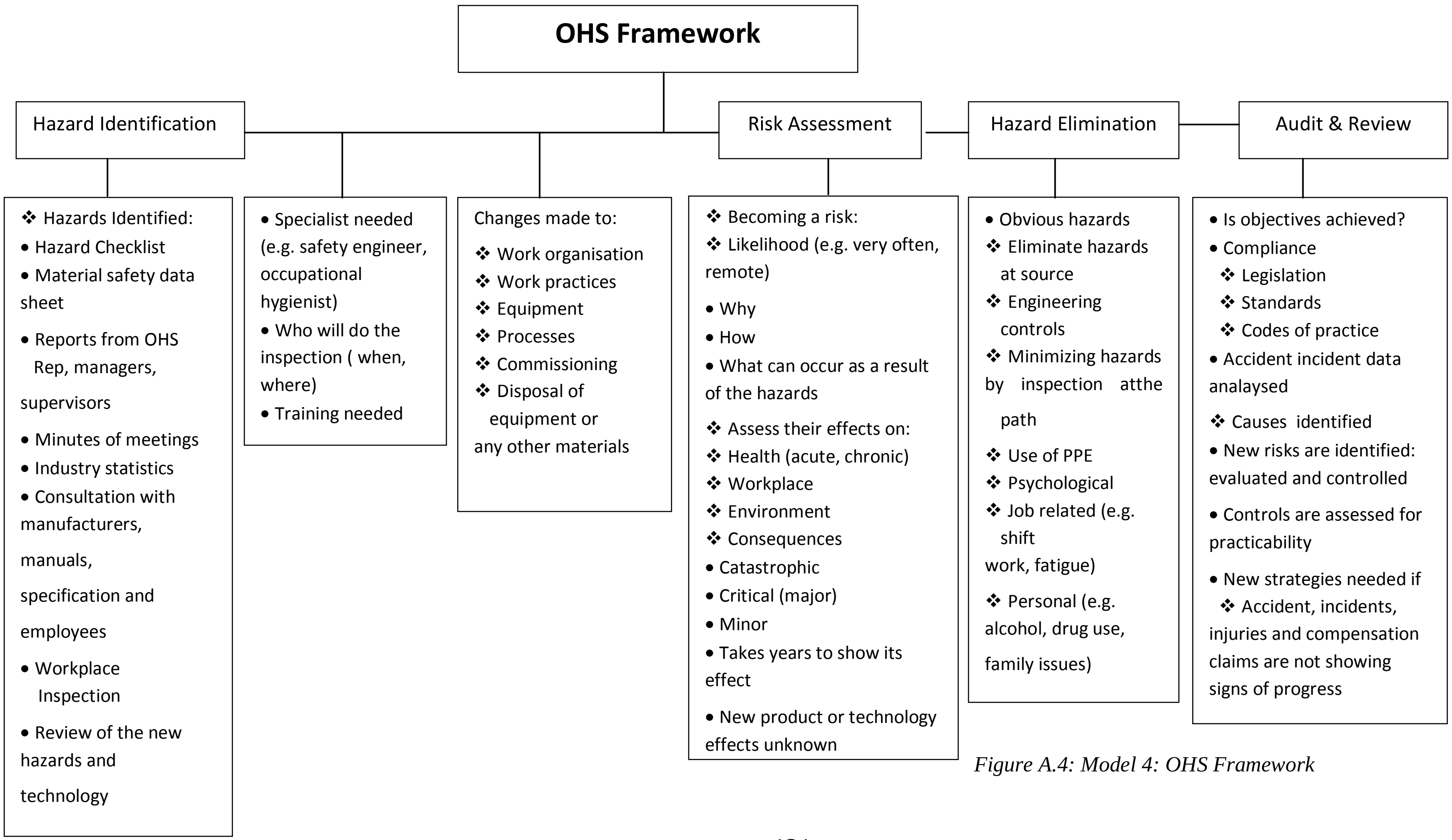


Figure A.4: Model 4: OHS Framework

At the stage of hazard identification and risk assessment, as well as the obvious hazards, attention should be given to issues such as the psychological aspects of the work involved, for example shift work, fatigue, repetitive work, overtime and other stresses (job related or personal) (Corboul and Warren, 1993; Mason, 1993; Roylett et al., 1994; Settenbrino, 1994; Emmett and Hickling, 1995; Viergutz, 1997; Winder et al., 2001) (AS/NZS 4804:2001).

Hazard identification

There are many kinds of hazards present in any workplace, including physical, chemical, biological, ergonomic, psychological and organisational hazards. The effects of these hazards can be acute (injury) or chronic (disease) (School of Public Health, 2005). There are many sources of information to assist in the identification of hazards, such as the minutes of meetings, audits, job safety analyses, reports from OHS representatives, managers and supervisors, consultation and advice from suppliers as well as manufacturers' manuals and specifications, employees, workplace inspections, industry statistics (compensation data, near miss and accident investigation reports), and finally, keeping up to date with research and reviewing new hazards and technologies.

Hazards should be registered in order to facilitate the following stage of risk assessment. Because many hazards are not detected by physical observation, there is a need for specialists (for example, occupational hygienists, safety engineers or ergonomists) to identify these kinds of hazards.

Material Safety Data Sheet (MSDS) contain vital information about chemical hazards and MSDM has information on precautions needed as well as ingredients, storage, disposal and general safety. However, it should be noted that MSDS or MSDM alone cannot predict workers' exposure to hazards. Sampling methodologies and techniques are needed to assess this. A hazard checklist (register) should be kept by the company and used to audit the hazards (School of Public Health, 2005).

Some occasions on which hazard identification is necessary include the design stage, when changes are to be made to work organisation and other arrangements such as work practices, equipment and processes. In addition, hazard identification is necessary during equipment shutdown, commissioning and disposal of equipment or any other materials (Corboul and Warren, 1993; Mason, 1993; Roylett et al., 1994; Settenbrino, 1994; Emmett and Hickling, 1995; Viergutz, 1997; Winder et al., 2001).

Risk assessment

According to AS/NZS 4360:2004, risk assessment is a process of determining why, how and what can occur as a result of any risk. Risk assessment is a fundamental concern in OHS and it is designed to determine hazards and their impact on the workplace. Before risk assessment can occur, the following procedures must be carried out and registered (risk register):

- Identify the number of hazardous substances in the workplace (list of hazards);
- Identify the exact location of hazards;
- Identify who is exposed to the hazards;
- Identify the human body's reaction to each of the hazards (e.g., headaches, asbestosis—takes years to develop, death);
- Identify the level of exposure according to established standards (Jansz, 2005).

The probabilities, contributory factors and potential for risks are assessed and prioritised according to their potential consequences (catastrophic, critical, minor or remote). Controls are assessed in relation to standards and identified as follows:

- Hierarchy of control measures;
- Workplace procedures for monitoring workers' exposure to hazardous substances.

Following the hierarchy of control measures, dates of implementation are set and recorded in the risk register. Strategies are planned to ensure the health and safety of the workforce (School of Public Health, 2005).

There are two approaches to assessing risks: quantitative and qualitative. The quantitative approach is concerned with the frequency of past incidents/accidents and their consequences (direct and indirect costs). The qualitative approach is based on perception, likelihood (very often, often, remote) and consequences (fatal, major and minor) (Quinlan et al., 2010) (Corboul and Warren, 1993; Mason, 1993; Roylett et al., 1994; Settenbrino, 1994; Emmett and Hickling, 1995; Viergutz, 1997; Winder et al., 2001).

Hazard elimination and risk management

Risk management has developed particularly over the past 20 years (Roylett,Guilmartin, Morgan and Marr, 1994).The establishment of risk management in a workplace and its suitability and effectiveness are determined by risk identification, analysis, assessment, control, and monitoring the effectiveness of controls and review (Emmet and Hickling, 1995). After risks are identified and evaluated strategies are to be set to develop a hazards assessment checklist and procedures are put in place. The staff member who will do the inspection is identified at this stage, and the time and place of the inspection is established as well as whether he or she will need training. The new hazards, technologies, purchasing, maintenance and commissioning procedures are reviewed and revised if needed. Findings are recorded and the effectiveness of the existing safety management system is assessed (audit). The hierarchy of controls and interventions is established, incorporating legislation, codes of practice and standards. The likelihood of someone being harmed is identified and existing preventative measures are assessed to identify whether they are adequate (AS/NZS 4360:2004).

There are some workplace organisational factors which may affect the implementation of control measures, such as:

- Workplace attitude to safety culture;
- Size and geographic location of the workplace;
- Changes in labour market;
- Organisational work practices (e.g., part-time, casual and contract workers);
- Level of communication skills;
- Familiarity with organisation’s OHS policies and procedures;
- Gender;

- Age;
- Cultural differences among the workforce;
- Language barrier;
- Literacy;
- Shift work;
- Rostering provisions;
- Level of training;
- Employees with particular needs (e.g., health related issues) (School of Public Health, 2005).

According to Viergutz (1997) risk management is the fundamental issue in regard to OHS. The principle of controlling the risk is based on eliminating the hazard at the source by substitution, if possible (this is the preferred option) (e.g., mechanical guarding), engineering and administrative controls, minimising by interception on the path (e.g., enclosure), and controlling the hazard at the receiver, the worker (this is the least desirable). Although the best option is to eliminate the hazard at the source, this is not always possible. Workers must be trained to be aware of hazards and their consequences. And follow safe systems of work planned by the organisation. The use of personal protective equipment (PPE) by the workforce should be the last option for controlling hazards (AS/NZS 4360:2004) (Corboul and Warren, 1993; Mason, 1993; Roylett et al., 1994; Settenbrino, 1994; Emmett and Hickling, 1995; Winder et al., 2001).

OHS audits

The aim of the OHS audit of an organisation is to examine the effectiveness of the OHS system and to identify whether it complies adequately with health and safety standards, guidelines, and legislation. In addition to examine if the set objectives are achieved, and to analyse and identify accident and incident causes and trends (Emmett and Hickling, 1995). It is a good management practice to carry out a regular audit (external/internal) of the organisation’s health and safety performance. External audits are preferably could be carried out by organisation’s insurer. The internal or external audit should cover crucial steps such as the analysis of accident data and consultation with management and the workforce to identify risk areas (AS/NZS 4801:2001) as well as new risks. After completing the audit process, making changes to the management program of the organisation and setting up the detailed risk control actions, it is very important that risk control procedures are followed to ensure that they are practicable. The practicability of risk control actions set up during the audit process is assessed by looking at the reduction in accidents and workers compensation claims. If the risk control measures do not show signs of progress, the audit process should be undertaken again and new strategies established (Corbould and Warren, 1993).

In the view of Quinlan et al. (2010), OHS audits and workplace surveys are an important part of safety management systems and need to be carried out on a regular basis. The fundamental aspects of OHS audits and surveys are based on gathering information on accidents, near misses, injuries, lost time injuries, illnesses, first aid records and absenteeism. In order to organise future training, information is needed on the skills, work experience and previous training of the workers. However it should be noted that some information on individual characteristics such as age or disability are discriminatory. In many cases this data is collected during the medical monitoring.

Consideration should be given to issues relating to work organisation and job design, such as workload, payment systems, equipment, work processes and materials the shortcomings in the (especially dangerous goods). This information will be used to determine organisation's OHS management systems and the methods to be applied to correct them. 'Health and safety audits are management tools that are intended to accurately measure compliance with a range of OHS-related matters' (Quinlan et al., 2010, p.556).

A2: Workplace OHS Management

Management of highly hazardous workplaces

The management of highly hazardous workplaces (e.g., refineries, chemical plants) is very different to the management of those with low risk levels. There is no single factor which causes a serious accident; there is always a chain of events leading to such an accident. Wearne (cited in Quinlan et al., 2010, p579) has identified some of the factors leading to accidents, particularly ‘problems with prioritising, responsibilities, expertise, attention to unusual operations, lack of inspection, lack of checking and lack of attention to warning signs’.

There are additional factors to be considered during the planning of OHSMS for highly hazardous workplaces. Quinlan et al. (2010, p 578) have proposed the following measures:

- Consideration of ‘catastrophic risk’ during planning;
- Emergency procedures (e.g., evacuation, supervision), training (e.g., scenario training), safe work procedures (SWP) and job safety analysis (JSA);
- Adaptation of worker and management safety behaviour;
- Reporting and investigation of all accidents (e.g., near misses, incidents);
- Monitoring of workers’ performance;
- ‘Independent system auditing and risk assessment’.

Lack of communication within the organisation and between management and workers, insufficient consultation with workers, and a lack of ‘feedback loops for reporting problems’ have been identified in many studies as contributory factors causing major occupational disasters (Hopkins, cited in Quinlan et al., 2010, p579).

The contributory factors in some major occupational disasters were outlined by Quinlan et al. (2010, p 579) as follows:

- Faults in the engineering design or lack of proper planning
  - the Westgate Bridge collapse, Melbourne (1970);

    - Piper Alpha, UK (1988);
    - Beaconsfield Mine, Tasmania (2006);
- Organisational complications and disorganisation in decision-making
    - Esso Langford, Victoria (1998);
- Fragmentation of work and authority (e.g., use of subcontractors):
    - Valujet flight 592, Florida, USA (1996);
    - AZF, Toulouse, France (2001);
- Lack of communication and 'feedback loops':
    - BP Texas City Refinery at which 15 workers lost their lives, USA (2005);
    - Beaconsfield Mine, Tasmania (2006);
- Inadequacy in risk assessment and auditing processes:
    - Moura mine disaster, Queensland (1994);
    - Beaconsfield Mine, Tasmania (2006);
- Political/regulatory compromises/failure:
    - Bhopal factory fire, India (1984);
    - Kader toy factory fire, Thailand (1993);
    - Georgia sugar refinery explosion (2008);

Another example was Flixborough, where the accident happened as a result of modifications to the plant. In this case the 'technical integrity' of the plant was violated and the modifications to the plant did not follow the same standards as the original ones.

Some other major accidents have been attributed to ignoring changes made to work procedures, organisational changes, financial pressures (e.g., corner cutting), productivity pressure, warning signals, effective auditing (e.g., identification of problems in OHSMS), and lack of communication. In Australia some state governments have introduced reforms for highly hazardous workplaces, such as the Safety Case Regime (SCR). Under the SCR it is the obligation of the operator to demonstrate to the regulator that they have documented hazard identification, risks assessment and effective control measures put in place for all stages ('construction/recommencement, operation and closure phases') of the operation. One of the highlights and strengths of the SCR can be seen in 'initial design of the workplaces and systems' (Quinlan et al., 2010, p 585). According to the Vectra Group (cited in Quinlan et al, 2010, p 585),research into the efficiency of the SCR shows that it improves the effectiveness of hazard identification by reviewing systems and processes and implying control measures, however the evidence indicates that 'the potential for further improvements corrodes over time'. Quinlan et al. (2010, p 585) also indicate that 'corrosion is a problem affecting OHSMS too'. A brief review of the Act, Regulations, Codes of Practice and Guidance Notes (the *Occupational Safety and Health Act, 1984)* and the OHS Australian Standards have been included in Appendix A1, Section 1.

Small workplaces

Although the concept of OHSMS has significant appeal for medium to large enterprises, there is a large gap between their needs and those of small enterprises. An OHSMS suitable to the needs of small enterprises is yet to be developed. Small enterprises or small businesses (with 30 to 50 workers) include the self-employed and subcontractors, and make up over 90% of all employers in Australia. The main issue concerning small business and OHS is that there is no single OHSMS that might suit all small businesses. The majority of small businesses do not have a documented OHSMS; some depend on their own experience (e.g., supervisory experience) and follow safety rules, while others may not have the resources, training, and expertise or may even have a changing workforce which makes it impossible to engage in any formal OHS issues (Quinlan et al., 2010).

Considering the number and prevalence of small businesses size in Australia there is a need for an effective OHSMS to suit them all. Notably there have been some initiatives by Australian government agencies (e.g., agriculture/farm safety) to improve OHS in the small business area. However, the effectiveness of these initiatives in eliminating hazards is yet to be proven (Legg et al., cited in Quinlan et al., 2010). In regard to this, a number of key principles have been suggested to government agencies by Eakin et al. (cited in Quinlan et al., 2010, p587) and Legg et al. (cited in Quinlan et al., 2010, p587). Some of these points have been outlined below:

- The OHSMS (or any strategies) for small business ought to have supporting 'evidence-based rationale', fit in an accurate 'evidence-based approach' for assessing the effectiveness of OHS strategies and should be planned to be 'sustainable'.
- Due to the number and prevalence of small businesses a 'top-down externally imposed regulatory approach' ('negative enforcement approaches') to preventing injury or illness is not feasible. However the success of OHSM in small business depends on the employers/ manager's knowledge and understanding of OHS.
- The problems relating to OHS in small business should be seen from the employers' perspectives, with solutions being low cost, with financial incentives, should lead to improvement of the business, be sensitive to the kind of business being undertaken, and be non-threatening.
- The success of OHS also depends on understanding the cultural and organisational differences between small businesses: 'the prevailing education-centred through the front door approach to small business OHS promotion is unlikely to adequately address the needs of many of the small business employees (e.g., casual/ part-time, migrant, youth)' (Quinlan et al., 2010, p 587).

According to Quinlan et al. (2010, p 588) the management of 'culturally diverse' OHS in small businesses could be as complicated as for medium or large enterprises, and in their belief, the key approaches to managing OHS in medium or large enterprises could be applicable to small businesses.

Workplace OHS committees

An important organisational strategy in any workplace is the formation of an OHS committee. In Australia and many other countries, the provision of OHS committees and representatives in workplaces is part of the statutory requirements. 'Participatory OHS committees provide a structure through which workers and management can cooperate and share responsibility for the development and implementation of strategies to protect the health and safety of workers' (Quinlan et al., 2010, p552). The characteristics of an OHS committee include the following:

- In some Australian jurisdictions it is a part of the legislative requirements that the number of worker representatives 'at least' be equivalent to the number of management representatives;
- Worker representatives should be selected by the workers themselves;
- Worker representatives should actively participate in issues concerning OHS matters, including 'the setting of safety standards and policy formation' (Nichols et al., cited in Quinlan et al., 2010, p552);
- Worker representatives should be genuinely involved in OHS issue;
- The OHS committee should receive report of injuries that indicate the causes;
- The OHS Committee should be aware of and contribute to workplace environmental monitoring, hazard identification and risk management procedures;
- Some management members of the OHS committee should 'have the authority to make decisions and influence the implementation of organisational policies' (Hodson, cited in Quinlan et al., 2010, p 553);
- The OHS committee should review medical and biological monitoring records and outcomes.

The influence of the committee depends on factors such as the skills, knowledge and training of the members, and their awareness of OHS problems in the workplace (e.g., the hazards present, their effect and the associated strategies). According to Wyatt and Sinclair (cited in Quinlan et al., 2010), the effectiveness of an OHS committee strongly depends on the commitment and consultative attitude of the senior management, staff support, funding, and the competency of the members. Other necessary skills include being able to collect and analyse data and apply preventative measures (Quinlan et al., 2010) (Figure A.5).

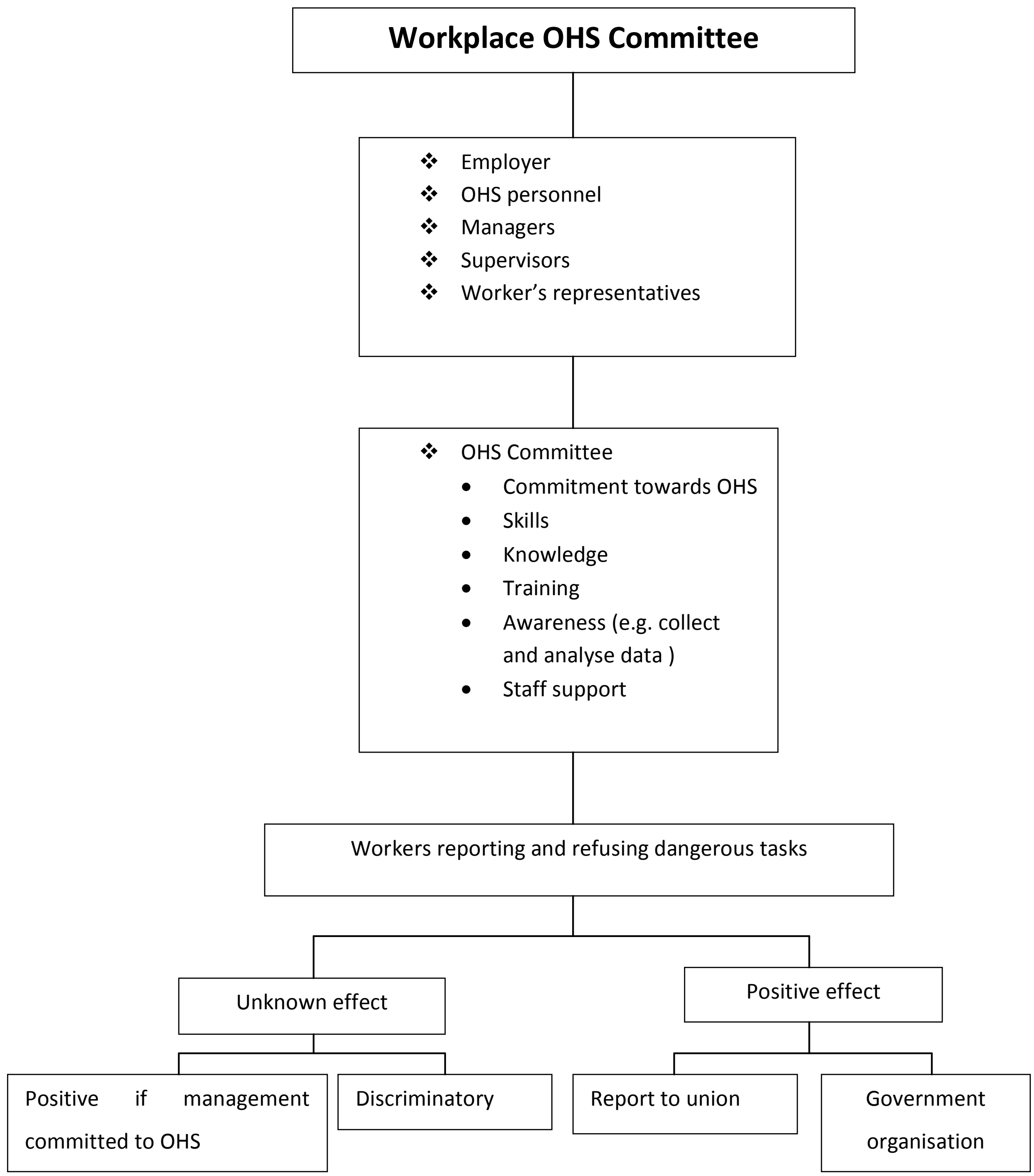


Figure A.5: Model 5: Workplace OHS Committee

Workers' involvement in OHS

According to Quinlan et al. (2010), in recent years OHS legislation in Australia has made a notable progress involving workers in OHS matters. The particular means include workers and unions formally being involved in advising government bodies at all levels on OHS standards, formation of workplace committees and addressing OHS issues. Health and safety representatives (HSRs) have also been nominated to address workers' concerns and the mandated employee announcement of certain hazards and in addition to have mechanisms for resolving management-worker differences over imminent risks. The most notable worker involvement under OHS legislation in Australia and also Nordic countries (Denmark, Finland, Norway and Sweden) has been through workplace health and safety committees and health and safety representatives. The functions and rights of safety committees in Australia are to communicate between workers and the employer to make sure the health and safety of workers are protected.

Traditionally, unions have supported workers in raising issues concerning OHS, and the development of workers compensation laws. Unions provide support for OHS representatives; however OHS has been seriously affected during last decade, by decline in union membership and union rights to enter workplaces to represent workers (Quinlan et al., 2010).

It has been recognised that since workers (and indirectly their families) are directly affected by hazards at their workplaces, they have the right to know what kind of hazards are present in their workplaces, to be engaged in solving OHS issues to be able to refuse dangerous tasks, and to have a say in the approval of OHS standards. Principally in recent years, these rights have been internationally accepted and practiced in highly developed industrial countries, however their practice and mechanism in OHS legislation varies between these countries. For example, the Nordic countries are more advanced in workers' rights practices. In the US, workers have a right to know about hazards in the workplace, but they do not have any legislative right to act. 'The participatory mechanisms found under current Australian and New Zealand OHS legislation would place it in the mid to upper range of this spectrum' (Quinlan et al., 2010, p 470). Even though workers have the right to refuse risky tasks, these rights are affected by the superiority of employers. This would be more obvious in small and medium enterprises. Although it is the right of workers to refuse unsafe work tasks, in workplaces without union involvement it is very difficult to avoid being penalised by employers. The evidence shows that workers might be subject to ‘some form of discrimination, discipline or retribution’ if they raise OHS concerns (Quinlan et al., 2010, p 479).

Union support provides training for worker representatives through the ACTU OHS training units, and protects workers from unfair dismissal. According to Tragardh cited in Quinlan et al., 2010, p 472) the effectiveness of workers’ involvement depends on union support. In addition, according to Quinlan (cited in Quinlan et al., 2010, p472) and some other studies (Weil; Milgate et al.; UK Health and Safety Executive by Walters et al.; Menendez et al., cited in Quinlan et al., 2010, p 480-2), it can be concluded that the factors influencing the effectiveness of health and safety committees and HSRs may include the following: legislative support, management commitment to OHS, professional hazard and risk evaluation and control, communication, training and information, union involvement and external support (union empowerment through policies, regulations and enforcement), organisational infrastructure, effective external inspection, independent worker representation in the workplace committee processes, selection of members, the ‘balance of power between managers and workers’, functions, meetings, budgetary: provisions and resources.

According to Hall et al. (cited in Quinlan et al., 2010, p 481), the effective representatives in a unionised setting’ were those who could autonomously collect and strategically apply legal, technical and medical knowledge as tools in this political activity’. Other studies have shown that workplaces with safety committees and worker involvement have fewer illnesses and injuries (Quinlan et al., 2010).

Worker involvement in OHS has been shown to benefit management in four ways, namely:

1. Contribution to understanding of hazards;
2. Contribution as suggestions and solutions;
3. Contribution in terms of loyalty; and
4. Contribution in terms of program review (Quinlan et al., 2010).

Measuring OHS performance

The monitoring of occupational health and safety performance is intended to identify where the organisation is in respect to its performance and where it is heading in the future.

Traditionally, OHS performance has been measured by either of the following incident/accident data, compensation cost, or lost-time injury frequency rate (LTIFR) (Simpson and Gardner, 2001). This approach was critically viewed by Amis and Booth (1992, p 45), who listed the limitations of measuring accident data in this way as follows:

1. ‘They fall short in measuring latent occupational disease’
2. ‘They measure injury severity rather than the potential for injury’; and
3. They are mainly inadequate ‘when assessing low-probability, high-consequence accidents’.

Simpson and Gardner concluded that measuring OHS performance in these ways is too complex to use in employees’ assessment; they assess ‘system failure and not successes and they provide a delayed measure of system effectiveness’.

According to Emmett and Hickling (1995), measures such as LTIFR, injury frequency rates, incident rates and workers compensation statistics are used to measure the failure of an organisation rather than its successes The review of the literature also indicates that lag indicators such as accident and/or injury rates, LTIFR or incident rates are not effective indicators of the performance of the OHS system.

The recommendation made to workplaces in AS/NZS 4804-2001(*Occupational health and safety management systems – General guidelines on principles, systems and supporting techniques*) was to integrate positive performance indicators (PPIs) into their OHSMS.

The following is a review of the papers presented at a WorkSafe Australia workshop. The main subjects of the papers and the discussion were LTIFR and PPIs. The participants’ view of LTIFR was that this measure was not an adequate indicator could not adequately be a good indicator of OHS performance. LTIFR is seen as a set of numbers showing ‘convincingly’ that everything is going well in an organisation. LTIFR is described in AS 1885.1-1990 and has been adopted as a measure of OHS performance all over the world. By contrast, PPIs were viewed as a means of showing improvement in process rather than outcomes'. The suggestion made as an outcome of the workshop was that PPIs need to be 'implementation oriented (procedures, methods and resources) and results orientated (products, outputs, outcomes)', and specific to the place of work (Blewett, 1994).

The cost of occupational accidents, injuries and fatalities

The cost of occupational accidents, injuries and fatalities is an important issue with regard to OHS. Many attempts have been made to estimate the cost of occupational injuries and fatalities. Generally the annual total cost of injuries has been estimated using workers' compensation claims in Australia. Since not all injuries are compensable, this is not a true indication of the costs.

According to Cullen (1994), there has been a great deal of debate in the press in relation to 'excessive health and safety regulations and over-zealous enforcement of these regulations'. Obviously, the improvement of standards in health and safety at any workplace involves costs. This has been discussed a great deal in terms of the burden on businesses, however the costs and benefits should be considered together. Lack of OHS management systems can be fatality, injury, disease and economic loss (for businesses as well as the country). Examples include the explosion in BP Grangemouth refinery, costing 100 million GBP and Piper Alpha1.5 billion GBP. These costs are hidden and they tend to be ignored. In order to prevent incidents/accidents, management should recognize that health and safety are as important as any of their other responsibilities, such as quality control or cost control (Cullen, 1994). It should not be forgotten that the burden on the workers and their families can never be estimated in dollars.

According to Quinlan et al. (2010, p140) 'injury is a major but poorly recognised problem in the workplace'. They point out while the cost of injuries and fatalities is based on compensation claims and annual reports, it would be very difficult to estimate the real loss based on this kind of data since not all injuries or illnesses are compensable According to Pezzullo and Crook (2006, cited in Quinlan et al., 2010, p 141), the direct cost of injuries can be divided as follows:12% production disturbance cost, 62% human capital costs, 14% health and rehabilitation costs, 1% administrative costs, 5% transfer costs and 6% all other costs. These estimates might vary from case to case and it is very difficult to allocate any percentages on the direct cost of injuries. However the figures of 62% allocated to human capital costs and 14% to health and rehabilitation are already alarming. With the addition of intangible costs, this estimate will be even more alarming to the government, workplace top management and the workers themselves. This must be an encouragement to all to strive towards achieving zero injuries and fatalities at workplaces. According to both the literature and the OHS learning materials, the following are the direct and indirect costs associated with workplace injuries:

Direct costs include:

- From injuries: The costs of first aid, medical attention and transport;
- Legal issues: For example, claims for workers compensation premiums, disruption during the legal process and increased insurance premiums.

Indirect costs include:

- Time lost due to dealing with an incident/accident investigation, including the writing of reports, management time, production down-time (e.g., cleaning up, idle time for other workers due to unsafe work environment), absenteeism, organising substitutes for injured personnel (overtime or temporary staff) and training them, purchase or maintenance of machinery (equipment) if damaged as a result of the accident.

According to Tappin et al. (cited in Quinlan et al., 2010, p 144), the review of the literature on the cost of occupational injuries indicates that there is a tendency to concentrate on tangible and direct costs. Indirect costs are more difficult to measure, however there are some obvious indirect costs and some which are more hidden (to both the worker and the employer), namely the chronic effect of the injury on the worker and the loss of productivity to the employer (Burton et al., 1999, cited in Quinlan et al., 2010, p 144). The social and other costs of injuries are difficult or even impossible to estimate. The New Zealand Department of Labour researched the social costs of injuries and found that ‘a considerable proportion of the indirect costs were borne by injured employees or their family’ (Adams et al., 2002, cited in Quinlan et al., 2010, p 144). The effect on the family life of an injured worker includes loss of intimacy and distance between the worker and his/her spouse and children. In the workplace, the relationship between the injured worker and his/her employer and workmates has been shown to be affected. This study also discusses the impact of injuries and fatalities on the government sector, including' the psychological impact of investigating fatalities, dealing with recalcitrant employers and comforting bereaved or confused families'. Other associated costs include medical and retirement expenses (government employees) and accident investigation costs (Adams et al., 2002, cited in Quinlan et al., 2010, p 144).

A question was raised by Weil (2001, cited in Quinlan et al., 2010, p 145) in relation to the time frame that should be taken into account for the analysis of occupational injuries and fatalities. For example, some injuries (and the expenses associated with them) may have a lifelong effect, or it may take many years for the effect of exposure to some kinds of hazardous substance to appear Therefore, it should be noted that some economic consequences (direct or indirect costs) of occupational injuries are immediate, while others might take many years to assess.

The review of the literature indicates that coverage of the circumstances surrounding the injured worker (the victim) and/or their dependents is lacking. However Quinlan et al. (2010) have made a broad report of other studies examining this matter in their book. The intangible costs in relation to injured workers, their families and the societal aspects have been categorised as loss of life, loss of life expectancy, loss of quality of life, physical suffering and mental suffering (Goodchild et al. (2002, cited in Quinlan et al., 2010, p142). The tangible and intangible costs of work-related injuries have been categorised by De Greef and Van Den Broek, (2004, cited in Quinlan et al., 2010, p143) (Table A1).

Table A1: Intangible and tangible cost elements

	Intangible	Tangible
Victim	Pain and suffering. Moral and psychological suffering (especially in the case of a permanent disability).	Loss of salary and premiums. Reduction of professional capacity. Loss of time (medical treatment).
Family and friends	Moral and psychological suffering. Medical and family burden.	Financial loss. Extra costs.
Colleagues	Bad feelings. Worry or panic (in case of serious or frequent accidents).	Loss of time and possibly also premiums. Increase of workload. Training of temporary workers.
Company	Deterioration of the social climate. Bad reputation. Weakening of human relations.	Internal audit. Decrease in production. Damage to equipment, material. Quality losses. Training of new staff. Technical disturbances. Organisational difficulties. Increase in production costs. Increase in insurance premium or reduction of discount. Administrative costs. Legal sanctions.
Society	Reduction of the human labour potential. Reduction of the quality of life.	Loss of production. Increase of social security costs. Medical treatment and rehabilitation costs. Decrease in standard of living.

Source: De Greef, M. and Van den Broek, K. (2004, cited in Quinlan et al., 2010, p143).

When management supports and implements a good health and safety management system based upon moral, humanitarian and ethical grounds, the results have been shown to include improved productivity and savings in direct, indirect and intangible costs.

Accident investigation

If at the planning stage of a workplace accident investigation, everybody knows what to do in the event of an accident, lives could be saved, property will be protected, work will be resumed quickly and as a consequence, the loss will be reduced and productivity protected. The question has been raised as which accidents (major, minor, near misses) should be investigated. It is in the interests of an organisation to investigate all accidents; this will show the dedication of management to safety, which in turn will be transferred to the workforce. Near miss accidents must be investigated and action taken to correct the circumstances that led to them. This may prevent an actual accident from occurring However, it should be noted that some employees are reluctant to report accidents, wanting to avoid being blamed by their employer, losing their bonus or ruining their good record (Jansz, 2005).

The incident investigation is completed by the making of recommendations to prevent such accidents from occurring in the future and the effectiveness of these recommendations should be followed up. The standard procedure for accident reporting is included in AS1885.1-199

A literature review by Vincoli (1994) in relation to accident investigation and loss control indicates that the process of accident investigation at planning stage depends on four factors, as follows:

- The objectives set by ‘upper management’;
- The priorities identified such as the level of accident (‘catastrophic, critical, sever, major, minor’);
- The planning process for loss control is established;
- The procedures for corrective actions in accident investigations and loss control are set after accident.

Post-accident investigation needs to be planned in advance and should cover the following matters:

- Establish the identity of the person to be contacted in case of an accident;
- Keep the phone numbers of those personnel to be contacted in the case of emergency up to date; (should be kept up to date) of nominated personnel during emergency;
- Establish the actions to be taken in response to an emergency;
- Establish the quick actions to be taken to control the accident area;
- Establish an action plan (e.g., use of fire and emergency equipment, lock out procedures for some machinery), which will depend on the identified hazards at the workplace, such as hazardous materials;
- Determine the procedure for securing the situation or area, including the rescue of endangered personnel and provision of first aid or hospital treatment; at this stage some personnel may need temporary psychological

comfort; this should be also considered at the planning stage. Bystanders should be removed from the accident area;

- Establish protection for personnel, preventing them from coming into contact with hazards such as acidic, caustic, toxic or radioactive energy sources, pressure vessels that might rupture or move and suddenly discharge their contents, the hazards of a weakened structure that could collapse, safeguards against the ignition of flammable or explosives, ventilation of toxic or asphyxiating atmosphere, and protection against suffocation and drowning;
- Appoint a member of personnel to contact next of kin in the event of fatalities, both to notify them of the loss and to obtain their permission for an autopsy to be organised if necessary;
- Determine which state and federal and regulatory agencies should be contacted depending on the circumstances of the accident, in order to protect the enterprise from penalties, fines and non-compliance with reporting procedures;
- Make provisions for notification and public relations, including the communication of factual information to the press, such as severity of the accident and its location in relation to public areas. Trained staff should be used who can communicate accurately during emergencies, bearing in mind that what they say can have an effect on financial liability and community/labour relations;
- Establish procedures to protect investigators from hazards to their health and wellbeing;
- Determine procedures for the gathering and safeguarding of evidence;
- Establish a list of witnesses to be interviewed;
- Make arrangements to shout down the workplace if it is wholly/partially unsafe for work. The accident site should be cleaned out and lockouts removed before arrangements are made for the workforce to return to work;

- Arrange facilities for the investigation team to be able to carry out interviews, conduct data analysis, organise the accident report and if necessary, provide ‘additional expertise’ for the assessment of the evidence. Depending on the scale of the accident there might be a need for some government or external agencies to conduct their own investigation, and provision must be made for this at the planning stage. Many investigations may require information in relation to product accountability to outside parties, such as suppliers of tools, equipment and other materials;
- Recommendations to prevent similar accident occurring in future should be made and their implementation followed up;
- Equipment should be assessed for its’ usefulness, serviceability, economic repair or salvage’; and
- Before work resumes, the workplace should be inspected to ensure safety and quality control are in place (Vincoli, 1994).

Details of the accident/incident investigation are covered in Figure 6.The details compiled in an accident/incident report can greatly contribute in identifying root causes of work-related fatalities. In addition to factors compiled in Figure A.6 to be used for the work-place are details which could be used for research, these are included in Figure A.7.

Accident/Incident Investigation Model

- ❖ Who will conduct the accident process?
- ❖ What happened?
- ❖ Where it happened?
- ❖ Photograph/sketches
- ❖ Who was injured?
- ❖ Duration of their service at the organisation
- ❖ Work experience
- ❖ Source of energy
- ❖ Part of the body
- ❖ The narrative of the accident

- ❖ Type of accident?
- ❖ What caused the accident
- ❖ Evidence not to be disturbed
- ❖ Contributory conditions
- ❖ Who will:
  - Analyse the contributory factors
  - Make the recommendations
  - Follow up
  - Inform relevant authorities (e.g. insurance company, workers compensation)
  - Review OHS management policies & procedures

- ❖ Environmental factors
  - Time
  - Month of the year
  - Season
  - Climate
  - Noise
  - Lighting

- ❖ Witness Report
  - List of everyone present
  - Interview everyone separately
  - Avoid giving direction of thought
  - Avoid implication of guilt

Figure A.6: Model 6: Accident/incident investigation Model

Accident/ incident report

Personal details:

- Age
- Gender
- Height
- Weight
- Vision
- Hearing
- Born in Australia
- Born elsewhere
- Country of birth
- Years in Australia

Education:

- Secondary
- TAFE
- Tertiary

Occupation:

- Multi Skilled
- Work Experience

Other Personal details:

- Known health conditions
- Medication
- Smoking
- Alcohol
- ❖ Drug use

Social factors:

- Permanent
- Contract
- Years of employment
- Festive time of the year
- Personal issues (e.g. sick relative)
- Other factors: (e.g.
- Just coming back from holiday, sick leave)

Environmental:

- Time
- Time to the Shift
- Year
- Month of the year
- Season
- Shift
- Normal (M to F)
- On/Off (Fly in /fly out)

Figure A.7: Model 7: Accident/incident report

It is very important for employees to realise that accident investigation is mainly intended to prevent the same accident happening in the future or to reveal where the system has failed, rather than being a means of assigning blame Vincoli, 1994).

OHS record keeping and computerised data handling

OHS records are kept for many reasons such as work-related incidents, injury, illness and workers compensation. The data collected may identify priority areas to facilitate government policy-makers in resource allocation and hazard control. In addition there are non-governmental organisations that could use the data, such as employers, unions, OHS professionals, educational organisations and international organisations such as ILO (International Labour Organisation) and WHO (World Health Organisation) (CCH, 1996). The records kept at organisational level include:

- Incidents, accidents, injuries and near miss records (to show trends over time);
- History of worker exposure to hazardous substances (to show the effectiveness of control measures);
- Medical records and results of medical tests (for future comparison);
- Occupational hygiene monitoring;
- Compilation of workers compensation;
- Performance evaluation and training reports;
- Rehabilitation information records, which should include a description of the injury or illness and the list of the personnel involved in the rehabilitation program, and the injured person's improvement (CCH, 1996).

Computerised OHS handling can be helpful and advantageous in many ways, if it is well planned and implemented. Some of the advantages are that it can improve the surveillance of issues, problem areas and quick intervention, provides easy access to information by staff, provides easy access to manuals, issues and information on penalties for not meeting the requirements, and is a quick source of information for those responsible for managing OHS (CCH, 1996).

In the event of system replacement, there are issues which must be considered during the planning stage. In the planning process, decisions have to be made about whether to buy or design OHS software to meet the organisation's and users' needs. During implementation, consideration needs to be given to ensuring that there is 'a good fit between the new system and interrelated systems and the need for management commitment and support' (CCH, 1996).While planning the objectives, the system users their needs must be considered, with users being classified as committed (e.g., OHS practitioners) and casual (OHS staff, worker delegates and managers). According to CCH (1996), the 'mismatch' between the new and old systems can cause major problems for the users. Therefore consultation with the OHS practitioner and other users of the system at the planning and purchasing stages is very important.

Data quality and reliability

Data should be secured from theft, fraud, data destruction and corruption. For the purpose of confidentiality, different access levels should be implemented (read data only, read and modify), and backup copies should be made on a daily or weekly basis (CCH, 1996).

Archiving

Archiving is like backing up, but only those records that need to be referred to in the future are archived, such as employee medical records, exposure data, safety procedures which may be needed for workers' injury claims, information about equipment that needs to be changed or repaired at a certain time and records that should be kept for a certain period of time for legal purposes (CCH, 1996).

Education, training and OHS

The review of the literature indicates that the benefits of implementing OHS in vocational and industry training have been shown (Baker and Wooden, 1995, cited in Quinlan et al., 2010). There is a lack of studies and statistics in this area; however it is known that only a tiny fraction of total employer activity has been dedicated to this area. This especially applies to small businesses in Australia, and considering that small businesses make up a major proportion of the workplaces in this country; this is a cause for concern. There are limited studies on small business workplace training and education and the general view is that 'small business employers tend to adopt a reactive, ad hoc approach to employee training and education' (Walters, 2001; Hasle and Limborg, 2006, 'both cited' in Quinlan et al., 2010, p 536). The major differences between smaller and larger workplaces may be attributed to finances, number of staff, time, resources, and level of competency.

According to Quinlan et al. (2010, p 534), the most effective OHS interventions include 'safety education and training, behaviour modification programs, administrative controls and stress management programs'. Areas of concern are 'temporary and part-time workers, subcontractors and temporary agency/labour hire workers', multi-employer workplaces, worksites with high numbers of workers, and isolated workers.

Education intervention (safety training) in the workplace should include the following:

- Training on workplace hazards and safety procedures by competent staff (formal training sessions, on the job training);
- Training for staff, supervisors, senior management and staff engaging in new tasks or moving to new jobs;
- Training for jobs that require a special certificate in Australia (e.g., operation of cranes, forklifts, some load lifting equipment);
- First aid services or other related services (e.g., on-site health centres);
- Procedures for workers compensation claims;
- Information about the health and safety committee and its roles;
- Warning signs (e.g., emergency procedures, safety showers, dangerous substances) (Quinlan et al., 2010).

One of the most important factors in the prevention of accidents is staff training, and it can be achieved either internally by safety inductions or externally via professional assistance through training centres.

According to section 19(1) (b) of *Occupational Safety and Health Act (OSHA) 1984 (WA)* there is a legal requirement by employers to provide competent work safety training for their employees. It is the management's responsibility to organise training in identifying hazards and risks and introduce safe work procedures and control measures. This especially applies to employees who are just starting a job, changing work activities at the workplace or engaging in high risk duties, or when new equipment replaces the old, or when there are non-employees present such as unpaid workers and visitors. Other concerns are employees' awareness of their responsibilities towards the health and safety of themselves and others (in relation to OHS policy) and emergency training procedures in case of accidents. Since many workplaces are engaged in using contractors, it is the responsibility of top management to obtain a copy of emergency programs from the contractors.

The safe interaction of humans with machines depends on training and following procedures. It is a requirement of occupational health and safety that training be organised for workers and staff when they start a new job. The review of many accidents has shown that a failure to follow procedures, missing procedures or changing procedures without the manufacturer's intervention have been the main causes of accidents.

There are many organisations running work-related competency training courses in Australia. In some industries such as construction and mining, there is a particular kind of training called induction. Induction training courses are organised for only experienced workers, not for workers completely new to the field, when they are either just have started to work in a new field or have been just employed.

Emergency medical services

According to Drury (1981) a study was carried out to identify whether people could make a prompt decision to call an ambulance in emergency situations In this study,1027 cases were selected from one week's patient records from two large hospitals. A five-point scale was used:

1. Absolutely yes;
2. Probably yes;
3. Undecided;
4. Probably no;
5. Absolutely no.

The arrival by ambulance or by a vehicle other than an ambulance was recorded along with ‘social, economic, demographic and medical characteristics’. The results of this study clearly indicated that people were biased against calling for an ambulance.

In some cases such as acute myocardial infarction, the pre-hospital delay is very vital. The time between the onset of symptoms and contacting the emergency system has been estimated to be from two to four hours (Simon et al., 1972).

A3: Workplace Health and Safety Hazards

Introduction

Different industries and workplaces have different hazards, such as chemicals, dust, heat, cold and the possibility of falling from a height. There are technological advances; however these might also create new hazards or take years to reveal their effects on workers (e.g., asbestos fibres, fibre cement).

Workplace hazards might be physical, chemical or biological. The physical and chemical hazards are briefly reviewed in the following sections.

Physical hazards

Workplace physical hazards have been identified as the cause of some occupational fatalities, injuries and diseases. There is an extensive amount of literature written in relation to physical hazards. It is beyond the scope of this research to cover these areas in detail. However, an attempt has been made to cover the important OHS issues, keeping in mind that the target audience are all stakeholders in the workplace with particular attention to the awareness of engineering students in these areas.

In the following sections some of these hazards will be reviewed, such as noise, vibration, heat, cold, lighting, pressure and falls from height (Tranter, 2004).

Occupational noise and its effect on health

Occupational noise has been recognised as a physical occupational hygiene hazard in the workplace. The intensity of the sound level generated depends on the power generated by equipment and transmitted to the workplace. Noise is classified as steady (e.g., turbines), fluctuating (e.g., engines operating at different velocities), intermittent (e.g., drills) and impulse (e.g., hammering). There is a direct relationship between noise emission from a source (workstation), the duration of exposure and other contributing factors to cause hearing problem (Tranter, 2004).

The ear is one of the most versatile parts of the human body and its function, apart from hearing, is to maintain balance and the orientation of the body. Exposure to inconsistent or extended occupational noise can lead to noise-induced hearing loss (NIHL) (this is permanent), which affects quality of life, causes communication difficulties and can be a cause of other health-related problems. Since the latency period for the effects of noise is usually prolonged, 'noise is seen as an insidious occupational hygiene hazard' (Tranter, 2004).

According to NOHSC (2000), it has been estimated that about 20% of those people affected by NIHL also experience tinnitus (ringing in the ears). This condition can vary among the affected people and can be very severe in some cases. Occupational noise-induced loss is recognised as a 'compensable industrial disease in Australia'. The economic cost of hearing loss is yet to be recognised by employers. It should also be noted that this is also a huge cost to Australia's economy, health and social services.

The noise exposure limit has been set at 85dB for a period of eight hours' work in accordance with OHS legislation in many countries including Australia, and the absolute maximum exposure level is set at115dB. Hearing loss at 80dB is negligible, increases rapidly at 85–90dB, and at 95dB the hearing is seriously affected (Bridger, 2003). The allowable unprotected exposure time (hours or minutes) has been extracted from code of practice, managing noise at workplace (WorkSafe Western Australia, 2002) and is displayed in Table A2.

Table A2: Exposure duration vs. noise levels (Code of practice, 2002)

Noise Exposure Level dB(A)	Allowable Unprotected Exposure Time (hrs or mins)
85	8
88	4
91	32
94	1
97	30 mins
100	15 mins
103	7.5 mins

According to NIOSH (cited in Quinlan et al., 2010, p 7) if working hours are increased to more than eight hours, the exposure limit has to be below 85dB, and NIOSH has set this figure at 83dB. Australia's legislative procedures under general duties do not offer adequate 'incentive for changes in workplace such as planning/design, tool technology and work processes that could significantly reduce exposure to undesirable sound' (Bohgard et al, cited in Quinlan et al., 2010, p 7).

According to Joubert (2007), the decibel is a logarithmic unit. For example, the sound intensity is doubled by an increase of 3dB in the sound pressure level. This means that a sound level of 88dB has twice the sound intensity of 85dB.

'Hearing damage associated with noise (undesirable sounds) is a very widespread occupational hazard and a common source of disability within the working population' (Bohgard et al., cited in Quinlan et al., 2010, p 6).Exposure to extreme noise can affect hearing in two ways, either temporary or permanent, including complete deafness and ringing in the ears (tinnitus), and in situations where the exposure is acute, can 'result in acoustic trauma, analogous to shell shock' (Mathews, Bohgard et al., ,cited in Quinlan et al., 2010, p 7).

In addition to the health effects of excessive noise, there is also interference with communication in the workplace, which may lead to accidents (due to workers not being able to hear each other). The risk of accident is increased when workers already have hearing problems and are wearing 'poorly designed hearing protection'

(NIOSH, cited in Quinlan et al., 2010, p 8), or are working in hot and humid weather conditions. This situation also increases the risk of ear infection. The abovementioned limitations enforce the necessity for primary intervention, being engineering control and personal protective equipment (PPE) for the last (temporary measure) option in reducing noise levels in the workplace (NIOSH, cited in Quinlan et al., 2010, p 8).

The main health effect of occupational noise is loss of hearing or deafness (sensorineural). This is a permanent condition and it occurs when the 'cochlear hairs are damaged by prolonged exposure to noise' (Tranter, 2004). Normal communication for workers so affected becomes very difficult and letters such as k, t and p are difficult to understand from background noise. The loss of hearing can also be temporary or age related known as presbyacusis. According to Tranter (2004), some studies suggest that age-related hearing loss is due to environment rather than to age.

A temporary threshold shift (TTS) occurs as a result of exposure to a 'high-amplitude noise' (e.g., metal-on-metal collision). This is a temporary hearing loss and after a while hearing returns. It has been suggested that tinnitus is an early stage of cochlear nerve degeneration. This condition is very annoying for affected workers, especially since it occurs in quiet environments when workers want to rest or sleep (Tranter, 2004). Some of the health effects of exposure to noise include:

- 'Heart palpitations
- Dilation of the pupils
- Secretion of thyroid hormone and adrenalin cortex hormone
- Churning of the stomach and intestines from muscle movement
- Skeletal muscle reaction
- Constriction of blood vessels' (Tranter, 2004, p 169).

Other health effects of excessive workplace noise include physiological stress (Bohgard et al., cited in Quinlan et al., 2010), fatigue, and if the exposure duration is long enough, high blood pressure and poor blood circulation (Quinlan et al., 2010, p 8). Excessive noise can also cause psychological stress NIOSH, 1996a, Bohgard et al., cited in Quinlan et al., 2010). According to Bohgard et al. (2009, cited in Quinlan et al., 2010), ultrasound (e.g., produced from plastic welding) and infrasound (e.g., produced from power plants) may also have health effects; however there has not been much research in this area. Finally, it has been suggested that the combination of simultaneous exposure to noise and some other hazardous materials (e.g., toluene, xylene) or some drug medications (e.g., aspirin) can aggravate tinnitus (Quinlan et al., 2010).

According to Tranter (2004, p 169), recent studies indicate that there is also a direct relationship between some chemical substances and hearing loss (known as ototoxic agents). Examples include ‘trichloroethylene, toluene, butanol, lead, mercury, manganese and arsenic’. The combination of exposure to some chemical agents (e.g., carbon disulphide, carbon monoxide) and noise can cause synergistic effects. That is, neither of these two agents on their own could cause such an adverse effect.

The measurement of noise, precautions during measurement, calibration, instrumentation and measuring parameters are not discussed here; however a great deal of attention should be paid to these areas during the measurement of sound, for the purpose of accuracy.

Management program for occupational noise

Strategies for noise measurement and protecting workers from excessive noise in the workplace should be addressed during the planning stage, when equipment is being purchased and the worksites being designed. The most important part of the risk management program is ‘recognition, evaluation and control’ (Tranter, 2004). According to AS/NZS 1269.1:2005 noise management programs ought to include the following components:

- Hazard identification;
- Hazard evaluation;
- Hazard and risk control;
- Program evaluation.

The first approach is to identify the hazards and the risks of exposure to noise. This is achieved by workplace audits, audiometric testing and consultation with workers. The next stage is to identify the set standards; workplace set standards or ‘benchmarks for performance’ (Tranter, 2004).

Control of hazardous noise

The hazard control management program for occupational noise is the same as the hierarchy of controls in any workplace, which is as follows:

- Elimination of the hazard;
- Substitution of the hazard;
- Engineering intervention to minimise the hazard;
- Isolation of the hazard;
- Administrative controls;
- Employ personal protective equipment.

The best method of control is to address the issue during the 'planning and design phase of a process as retrofitting and redesigning the process is often very costly' (Tranter, 2004, p 181).

Engineering control is known as the best method of reducing the transmission of noise, for example,' either through absorption, damping or isolation methods' (Tranter, 2004, p 181).

The isolation of a workforce from a noise hazard can be achieved by administrative controls. Tranter (2004, p 187) has outlined some of the controls that minimise the effect of noise hazards on the workforce, including:

- 'Minimising exposure duration through reduction in exposure time or job rotation;
- Organising for high-risk operations to be conducted out of hours or when few workers will be exposed;
- Reorganising the workplace to locate work activities or noisy equipment away from the main work area;
- Utilising the results from noise contour plans to mark zones where noise exposure may exceed regulatory or the organisation's standards;
- Limiting or prohibiting certain high-risk tasks (e.g., compressed air);
- Training workers on the effects of noise exposure, basic acoustics and how noise is measured and controlled'.

An example of administrative control relates to the fact that sound intensity can be decreased by increasing the distance between the worker and the source. This is known as the inverse square law. For example, doubling the distance between a worker and a sound source will lead to a 6dB decrease in the intensity of a sound. A 3dB reduction in sound level will halve the sound energy, consequently reducing the exposure of the workforce to excessive noise hazards. Every 3dB reduction in sound level results in a halving of the sound energy. ‘So two machines with a sound energy output of 85dB added together will give a total sound level of 88dB’ (Joubert, 2007, p 2). Reflective surfaces are also to be avoided, and it has been shown that sound energy is considerably diminished if the source of noise is situated in a free environment. Some relevant information on noise is provided in Appendix A1, Section 2 (WorkSafe Western Australia, 2002).

The effect of vibration on physical health

Workers in industries such as agriculture, transport, construction and manufacturing are exposed to excessive amounts of vibration. There can be both short- and long-term health effects from prolonged exposure to vibration. Short-term effects include loss of muscle strength, pain, fuzzy vision, nausea, and dizziness. Long-term health effects on the body (whole-body vibration (WBV)) include injuries to the neck, back and lower part of the body. Examples of equipment causing WBV include vehicles such as long haul trucks, tractors, mining vehicles, trucks and forklifts (Joubert, 2007). In the case of hand-arm vibration (HAV), the effects on the fingers can include ‘permanent damage to the tissue and blood vessels (constricting blood flow) (Joubert, 2007).This is known as Raynaud’s phenomenon and it is incurable. Another known effect of HAV is carpal tunnel syndrome. The examples of sources causing HAV are ‘power tools, jackhammer, pneumatic chisel, rowers, shearers and garden equipment, handheld tools such as drills, sanders, polishers and grinders’ (Joubert, 2007, p 7).

The association between Raynaud’s disease and the use of vibrating tools can be seen in a condition known as vibration white fingers (VWF or hand-arm vibration syndrome). This condition causes ‘local ischemia, pain and numbness’ in the hands and it are known that working in cold climates can aggravate this condition. VWF is caused by operating hand tools such as chipping tools, riveting hammers and grinders

(Bridger, 2003, p322).Vibration can also affect the human body in other ways, such as causing fatigue, and it can also affect ‘task performance and communication’ (Bridger, 2003, p321).

Internationally, WBV is measured in accordance with ISO 2631/1: 1997. In Australia the exposure limits are determined according to AS2670.1. Three types of exposure standards are given in Australia, including the exposure limit, fatigue-decreased proficiency boundary and reduced comfort boundary (The exposure limit is the value most commonly used by occupational hygienists) (Tranter, 2004). In relation to WBV, Joubert (2007, p 7)claims that there is a ‘very unclear dose-response relationship and so it has been difficult to set single digit exposure limits and therefore a range of exposure or guidance limits had to be used in the past’.

Internationally, hand-arm vibration measurements and the evaluation of human exposure to hand-transmitted vibration are carried out in accordance with ISO 5349. Australian standards for HAV are in accordance with AS2763:1988(Joubert, 2007). HAV measurement limits are set out in AS2763: 1988 for an exposure period of four hours.AS 2670.1 includes guidance material on exposure to vibration and control of its effects on the human body. The human response to vibration and the effects of it on the health of the human body are summarised in TablesA3 and A4 (Bridger, 2003, p 322).

Table A3: Human response to vibration (Bridger, 2003, p322)

Axis	Frequency (HZ)	Effect
Vertical	0.5	Motion sickness, nausea, sweating
	2	Whole body moves as one Difficulty positioning hands
	4	Vibration transmitted to head Lumbar vertebrae resonate Problem writing or drinking
	4-6	Resonance of gastrointestinal system
	5	Maximum discomfort
	10-20	Voice warbles
	15-60	Vision blurred (resonance of the eyeballs)
Horizontal	<1	Increased postural sway
	1-3	Upper body established
	>10	Backrest is a prime cause of vibration transmission to body

Table A4: Health effects of vibration exposure (Bridger, 2003, p322)

Disorder	Effect of vibration
Low back problems	Microfracture of vertebra endplate Schnorl's nodes (following sudden intense shock) Increased disk pressure caused by higher back muscle activity Decreased disc height Increased radial disc bulge (after chronic exposure) Bad posture amplifies effects of vibration
Gastrointestinal problems	Increased secretion of gastric juices causing acute stomach ache Possible link with gastric ulcers
Urogenital problems	Slight evidence for a link with whole-body vibration in women
Cardiovascular problems	No evidence of association
Hearing problems	Some evidence that whole-body vibration combined with noise amplifies hearing loss by 6 dB

Musculoskeletal injury from whole-body vibration and injuries from hand-arm vibration have been recognised as occupational diseases in some European countries and HAV diseases are even compensable in these countries (Joubert, 2007).

Methods of controlling exposure to vibration

The best method of controlling exposure to vibration is by the redesigning of jobs and equipment, job rotation, and limiting the time of exposure. According to Bridger (2003), one method of controlling the exposure to vibration for 'high risk processes' is by automation during work design. Other methods of protections are rubber handles (damping), avoiding the use of vibrating tools in cold climates and wearing gloves. Hansson et al. (1987, cited in Bridger, 2003, p323) claim that different hand tools have different vibration exposure measurements and suggest that rubber dampers positioned between the tool and handle can decrease vibration approximately by 65%.Methods for controlling exposure to vibration include:

- 'Re-balancing unbalanced fans or rotating drums;

- Maintaining components of large machinery to minimise vibration generation;
- Altering the energy requirements of the process that can generate vibration;
- Otherwise, isolation of the vibration source; or
- Restricting its transmission' (Tranter, 2004, pp198–200).

The feasibility and effectiveness of isolating techniques depends on the 'ratio of disturbing frequency to natural frequency' being greater than √2; if this ratio is less than √2, damping is recommended (Tranter, 2004, p198).

Examples of isolation methods are anti-vibration mountings (AVM) and inertia blocks. Types of anti-vibration mountings (AVM) include springs (the most effective form), rubber mats, cork isolators and insulation pads (Tranter, 2004). The use of AVM in industry may include:

- 'Mounting heavy vehicle drivers' seats on a suspension system;
- Placing laboratory benches with sensitive scales on spring isolators;
- Mounting the vibration screens in coal preparation plants mounted with springs to reduce overall vibration transmission throughout the plant' (Tranter, 2004, p197).

Inertia blocks are used to minimise the effect of vibration amplitude and rocking. Inertia blocks are especially used for some vibrating plants that are in continuous vibration (Tranter, 2004). Damping allows the conversion of mechanical energy produced by the vibrating source to thermal energy, for example:

- 'Lining pipes and chutes with rubber;
- Using a combination of hardwood and fibreboard for wall construction;
- A combination of steel plating and a thick damping layer to enclose a vibrating plant in a large workshop' (Tranter, 2004, p199).

From an occupational hygiene viewpoint, if the damping of the vibrating system is efficient and adequate, the normal frequency becomes zero. 'This means that after a disturbance the system returns to its equilibrium position without any oscillation' (Tranter, 2004, p196).

Some examples of administrative controls include arrangements for work-rest periods, and the use of anti-vibration gloves that protect the workers from high frequencies, keep hands warm and prevent them from receiving cuts and scratches. However, the disadvantage of gloves is that they can be bulky and reduce physical reaction and grasping power. If signs of ‘numbness, tingling or white or blue fingers’ occur, medical advice is required (Tranter, 2004, p 199, 200). Some relevant information on vibration is provided in Appendix A1 Section 3.

Lighting

Workplace lighting is another factor to be considered in relation to physical workplace safety. Workplace lighting comes under a branch of industrial ergonomics and is known as a physical stressor which can contribute to risk in any workplace (Tranter, 2004). Lighting can be the causeof eye fatigue, headache and general tiredness. According to Tranter (2004, p 281), glare should be avoided as it may harm vision and cause ‘disability and discomfort’. Tranter (2004, p 281) points outthat glare comprises three factors, ‘contrast, adaptation and saturation.’ Contrast occurs when there is extreme brightness. Adaptation special effects occur when moving from a dark to a bright environment. Saturation special effects occur when the lighting is so bright that the eyes cannot acclimatise to it. The recommended illuminance for different settings is shown in Table A5.

Table A5: Recommended Illuminance

TYPE OF TASK OR INTERIOR	MAINTENANCE ILLUMINANCE(LUX)	MAXIMUM GLARE INDEX	NOTES
Entrance halls, waiting rooms	160	19	LL
Corridors, stairs, lifts	40	22	
Toilets	80		
Storerooms, packaging and dispatch, wrapping, labelling, filing	160	25	
Gem cutting, polishing, setting	1200		CR,LL
Gas and arc welding	160	28	LL
Tasks involving typing, reading, filing, etc	320	19	UR
Homework and sustained reading	240		LL

LL = Local Lighting, CR = Colour Rendering, UR = Unwanted Reflections

With acknowledgement to Standards Australia

Workplace lighting can play a major role in preventing accidents and injuries. Too much lighting can damage eyes, whereas too little lighting can cause headache. The level of luminance for the workplace must consider the work activity as well as the 'needs of workers with existing visual impairments' (Bohgard et al., cited in Quinlan et al., 2010, p 12).Units of measurement for lighting have been included in Appendix A1 Section 4.

Electrophysical agents (electromagnetic radiation)

Electrophysical agents include an array of 'sources of radiant energy emission including microwaves and ultraviolet radiation such as lasers, ultrasound and X-rays' (Quinlan et al., 2010, p 12). Working for extended periods of time in close proximity to sources of electromagnetic radiation is hazardous to health. Workers in many industries are exposed to such hazards, for example in healthcare, telecommunications, construction, printing and manufacturing.

The physical hazards of ultraviolet radiation (UVR) were highlighted as ‘an emerging risk’ in a report by the European Agency for Safety and Health at Work ‘As with chemicals and other hazardous substances, knowledge about the extent of exposure to harmful doses of radiation across a range of industries and workplaces is fragmentary and inadequate’. (European Agency for Safety and Health at Work, cited in Quinlan et al., 2010, p 12).

Health effects of radiation

The health effects of exposure to high levels of non-ionising radiation, optical radiation and microwaves include skin problems, eye damage, increase in body temperature and blood pressure. Synergistic effects occur when this situation is combined with the presence of some types of chemicals, for example, trichloroethylene (Bohgard et al., cited in Quinlan et al., 2010, p 12).

Although the health effects of low frequency magnetic fields are not recognised, there is evidence of health problems among workers using CRT monitors and pregnant women working in situations where they come into contact with these fields,. In addition there is evidence of child leukaemia and brain tumours among families living in proximity to power lines (Bohgard et al., cited in Quinlan et al., 2010).

The regulations only cover high-frequency electromagnetic fields, ‘leaving other electromagnetic fields unaddressed’ (Quinlan et al., 2010, p 13). There has not been sufficient research into OHS relating to new equipment, their use processes or maintenance using electrophysical agents, for example, the use of lasers on construction sites. There have been some incidents, indicating that there is a cause for concern in this area (Dalton, cited in Quinlan et al., 2010). There is legislation in relation to the transportation, storage and use of radioactive materials in Australia ‘however, there is little direct regulation of workplace exposure’. Another OHS concern is the effect of the sun’s radiant energy on workers engaged in activities outdoors. There has been ‘a strong public campaign’ to prevent skin cancer in

Australia, however its effect on OHS has been a ‘spill over’ and there is still a lot more that needs to be done in this area (Quinlan et al., 2010, p 13).

Pressure

There is a group of workers who are exposed to high levels of pressure as part of their occupation. An example is divers, and the health hazards associated with their work include the bends, bone damage or necrosis (Phoon, cited in Quinlan et al., 2010). In Queensland and Western Australia during the late nineteenth and early twentieth century there were hundreds of fatalities among divers in the pearling industry as result of the bends. The introduction of recompression chambers has saved many lives however ‘decompression illness’ is still a problem (Richardson, cited in Quinlan et al., 2010, p 14). Other professions involving diving include maintenance workers on off-shore oil and gas rigs, abalone divers and those in the tourist industry. The hazard issues for divers include working in isolation, competition, being mostly self-employed or working for incentive-based rewards (e.g., abalone divers), a lack of training, and insufficient regulation. ‘In recent years a number of state governments have strengthened regulations in relation to diving but interstate inconsistencies remain a problem’ (Kristovskis, cited in Quinlan et al., 2010, p 14).

Chemicals and other hazardous substances

According to Bohgard and Albin (cited in Quinlan et al., 2010, p 14), exposure to chemical hazards is of the most common and ‘least well documented’ hazards in OHS. At the beginning of the 1990s, there were about seven million known chemicals, and since then there have been another 25,000 new chemicals introduced each year.(ILO, cited in Quinlan et al., 2010).According to Mathews (cited in Quinlan et al., 2010, chemicals can affect the health in five different ways, as follows:

- By causing burning (corrosive) (e.g., eyes, skin, lungs or other tissues in the body);
- As a form of an irritant to the skin (e.g., dermatitis, bronchitis);

- By acting as a sensitiser (e.g., long term effect on the skin and lungs, causing allergies, dermatitis and asthma);
- By causing burns or asphyxiation due to volatile properties (explosive, flammable);
- By poisoning, leading to acute effects on health (e.g., collapse or asphyxiation) or chronic effects (e.g., cancer, other diseases).

The most widespread work-related health effects of exposure to chemicals involve the skin (e.g., dermatitis) and respiratory system (e.g., asthma) (NIOSH, cited in Quinlan et al., 2010).

The International Agency for Research into Cancer (IARC) (Quinlan et al., 2010, p 16) has identified some substances as being carcinogenic, such as ‘metals, arsenic, cadmium, chromium and nickel in coke oven emission’.

Other hazardous chemicals to which workers can be exposed vary broadly across industries, including: minerals (e.g.,’ cadmium, chromium, lead, manganese, beryllium, phosphorus, arsenic and mercury’), mineral fibres (e.g., asbestos, artificial mineral fibres), organic and inorganic dusts, and some airborne pollutants (e.g., oil, coal and petroleum). Biological infectious agents include Q fever, brucellosis, hepatitis, HIV, SARS and some flu strains. ‘As with chemicals, identifying the extent to which diseases are the result of work-related exposure to hazardous substances is often difficult, except where the work exposure overwhelms all other possibilities’ (Quinlan et al., 2010, p 19).An example of this is malignant mesothelioma caused by asbestos fibre, which has caused the highest number of work-related fatalities in Australia (Quinlan et al., 2010).

Some toxic minerals such as arsenic, cadmium, mercury and lead can affect the health in two ways, being either acute or chronic poisoning. For example, the health effects of acute cadmium poisoning include severe nausea, nonstop vomiting, diarrhoea, shock and collapse, whereas chronic poisoning can cause fatigue, loss of weight, pain, nausea and mild hypochromic anaemia (Waldron, cited in Quinlan et al., 2010). Some relevant information on chemical hazards (‘Skin’ Notations for chemical hazards (Joubert, 2007) and Biological Exposure Indices (BEI) (Joubert, 2007) have been included in Appendix A1 Section 5.

A4: Human factors

Ergonomics and environmental factors

Bridger (2003) claims that the principles of ergonomics are intended to fit the work to the worker (human) rather than the worker to the work. Ergonomics considers the worker's biological and physical capabilities and limitations, the work design, equipment and the environment in any work setting. There are many factors which influence the work capacity of an individual. Some of these are listed in Table A6.

Table A6: Factors affecting physical work capacity (Bridger, 2003, p205)

Personal	Environmental
Age	Atmospheric pollution
Body weight	Indoor air quality
Gender	Ventilation
Alcohol consumption	Altitude
Tobacco smoking	Noise
Active/non-active lifestyle	Extreme heat or cold
Training/sport	
Nutritional status	
Motivation	

Stress, job stress and mental strain

According to Tranter (2004), stress is recognised as being a serious issue affecting human health. Stress can become hazardous when it occurs regularly, is too extreme, or the coping ability of the person is insufficient to neutralise it. The symptoms of stress can be physical (e.g., wellbeing related, tension headaches, shallow breathing, chest pain, etc.), psychological (e.g., low confidence, depression, anxiety, memory lapses, anger etc.) and behavioural (e.g., insomnia, poor concentration, loss of libido etc.). According to Dhillon (2003), the importance of human factors and job stress in safety is very well recognised and the cause of many accidents has been identified as job stress. The same job may have different stress levels for any one worker depending on individual differences and personal characteristics such as personality, work experience, knowledge and ‘genetically inherited physiologic responsiveness (Dillon, p 111). ’Occupational stressors may be classified as follows:

- Work overload: when the work exceeds the worker’s capabilities;
- Work underload: when the work lacks appropriate motivation (repetitive work, any work that does not engage the worker in using knowledge or skills);
- Occupational change-related stressors: are attributed to matters such as organisational restructuring, relocation and promotion. These stressors are affected by the workers’ characteristics (e.g., behavioural, physiological);
- Occupational frustration-related stressors: caused by lack of effective communication and guidance, role uncertainty and failure to meet set objectives;
- Miscellaneous stressors: related to the working environment, for example, too much or too little lighting, noise and poor interpersonal interaction (Dhillon, 2003).

Workplace stressors can have many negative effects on both the organisation and the worker (e.g., alcoholism). The organisations will not only face decreased productivity and low quality production, it will also face high absenteeism, accidents, low workforce morale, more complaints than usual, grievances, and possibly even the malicious damage of equipment (Dhillon, 2003). When workers exceed their limitations in order to carry out a given task or their work, the potential for making errors is considerably increased (Dhillon, 2003). Dhillon (2003) has pointed out twelve work-related stressors with the potential for causing accidents (Table A7).

Table A7: A checklist of work-related stressors (Dhillon, 2003, p114)

No	Stressor
1	Unhappiness with the current job or work
2	Performing tasks under time pressure
3	Experiencing serious financial difficulties
4	Working with individuals with unpredictable temperaments.
5	Limited scope for promotion at work
6	Rumours of redundancy at work
7	Excessive demands from higher authorities in the workplace
8	Experiencing difficulties with spouse or children or both
9	Currently working at a job that is below one's professional
10	Qualifications
11	Poor health.
12	Having inadequate expertise to perform the task being executed. Regularly taking work home to meet deadlines.

Dhillon (2003, p 115) points out the importance of a worksite analysis program for human factors, which is briefly outlined as follows:

- Collect data:
  - medical records;
  - safety records;
- Perform baseline screening surveys:
  - 'identify jobs that put workers at risk of developing cumulative trauma disorders';

    - note the situations when the work-places workers at risk of being injured;

- Perform human factors job hazard analysis. The survey is conducted with a human factor checklist containing basics such as:
    - posture, material handling and upper extremity factors, prolonged static postures, repetitive or prolonged activities, forceful exertions, excessive vibration from power tools, improper tools, cold temperatures, workstations, job processes or work procedures, continued bending over at the waist, poor grip on handles, prolonged sitting, slippery footing, lifting objects of excessive weight;
- Perform human factors job hazard analysis. This type of analysis is very useful to validate whether the risk factors have been controlled.
- Conduct periodic surveys and follow-up studies.

A study by Karasek (1979) found that the cause of mental strain (e.g., exhaustion, depression, anxiety, sleeping problem) was due to the relationship between the interaction of job demands and job decision latitude, pointing out the importance of individual differences such as age, education, social class, and mental and physical wellbeing. This study analysed data from the United States and Sweden and developed and tested 'the stress-management model of job strain'. There was found to be a direct relationship between mental strain and job dissatisfaction and 'heavy job demands and low decision latitude'. There was also found to be an association between mental strain and the consumption of pills (e.g., tranquillisers, sleeping pills) and number of sick days (Karasek, 1979).

According to Bridges (2003, p 212) 'Physiological mechanisms set limits to the worker's capacity for physical work' and excessive work demands can cause physical stress and fatigue leading to poor performance.

Shift work and health

Shift work (unusual work times outside the daylight hours) and irregular working hours have been recognised as a risk to health and disturbing to physiological functions (eating, sleeping patterns and quality of sleep), psychological wellbeing, work performance, social isolation, and family life. Shift work has become a necessity for the modern world (e.g., fire protection, police and the health care system), and might include patterns such as an eight hour day shift, eight hour afternoon shift, eight hour night shift or the 24 hour cycle divided into 12 hour shifts. Shift work affects workers' health in many ways (e.g., unbalanced patterns of eating, sleeping, family time and socialising) and also reduces performance, judgment and attentiveness and increases the risk of accidents (Industrial Relations and Employment, 2006).

The standards for occupational exposure to hazardous agents (e.g., noise, vibration, chemicals) have been developed for a five day working week of eight hours per day. Extended working hours in a day will increase the exposure of the worker to hazardous agents (Tranter, 2004).

According to the Australian Workers Union (2010), shift work is any work that starts before 8.00 am and finishes after 6.00 pm. 'A biological definition of shift work would be any work pattern that causes a change in normal sleep patterns' (Australian Workers Union, 2010, p.2). Some medical practitioners and ergonomists reject work shifts of three to four days with increased hours on the basis of medical and physiological grounds. They add by also take into considering the effect of environmental factors (e.g., lighting, air quality, weather conditions etc.) and note that increasing to nine or ten hours of shift work per day can cause excessive fatigue (chronic fatigue – tiredness even following a period of sleep) and may lead to increased absenteeism. A twelve hour work shift can affect workers and their families in many ways. There is very little time left in a working day to spend with family and engage in any social activities. Many issues should be considered when planning shift work, such as the age, marital status, parental status of workers, and their education and training. Consideration should be given to those who work alone, and who may be faced with dangerous circumstances (Australian Workers Union, 2010, p 2).

Fatigue

According to the Australian Workers Union (2010), 17% of Australian employees are engaged in night shift work. Night or any shift work can cause fatigue. Fatigue 'is a general term used to describe the feeling of being tired, drained or exhausted. It is mental or physical exhaustion that stops a person from being able to function normally' (Australian Workers Union, 2010, p 2). Even though the effect of workplace fatigue has been proven to be four times more likely to cause workplace injury than alcohol or drugs, employers are not aware of the negative effects of workplace fatigue on safety as well as productivity. There are many signs of fatigue, for example poor decision-making, reduced concentration and reduced motivation. One of the main causes of fatigue is night shift work or extended working hours (longer than eight hours). Shift workers should be assessed for fatigue, this should be addressed like any other workplace hazard and control measures should be applied with 'attention on the most oppressive jobs' (Karasek, 1979).

There has been much research into the area of rosters. However, still there is a lack of knowledge on the health effects of irregular working hours on workers for each of these rosters (Quinlan et al., 2010, p 281). Kogi (cited in Quinlan et al., 2010, p 281) have identified four basic criteria to illustrate different work rosters:

1. 'Whether the schedule requires work at night;
2. Whether the schedule is continuous (covering the full week) or discontinuous (omitting one or more days, usually weekends);
3. Whether shifts are permanent or rotating;
4. Whether the day is divided into two, three, four or more shifts'.

There are other important factors to be considered for these criteria (e.g., number of working days and days off in between).

A longitudinal study on regular night work over a six month period and a further period of four years by Meers et al. (cited in Quinlan et al., 2010, p 283) indicated that the health of the group under study 'declined significantly after six months, and that continuing deterioration was apparent four years later'.

A review of the studies on shift work and roster work by the International Agency on Cancer Monograph Working Group concluded that shift work is a Group 2A carcinogen (Straif et al., cited in Quinlan et al., 2010).

There are some groups of workers whose health problems may be exacerbated by night work. These health problems may include 'diabetes mellitus, thyrotoxicosis, epilepsy, severe depression, narcolepsy, chronic respiratory, cardiovascular and renal disorders' (Akerstedt; Angersbach et al.; Kerkhof; Koller et al.; Rutenfranz et al.; Winget et al., all cited in Quinlan et al., 2010, p 304).

The short term effects of irregular working hours on workers may include sleep disorders, gastrointestinal complaints, dizziness, anxiety, depression and fatigue. However, these effects are not entirely recognised by enterprises. 'Night work conflicts with the circadian (daily) rhythms of most human physiological, behavioural and performance variables. Night shift requires work when most circadian rhythms are in an early-morning trough, between 2.00 am and 6.00 am. It also requires daytime sleep, which is disrupted by circadian factors' (Quinlan et al, 2010, p 281). In recent years, other health problems such as cardiovascular disease, psychosomatic complaints and some forms of cancer have been attributed to shift work (Costa, 2003a; Knutsson, 2003, both cited in Quinlan et al., 2010).

There is a lack of research on the effects of shift work on older workers Recommendations for night shift were made by Costa (cited in Quinlan et al., 2010, p 308–9) for the age group over 45 as follows:

1. Limited or no night shift work;
2. Permanent shift work only on a voluntary basis;
3. Option of preference for shift work;
4. Reduced workload;
5. Shorter working hours;
6. More frequent short rest pauses and short naps must be allowed;
7. More frequent health checks;
8. 'Greater counselling and training on coping strategies should be provided'.

Another concern is that different studies show conflicting results. This might be because of the limitations in research methods or other factors such as workplace differences and human factors (Quinlan et al., 2010, p 309).

According to Industrial Relations and Employment (2006), rapid shift rotations make it difficult for workers who have to take medication for their illness (e.g., diabetes, hypertension, and asthma) to manage or control their illness. Shift work and night work are becoming very common in Australia. 'There is considerable evidence that almost all processes in the body have a cyclical rhythm which is related to the light/dark cycle. These rhythms are called circadian rhythms' (Industrial Relations and Employment, 2006). These rhythms lead to changes in the body during the light/dark cycle (change in body temperature). Although night shift work changes the body's rhythm cycle, it does not reverse it and the body does not adapt to night shift work. The consequences of adapting to night shift work have-not been fully identified. Some studies indicate that night shift workers experience more sickness, digestive problems and sleeping problems. There is evidence from some studies that a decrease in production, increase in accidents and increase in errors (e.g., switchboard operators, truck drivers) occur during the night shift (especially between 2.00 AM and 5.00 AM).The most important negative effect of night or afternoon shift work is upon the social life of workers and the time spent with their family in the evening or at night (Industrial Relations and Employment, 2006).

It has been estimated that night shift workers lose about one to four hours a day of sleep and this may build up over time and cause a sleep debt, which can have a negative effect on performance and safety and reduce productivity. Their quality of sleep is very poor, especially at the start of night shift work and they feel more tired during or after their shift, compared to day shift workers. The effects (e.g., bad temper, moodiness, decreased awareness) and consequences of these problems faced by afternoon and night shift workers can be very serious and cause accidents at work and create marital and family problems. In addition, a review of related studies shows that shift workers have more medical conditions (e.g., flu, cold, gastrointestinal problems, mental health issues) and more cardiovascular disease (e.g., heart attacks). The cause of such medical problems may be attributed to poor diet and increased stress, smoking and caffeine consumption (Sleep Disorders Australia, 2006).

Accidents caused by sleepiness (most involving industrial or traffic) cost the United States USD 56 billion and 25,000 lives each year. Many major accidents have been attributed to human error and shift work and have occurred in the early morning, when workers are worn-out. Examples include the Exxon Valdez (at 12.30 am), the Three Mile Island Nuclear Plant (at 4.00 am) and the Chernobyl nuclear accident (1.30 am) (Sleep Disorders Australia, 2006).

Another issue concerning night shift work is ‘driving drowsy’. A study of road accident statistics confirms that at least one in six road accidents is a result of ‘inattention or lapses’. This figure increases to one in four for single country road drivers who fall sleep. In Australia, road accidents as a result of drivers being drowsy cost the community up to AUD 2 billion each year (Sleep Disorders Australia, 2006).

Women and shift work

Early studies on shift work have focused on by males in heavy industries (Monk and Folkard, 1985, cited in Quinlan et al., 2010). The evidence shows that it is more difficult for women to adapt to shift work than men, especially women who have partners and dependent children and carry more workload with family and domestic duties. According to Gadbois (1981), women with night shift rosters seem to be engaging in home duties at daytime while they should be sleep, and married women get one hour and twenty minutes less sleep than their unmarried counterparts. A population-based report on 7035 women with breast cancer and individually-matched control groups of women who did not have breast cancer revealed that among 60% of the women who had worked at night for at least six months in any occupation, the breast cancer was 50% higher. This study had controlled for the biases which could have affected the results of the study, such as age, socioeconomic background and reproductive history. It was also revealed that an increase in the duration of shift work corresponded with an increase in the risk of breast cancer. There have been other studies which support this result (Hansen, cited in Quinlan et al., 2010). Some research suggests the possibility that artificial light at night might be the reason for the increased risk of breast cancer among women working night shift. It is known that artificial lighting ‘suppresses melatonin secretion by the pineal gland and may induce continuous production of estrogens’ (Davis et al.; Hansen, both cited in Quinlan et al., 2010, p 285). The exposure to artificial night light can also ‘lead to compromised immune function’ (Straif et al., cited in Quinlan et al., 2010, p 285).

There have been more studies in recent years in relation to women doing shift work; however these studies fail to examine ‘sex differences in shift work tolerance’. It is recommended that this study method be based on longitudinal studies of men and women working under the same working conditions (Quinlan et al., 2010, p 306).

Human error

Human error is something that will always be present; however the only way to protect ourselves and others in accident situations is by undergoing training and following instructions. The review of the literature in relation to psychological assessment of human error is attributed to unsafe acts. These are lapses and slips which are unintentional; mistakes and violations are counted as intentional. Human factors are another key issue in this matter, for instance, how people communicate with each other, how they work in groups, and their biological and physical characteristics (e.g., age, fitness, sex,). According to Klelz (1991), some errors can be prevented by improvements to plant design, work methods, training and supervision. In this way the errors are reduced or their effect is minimised. Klelz describes human error as follows:

1. Errors that can be prevented by better training (e.g., to be able to diagnose unexpected problems) or instructions;
2. Errors due to lack of incentive, such as a person ignoring rules and believing it was justified (e.g., not wearing correct protective clothing);
3. Errors due to physical or intellectual ability, for example, people who are over- or under loaded or not suited to the job;
4. Errors as a result of slips or lapses of paying attention. It should be accepted that this kind of error might sometimes happen. Human error can be prevented by engineering approaches in plant design and work methods (Reason, 1982);
5. Management errors; it is the responsibility of the management to not rely on instructions alone (Klelz, 1991).

In addition, in many cases the tendency has been towards assigning blame rather than looking at situational factors. Using past errors as examples during training programs could be a positive approach to preventing future accidents.

Physical work capacity

A worker's capacity for work depends on his/her physiological mechanism. The physical work capacity of a worker is referred to as his/her energy output. One of the age-related factors for adult middle-age spread is the decrease in basal metabolic rate (BMR). The BMR decreases further (20%) in chronically malnourished individuals (Bridger, 2003). Excessive work can contribute to poor performance. Some characteristics of poor performance resulting from excessive work demands have been compiled by Strong (cited in Bridger, 2003, p 213) as follows:

1. ‘Slower reaction time

   Increased time to complete task

2. Increased time needed to learn new information and procedures

   Increased forgetfulness

3. Failure to take all information into account when making decisions

4. Increased need to report steps in a chain of reasoning

   Inability to concentrate

5. Lapses in attention

   Missing or misinterpreting signals

   Omitting steps in a procedure

6. Slowness in noticing changes in task requirements

   Slowness in initiating new tasks as required

   Increased need for instruction

7. Narrowing of attention

   Increased concentration on individual subtasks

   Neglect of other tasks

8. Erratic operation of controls

   Mistiming of actions

   Inappropriate gauging of responses

9. Making unnecessary responses

   Carrying out irrelevant tasks

10. Increasing tolerance of own errors

Acceptance of lower performance standards' (Strong, cited in Bridger, 2003, p 213).

Work hardening

Work hardening is a program set up to improve employees' physical capacity for job-related activities to protect them from being injured. The training is carried out either by adding to the time of the exercise or increasing the exercise itself. The regular training is needed to maintain the fitness achieved during work hardening for the work involved. The structure of the muscles changes with increasing age, and if this is combined with a lack of exercise, flexibility decreases and there is a greater chance of accidents occurring There are three main elements in work hardening, 'strength, flexibility and endurance' (Bridger, 2003, p 226).

Woodson (cited in Bridger, 2003, p 226, Table 8.3) has outlined the energy cost (kJ/day) for men and women in some occupations. The range for men was from10, 000 (bookkeeper) to 20,100 (athlete), with 16,300 estimated for labourers and carpenters. These figures were lower for women, being 8,400 for a bookkeeper, 17,800 for an athlete and 13,600 for labourers and carpenters. 'Under normal conditions, no man should be expected to work at a higher rate than 2,400 kcal/day' (Bates, 2007, p 5). Any work beyond the aerobic capacity of a person will increase the heart rate, pulmonary ventilation, blood lactic acid and body temperature. These factors cause fatigue and recovery from the work will take a long period of time (Bates, 2007).

Relative humidity

Relative humidity is one the most important factors in determining the effectiveness by which heat is lost through evaporation. The body's reaction to heat is to produce sweat, which then cools the body by evaporation. 'When humidity is high the ambient vapour pressure approaches that of moist skin', and this results in the body not being able to dissipate body heat, regardless of the fact that a large amount of sweat is produced. This will result in a rise in body temperature and dehydration. The body can tolerate relatively high environmental heat as long as the humidity is low (Bates, 2007, p 20).

Air pollution

An individual's work capabilities are affected by carrying out heavy physical work in urban areas, due to the level of carbon monoxide (this could range from 37 to 54 parts per million (ppm)). A concentration of more than 6.5 ppm carbon monoxide will lead to a build-up in the blood (hypercapnia) during heavy work (Bridger, 2003).

Altitude

The work capacity of workers is reduced at high altitude due to a decrease in oxygen. Workers can adapt to working at high altitude after a few weeks. Working conditions that are not oxygen-dependent (e.g., lifting a heavy load) are not affected by the altitude (Kroemer, cited in Bridger, 2003).

A5: Work environment

Work environment and extreme temperatures

There are some industries in which work activities are carried out in a hot or hot and humid environment, for example iron/steelworks, boiler rooms and brick factories (NIOSH, cited in Quinlan et al., 2010, p 9). In other industries such as construction and farming, the workers are exposed to both hot and cold conditions. It has been recognised that 'thermal discomfort' caused by extremes of temperature can affect the wellbeing of workers and cause stress (European Agency for Safety and Health at Work, cited in Quinlan et al., 2010, p 9).

The thermal comfort temperature depends on air temperature (19–23 °C) and relative humidity (40–70%). Workers' thermal comfort depends on six factors; including air temperature, absolute humidity, mean radiant heat, air velocity, clothing and metabolic rate, and these are the main causes of heat stress and heat strain. 'Although heat stress is easier to measure than heat strain, heat strain is the main risk factor to people's health and safety' (Bates, 2007, p 20).

There are factors which should be considered before workers are engaged to work in a hot environment, and some of these are listed in Table A8.

Table A8: Some factors influencing the ability to work in heat (Bridger, 2003, p 242)

1. The characteristics of the worker	Physiological heat tolerance Age Aerobic capacity Degree of acclimatisation
2. The thermal environment	Relative humidity GT/radiant heat/shade Wind speed
3. The requirements of the task	Work rate Provision of rest pauses Provision of protective clothing

Carrying out heavy and demanding work in hot climates can have a negative effect on the cardiovascular system. Dry-bulb temperature (DBT) indicates the thermal state of the air; however there are other factors which can affect heat gain or loss. Workers are different in their tolerance to heat stress. Those workers with 'hyper-heat-tolerance' can work in hot environments without having had any 'prior acclimatisation'; however 'heat-intolerant individuals' should not be working in a hot environment. This group of workers should be identified at selection time, especially if they are going to be engaged in the mining industry (Bates, 2007).

According to Quinlan et al. (2010), there are many ways that exposure to or injury from heat or cold might take place. Firstly, the workers might come directly into contact with hot or cold objects, for example hot or molten metal, steam and hot water, or dry ice and liquefied gases. Secondly, the environment in which workers are working may expose them to extreme heat or cold. In industries where workers are already exposed to extreme heat or cold, adding to this environmental condition can be very stressful to the workers.

Bates (2007) recommends a number of ergonomic interventions to ease the effect of high heat/and or humidity on the workforce, some of which are listed below:

- Reduction in humidity (indoor) depending on the size of the workplace.

  Use of ventilation or dehumidifier equipment. According to Bridger (2003), for example, a dry-bulb temperature (DBT) of more than 38°C is only tolerable when the humidity is below 20%. However at 32°C and a humidity level of about 90%, the worker is only safe if the work activity is not very demanding and air movement is present.

- Use of fan.

  This can be very helpful to ease the effect of heat on the workforce. However it is not suitable for some workplaces if it mobilises the dust, and the cool air may not reach all workers.

- Reduce the workload. If this is not possible, then work/rest cycling is necessary.

- Clothing.

  Cooling vests and heat reflecting clothing can decrease the effect of heat on the workers.

- Shielding the heat if possible.

- Availability of cool water.

  Hydration is a key means of avoiding heat illnesses.

- Salt tablets.

  If salt tablets are used to replace the salt lost through sweating, their usage must be monitored.

- Work breaks areas.

  A temperature of 20–25°C is recommended.

Workers who work in hot environments for a period of time become acclimatised (‘physiological adjustment’) to exposure to heat, however if they are absent for a period of time this will dissipate (Bohgard et al., cited in Quinlan et al., 2010, p 10), and they need to be acclimatised (gradually increase their work activity) again when they resume work. There is not much evidence showing that acclimatisation of workers takes place in cold environments (Mathews, cited in Quinlan et al., 2010, p 10).

Thermal balance

The factors that determine body temperature are metabolic heat production and the body's rate of heat loss. The ideal body core temperature is in the range of 36–37°C. If it increases beyond39.5°C, it is disabling, and over 42°C it is fatal. The lower acceptable range has been estimated at 33–35.5°C. Cardiac disturbance begins at 33°C, and a temperature of 25°C or below is fatal (Bridger, 2003). The equation for human thermal balance is given in Table A9.

Table A9: Basic equation for human thermal balance (Bridger, 2003, p 234)

S = M – E ±R ±C – W
Where S is Heat gained or lost by the body;
S = 0 when the body is in thermal balance with the environment
M = Metabolic energy production
E = Heat dissipated through evaporation (sweating)
R = Radiant heat to or from the environment
C = Convection to or from the environment
W = work accomplished by the worker

According to Bates (2007), thermal loads are associated with industrial activities (e.g., muscular activities) and in conjunction with the climatic setting; this creates a thermal load on the workforce, leading to thermal stress. The normal human body temperature falls in the range of 36.0–37.5°C.The core temperature of the body remains constant within 5 °C below and above the normal body temperature range. This is true at temperatures as low as 10 °C and as high as 40 °C in dry air conditions. However the surface body temperature changes (rises and falls) with surrounding temperature.

Heat acclimatisation

It has been acknowledged that when workers start to work in a hot climate for the first time their body core temperature increases, leading to poor work performance and heat illnesses (e.g., hyperthermia, heat syncope, heat exhaustion or even heat stroke). Acclimatisation is required in order for workers to adapt to working in such environments. It is thought that four to five days is enough to adapt, however it takes 14 days to fully acclimatise (Bates, 2007).

Heat acclimatisation is the process of physiological adaptation of the worker working in a hot environment. This process increases the ability of the body to produce sweat and at the same time decreases the core temperature threshold rate for the occurrence of sweating (Diamond, cited in Bridger, 2003). The rate of sweat production can increase from 1 litre/hour to 2 litres/hour when the worker is acclimatised. Acclimatised workers are less prone to dehydration and salt loss. The assumption has been made that the capacity of individuals to make sweat is determined at an early stage of life and depends on the climate in which they grew up (Diamond, cited in Bridger, 2003). According to Hanna and Brown (cited in Bridger, 2003), this happens just in the first few years of life.

Health effects (heat and cold)

One of the conditions caused by exposure to heat is thermal stress. The symptoms of thermal stress are an increase in the temperature in the skin and heart. Fluid and salt loss through sweating can cause muscle pain and cramps and impair stomach and intestine functions, leading to tiredness and exhaustion (Bohgard et al., cited in Quinlan et al., 2010). Apart from air temperature, other factors contributing to thermal stress are air movement, relative humidity and the radiant temperature of the surrounding work area. The health effects of exposure to heat can be short or long-term, and can include:

- Lack of concentration, causing stress which may lead to accidents and injuries;
- Increased burden on workers already working in a stressful environment (e.g., noise, toxic substances);
- Aggravation of workers’ existing health conditions, such as heart and blood pressure problems;
- Lung damage or burns arising from direct contact with heated air or steam;
- Heat cramps, heat exhaustion or heat stroke (some heat illnesses are reviewed in detail in the following sections);

- ‘Heat rash, chronic heat fatigue and reproductive disorders’ (Mathews; Bohgard, both cited in Quinlan et al., 2010, p 11).

According to Bates (2007), replacing the water lost from the body through sweat is necessary to be able ‘to maintain optimal safe work performance’ in a hot environment. Dehydration is one of the most important issues of working in hot climates and can lead to injuries and accident since dehydration can affect a worker’s mental and physical performance. Managers and workers should take the signs of heat effect seriously before they turn to something more serious, such as syncope. The signs could include headache, nausea, faintness, pale skin, very high heart rate and low blood pressure. At this stage, the worker should leave the workplace immediately and be placed in a cool area and provided with drinking water, which should be sufficient as a remedy. However in some more serious situations fluids may need to be administered intravenously (Bates, 2007). Some relevant information for measuring the thermal environment has been included in Appendix A1 Section 6.

Heat stroke

Due to heat and workload, and affected by other factors (e.g., age, sex, physical fitness, body fat), the thermoregulation of the body fails. The core temperature of the body goes over 41 °C, the skin becomes red, hot and dry, and if the condition is not treated by cooling, it can be fatal (Bates, 2007).

The physiological signs include a rapid heartbeat and high core body temperature. Heat stroke affects many organs in the body such as the brain, liver and kidneys, and causes tissue damage. The mortality rate is about 80% among people who get into this stage (Bates, 2007).

Heat exhaustion

According to Bates (2007, p 17), heat exhaustion ‘is the inability of the circulation to meet metabolic and thermoregulatory demands.’ The symptoms are serious (e.g., weakness, lack of coordination, weak pulse) and affect the worker’s judgment, which can lead to accidents. One of the factors contributing to heat exhaustion is dehydration. If heat exhaustion is not treated (e.g., by hydration, cooling), it can lead to heat stroke. It is important to realise that workers whoare obese, unfit for work, dehydrated and who are also unacclimatised are more at risk of this condition (Bates, 2007).

Heat syncope

The unacclimatised worker with the condition of 'inadequate venous return' can be prone to fainting. This can be fatal if the worker does not take a rest. Heat syncope mostly happens in confined spaces (Bates, 2007, p 17).

Heat hyperventilation

This situation occurs while wearing protective clothing and working in hot environments. 'Hyperventilation results in an excessive loss of carbon dioxide' and the situation is corrected by breathing into a small bag for a few minutes (Bates, 2007, p 17).

Prickly heat

Prickly heat is a 'superficial skin rash' and is caused by extreme sweating in the heat. **'**The sweat gland ducts become blocked and so the sweat is forced out across the wall of the sweat duct into the tissue under the skin', causing the skin to swell and possibly leading to infection. The worker should be moved to a cool area and good hygiene is recommended for a quick recovery (Bates, 2007, p 17).

The adverse health effects of exposure to cold weather can also be short or long-term and can include:

- Numbness in sensory parts of the bodies causing delayed responses which may lead to accidents or injuries;
- Unpredictable behaviour changes, hypothermia, frostbite, muscular weakening and cramps;
- Arthritis, rheumatism, chest and heart problems (Mathews; Bohgard et al., both cited in Quinlan et al., 2010, p 11).

In many countries including Australia 'there are few legal requirements in relation to exposure to the extremes of heat and cold, except in the most extreme circumstances' (Mathews, cited in Quinlan et al., 2010, p 11).

Hierarchy of control measures (heat and cold):

In some workplaces, such as factories, it is not possible to provide air conditioning, however consideration can be given during the design stage to workplaces (air circulation), workstations (equipment arrangements), isolation, barriers and ventilation, which can effectively reduce the discomfort of the workforce who may already wearing heavy personal protective equipment (PPE). The type of PPE worn by workers in extreme environments can have a positive or negative effect on their working conditions. This must also be considered in addition to other issues, such as workload.

Workplace procedures must clearly outline work stoppages, exposure time, job rotation, acclimatisation, fluid and salt tablet intake, rest time breaks and rest areas. In addition, the workforce should be provided with information on the symptoms of the adverse health effects of hot and cold conditions and the procedure for reporting. 'In practice, as with other physical hazards, remedies too often focus on PPE and administrative controls rather than eliminating or minimising exposure through more fundamental engineering/workplace design or work reorganisation intervention' (Quinlan et al., 2010, p 11).

Sweating

The human body produces a lot of sweat during heavy work in hot environments. Sweat is a combination of a range of electrolytes, mainly sodium, potassium and chloride and it can become sensible if exceeds about 100 grams per hour. Dehydration occurs if sweat loss exceeds 2 litres/hour in a very hot environment. If the water lost from the body is not replaced in time, the working ability and performance of the worker can be affected (Bates, 2007).

Sweat cools the body while evaporation is in progress. However in humid environments, evaporation decreases, while sweating continue. At this stage, the cooling of the body is affected. There are two issues associated with copious sweating: dehydration and loss of salt. The reduction of sodium in the blood stream can increase the heart rate, lower the blood pressure and lead to ‘a reduction in peripheral circulation’. In hot working environments, water must be available at all times to prevent both ‘dehydration and overhydration’ (Bates, 2007, p 15).

Bates (2007) has made a number of recommendations for remedying sweating, including:

- Meal breaks;
- Food containing salt (to replace sweat loss) and glucose and;
- Avoiding commercial drinks;

‘Drinks with high concentration of carbohydrate (sugar) and electrolytes (salts) have relatively slow rates of gastric emptying, and are thought to impede fluid replenishment’ (Bates, 2007, p 15).

- Avoiding drinks high in sugar content and caffeine;
- The most appropriate fluid substitute to be provided to the workforce at regular intervals;
- The most appropriate drinks are water (cool rather than cold – ‘to maximise palatability’), low joule cordials;
- Coffee and tea;

No more than two cups per shift to be consumed, especially in hot climates, when the sweat rate is high (Bates, 2007).Dehydration affects the mental and physical wellbeing of the workers as well as causing a severe threat to their health (Bates, 2007, p 16).

Protective clothing

Protective clothing (e.g., gloves, overalls, helmets and boots) and equipment (e.g., respirators, goggles, ear muffs and welder’s masks) can have a major effect on the worker and his or her work capacity in relation to the heat lost or gained by the body. If the clothing and equipment traps heat, it can cause an increase in the heart rate and reduce the worker’s capacity and cause further fatigue (Bates, 2007).

A6: Health and the Workforce

Health monitoring of the workforce

Pre-employment and regular health monitoring of the workforce can be a good source of data for revealing the effects of hazards in the workplace, allowing preventive measures to be taken and analysing the effectiveness of the measures. Moshe et al (cited in Quinlan et al., 2010, p 524) carried out a study classifying and comparing methods for the medical screening of workers, as follows:

1. The procedure is run by an occupational physician;
2. The screening is carried out by a general practitioner and evaluated by an occupational physician;
3. The health screening is carried out by questionnaire which then is evaluated by an occupational physician.

This study concludes that the third option mentioned above was the preferred and most economical method of worker medical screening in a non-hazardous working environment. Pre-employment health screening of workers has brought upethical as well as practical issues, for example the use of illicit substances, or colour vision, since some of the 'tests themselves are often inadequate as a guide to overall employment suitability' (Quinlan et al., 2010, p 524). Another controversial issue is the genetic testing of workers in order to determine their tendency towards or family history of a particular illness. This might be valid in some 'specialised circumstances' (Palmer et al., cited in Quinlan et al., 2010, p 525) however its misuse is a matter for legal intervention. The most important danger of using genetic screening is that it can divert attention from the implementation of protective measures to control exposure at the source in the workplace (Quinlan et al., 2010).

Geppert and Roberts (cited in Quinlan et al., 2010) claim that genetic testing at the workplace must be used only with the consent of the worker and workers must have the control over access to this information.

According to Piotrowski and Armstrong (cited in Quinlan et al., 2010, p 526) 'there is a concern that pre-employment tests have not been standardised and that there is a lack of predictive validity data on the selection measures'. Quinlan et al. (2010, p

526) conclude that the pre-employment health screening of workers must be used as far as feasible for non-exclusionary purposes. The records of regular health monitoring must be kept confidential and workers should have access to their health records to monitor their own health changes if necessary.

In Australia under special circumstances (selection of substances), employers are liable to provide employees with medical screening examinations. This applies to situations where hazards are present in the work processes for which there are no reasonable alternatives available, or the relationship between hazards and health effects is not well known.

Medical screening is based on the regular examination of the worker to detect the symptoms of occupational disease or illness. Medical monitoring tests include a general clinical examination, allergy tests, X-rays (e.g., used to detect scarring of the lungs in workers exposed to dust), lung function tests (e.g., used to detect lung damage), hearing and eye tests and tests of cellular abnormalities (Koh and Aw, cited in Quinlan et al., 2010).

Another means of protecting workers from exposure to specific ‘toxins, or their by-products, in the body’ is by blood test analysis or analysis of the samples taken from urine, hair or exhaled air. According to Mathews (cited in Quinlan et al.,2010, p 527) the baseline for medical or biological monitoring must be established at a pre-employment assessment, in order to be able to follow up the health effects of occupational exposure during employment and further health monitoring of the workers.

Motivation

Motivation is a key determinant of work capacity, and many factors including personal (career goals, personality) or work organisational (other forms of employment, e.g., piece rate scheme), can affect the individual’s motivation and work capacity (Bridger, 2003).

Age

Age has been shown to have a considerable effect on work capacity. An individual’ maximum VO2 declines slowly after the age of 20. The theory is that there is a direct relationship between ageing and loss of muscle function. By the age of 60, an individual's aerobic capacity is about 70% of that at 25 years old, possibly due to the heart being a muscle, and the fact that cardiac output decreases with age. Compared to children, older people are less tolerant of higher heat stress due to having an elevated skin temperature threshold for the inception of sweating. However it has been suggested that the mortality of the elderly during heat waves is more due to the 'increased cardiovascular load than the heat stress'. When an individual reaches his/her maximum oxygen uptake, it is not possible for him/her to continue to work any harder (Bridger, 2003).

Sex and work capacity

There are some physiological differences between men and women which affect their work capacity, the main ones being body size, upper body strength and aerobic capacity. In View of Bridger (2003), there are no qualitative differences between men and women in respect to acclimatisation to heat. There have been some suggestions that women are more tolerant to heat with respect to sweating, and their maximum VO2 is lower than that in men, which may be attributed to them having a higher body fat content than men (Bridger, 2003).

Alcohol

'Alcohol may increase cardiac output in submaximal work, thereby reducing cardiac efficiency'.'Alcohol affects liver function and can cause low blood sugar (hypoglycaemia) (Bridger, 2003, p 206).

Tobacco smoking

The work capacity of individuals is affected by tobacco smoking, because of the many carcinogenic chemicals and carbon monoxide (CO) (4% by volume) associated with smoking tobacco It also reduces the oxygen carrying (because CO is present not in the tobacco itself but in the fumes inhaled when the tobacco is burning) capacity of the blood, causes chronic injury to the respiratory system and causes fatigue (Bridger, 2003).

Alcohol and drug observation at workplace

The influence of alcohol and drugs has been a great concern of employers in recent years, affecting OHS and productivity. However, despite the fact that alcohol and drugs are known to affect behaviour, it is difficult to prove that the effects of drug and alcohol use are the sole reason for an accident. In the case of fatalities, the only way to prove that alcohol and drugs were involved or caused the accident is by the results of an autopsy. Other contributory factors must also be considered.

According to ILO (Holland et al., cited in Quinlan et al., 2010, p 529), between three and 15% of workplace fatalities taking place in Australia are blamed on alcohol and drug use. These figures should be regarded with caution since there have not been many large scale studies on this matter. Other issues to be considered are the accuracy of the data and the methodologies used to justify that alcohol/drug related injuries are not exaggerated.

A study by Berry et al. (cited in Quinlan et al., 2010, p 529) estimated that about 44% of Australian workers (including construction workers, young workers and blue-collar occupations) are occasionally involved in 'risky drinking'.

There is currently a two-step process for alcohol and drug testing in the workplace. The first step is a low-cost and simple process and the second step is a confirmatory analysis which is more accurate. However there is no single method or universal test for all types of drugs. A review of the literature, with a special emphasis on studies in the US and UK, shows that 'drug testing has little positive impact on prevention and rehabilitation' in the workplace (Kesselring and Pittman; Wickizer et al. both cited in Quinlan et al., 2010, p 530). Evans et al. (cited in Quinlan et al., 2010, p 530) came to the same conclusion in their study and added that 'a comprehensive and carefully administered drug testing program can be extremely costly to implement'.'Other issues dominating the argument in the literature in relation to drug-testing are legal and ethical considerations, the Privacy Act (1988) and the negative effects of testing on workers' self-esteem and the employer-employee relationship.

According to Quinlan et al. (2010, p 531), alcohol and drug use must be considered as an illness, with employers organising support and treatment (through trained health personnel) for workers, and 'punitive' action to be the last resort. There is a lack of research and evidence in the literature showing the 'scope, nature and implementation of drug testing and management regimes' However some of the literature identifies underlying factors in drug and alcohol use including work-related stress, shift work, working in an isolated environment (e.g., miners), work processes and other job-related issues.

Physical fitness

Physically fit workers are more tolerant to heat and become less stressed in a hot environment. Correspondingly, obese workers are less tolerant to heat than fit and lean workers (Bridger, 2003).

In their study, Morris et al. (cited in Bridger, 2003) concluded that the incidence of heart disease was considerably lower in a group engaged in dynamic work than in a group doing sedentary work. The group engaged in sedentary work had higher cholesterol and blood pressure and smoked more. However, the study also pointed out that both groups had these characteristics even before they entered employment. A second study by the same authors in 1973, in relation to coronary risk factors, compared two groups of employees engaged in sedentary work, where one group exercised with vigorous leisure time activities and the other did not exercise. The result was that the group who exercised (even those who smoked were less at risk) had one-third less heart attacks than the inactive group.

Pheasant (cited in Bridger, 2003) has reviewed the relationship between low blood sugar and low performance and higher accident occurrence, reporting that it is best to spread calorie intake over the day with three meals and morning and afternoon snacks.

The relationship between food intake and the productivity of a group of malnourished workers of Gambian origin was studied by Diaz et al. (cited in Bridger, 2003) over a 12-week period at a time of food shortage. The workers were divided into two groups of six. One group was provided with a food supplement in the first six weeks of the trial and the other group received the supplement in the second part of the trial. Both groups gained weight during the six weeks of the food supplement, however the productivity remained constant. This could be attributed to the fact that employment was on a piece rate basis.

Workplace wellness program

In recent years the health and wellbeing of workers has been of concern to workplaces in developed and developing countries, specifically larger enterprises. The main targets of workplace wellness programs are exercising to keep fit, obesity, smoking, alcohol consumption, drug taking, healthy diet, blood pressure control, and the balance between work and home. Some workplaces have established a company-sponsored program known as Workplace Health Promotion (WHP) to improve employees' wellbeing. 'The goal of WHP is attitudinal and behavioural change, leading to changes in mechanisms that mediate chronic disease (such as cholesterol, sun exposure and drug use) and injury (via exercise) as well as prompting mental wellbeing' (Abrams et al., Pritchard and McCarthy, both cited in Quinlan et al., 2010, p 560). The benefits of this program are twofold; a healthier workforce and increased productivity of the enterprise. In some European countries (the Netherlands, Sweden, Finland and Norway), it is required by law to have some kind of WHP. Indeed WHPs are more advanced in these countries than in some other industrialised countries, and mostly permanent employees benefit (Quinlan et al., 2010).

According to a Dutch study by Alavinia et al. (cited in Quinlan et al, 2010, p 560), the health management in a workplace is required to assist workers with health problems, so that they can stay working for a longer period of time, according to their abilities. This means adapting the work practices to the workers rather than adapting the workers to the work practices. WHP is of limited use to companies which make use of outsourcing, subcontracting, home-based workers, shiftwork or which are downsizing.

Some larger workplaces have their own on-site OHS centres. These centres are made up of most of the facilities needed to support workers' health and wellbeing, such as first aid, training, medical care and monitoring, and return to work programs after injury and rehabilitation.

Other functions of on-site OHS centres include' emergency procedures (evacuation/refuge points and procedures, rescue teams, first aid and emergency showers); maintaining medical and OHS records, including records of screening and health surveillance; induction; training competency/currency; OHS KPls; injury and hazard exposure records; near miss and dangerous incident reports; workers compensation claims and return to work; EAP usage; compliance with SWPs, JSAs and the like; employee health and wellbeing surveys; OHS program monitoring; and maintaining copies of investigations and external audit or consultant reports'(Quinlan et al, 2010, p 564–5). Health monitoring of workers must be kept strictly confidential, and these records are very valuable for research purposes if they are analysed and used efficiently. Other functions of on-site OHS centres are their relationship and communication with the OHS committee, relevant unions, and local medical facilities (Quinlan et al, 2010).

The establishment of occupational health services in European countries has been mandated, however the level of services differs among these countries and changes in work organisation have also shown adverse effects. In Australia, only some of the largest organisations have their own OHS services, and this is yet to be mandated (Husman and Husman, cited in Quinlan et al., 2010).

A7: Construction Industry and OHS

Introduction

The construction industry is known as a hazardous and complex working environment. What makes this industry so dangerous is the dynamic nature of the work involved, the multiplicity of the trades, the variety of substances, different kinds of machinery and constant climatic change. The most obvious hazards and their associated risks are falls from height, slips and trips, being hit by objects, manual handling, contact with machinery and electricity, vehicle accidents, weather conditions and contact with hazardous substances.

A sample study in the UK published in 'Blackspot construction' by the Health and Safety Executive concluded that 90% of work-related fatalities were preventable and positive preventive actions by the management could avert 70% of the fatalities (Holt, 2001).

Australian construction firms are mostly small businesses. A survey carried out by the Australian Bureau of Statistics (2011–2012) for the year 2011–12 showed that in that year the total number of businesses in the construction industry was 209,783, employing 950,000 persons and the total industry value added by these businesses was AUD 99.4 billion. This survey included 'employing and non-employing private sector and public trading businesses in Australia (ABS, 2011-2012).' The main occupations included tradespeople (33.1%) and labourers (20.4%). The construction businesses in Australia in 2011–12 included:

- Building construction:
  - number of businesses: 31,297
  - working persons: 16.8%
- Heavy and civil engineering construction:
  - number of businesses: 5,789
  - working persons: 16.2%
- Construction services:
  - number of businesses: (concreting, carpentry, pluming, etc), 172,697

    - working persons: 67%

The structure of construction businesses included:

- Small businesses:
    - range of employment : 0–19
    - employed persons: 62.1%
    - accounted for: 97.7% of all construction businesses
    - total income: 49%
- Medium size businesses:
    - range of employment: 20–199
    - employed persons: 19.3%
- Large size businesses:
    - range of employment: 200
    - employed persons: 18.6%
    - accounted for: 0.1% of all construction businesses
    - total income: 27.3% (ABS, 2011–12).

This survey suggests that majority of construction businesses are small businesses and it is a good indication of the effect of small construction businesses on Australia's economy. However it has been suggested by some studies that small construction businesses in Australia lacking in the way they address issues, risks and compliance with laws concerning OHS, compared to larger businesses (Holmes, Mayhew, cited in Rowlinson, 2004). According to ABS (2011–12), the construction services had the highest number of workers (172,697) with 67% of the workforce and small businesses employed 62.1% of the workforce in the construction industry and comprised 49% of the income. The dominance of these sorts of business is a matter of concern.

Failure to take action on construction sites

The dedication and concern shown by management to health and safety is a good example for the workforce to follow. Failure to take action on construction sites mainly with high risk or complex projects depends on:

- Selection of principal contractor;
- OHS safety plan for the tender (e.g., OHS management system, written risk assessment, lack of compliance);
- Lack of health and safety information;
- Whether the health and safety of all involved in the construction, maintenance and commission phases has been taken into account during the design stage;
- Lack of safe procedures undertaken by the principal contractor to prevent unauthorised individuals from entering the site;
- Documented codes of behaviour;
- Assessment of the contractors' OHSM systems;

Another area of concern is the procedures that need to be planned for managing fire or medical emergencies. The planning supervisor must be selected by the client and the designer in the initial stages of the project. Health and safety matters should be reviewed at the design stage by the planning supervisor in order to ensure they are complete and adequate (Baxendale and Jones, 2000).

Management commitment and involvement in OHS includes the following attributes:

- Promotion of safety in company meetings and during planning actions;
- Higher up managers to be involved in safety matters;
- Safety officers at a high level within the organisation;
- Open dialogue between workforce and management on safety issues;
- Communication of the importance of safety inspections, environmental control and general housekeeping;
- The importance of safety training for employees at all levels; and
- Supporting of safety awareness within the organisation (Fleming et al., 2006).

Some important preventative measures for construction sites include daily housekeeping, disposal facilities to be emptied on a regular basis, keeping tools and equipment in an orderly manner, use of correct personal protective equipment by the workforce, electrical equipment to be kept away from water and safe from being damaged, work areas such as excavations and overhead to be fenced and warning signs displayed.

The safety of the organisation must be measured and evaluated on a regular basis. The most reliable mechanism for measuring safety is a combination of leading and lagging OHS indicators. This is achieved by internal and external audits, workplace inspection, lost time injury rates, compliance, behaviour assessment and benchmarking.

Root causes of construction accidents

Identification of root causes of construction injuries and fatalities in the construction industry depends on:

1. Size of the organisation;
2. Structure and ethnicity (cultural analysis) of the workforce
    - First speaking language English;
    - English as a second language;
3. Management commitment to OHS;
4. Enforcement by government through workplace inspection (site visits without prearrangements);
5. Workers' regular health assessment;
6. Worker training;
    - New workers;
    - Existing workers.

In addition to the above, the knowledge of civil engineers about OHS and safe design is also important.

Health problems in the construction industry

Rowlinson (2004) highlights the key issue of health problems and the failings of the construction industry in this regard. Every year, countless numbers of construction workers suffer from ill health. He points out that occupational health has been ignored by the media and there is rarely any coverage of its seriousness in the press or on TV.

In 1995, a survey of 'self-reported work-related illness' in the UK was carried out by Gibb, Haslam and Gyi (cited in Rowlinson, 2004). This survey estimated that in 1995 134,000 construction workers reported ill health related to their work, with an estimated 1.2 million hours of working days lost among a workforce of 1.5 million.

Work-related exposure to some hazards may take many years to show its effects, such as exposure to asbestos dust which might sometimes take 30 to 40 years. It has been estimated by the UK government that by the year 2020, about 10,000 people annually will lose their lives from asbestos-related diseases (Croner, cited in Rowlinson, 2004).

According to Rowlinson (2004), common health issues in the construction industry include:

- Decompression sickness;
- Tendonitis of hand or forearm;
- Inflammation of skin;
- Inflammation of mucous membranes;
- Gas poisoning;
- Silicosis;
- Asbestos-related diseases; and
- Contact dermatitis: according to Black (1990) it is believed that 40% of occupational dermatitis in the UK is related to the effects of cement material.

Other health and physical injuries are vibration white finger, bursitis, skin cancer, carpal tunnel syndrome, synovitis, Raynaud's disease, job stress, eye injuries, cuts, amputations, fractures and effects on the musculoskeletal system. The foremost mechanisms of injuries are overexertion whilst lifting or carrying materials, being struck by moving objects and falling from height. Other major hazards at construction sites include contaminated ground (e.g., asbestos), location of underground services (e.g., electricity, sewage, gas, water), hazardous materials and substances (e.g., lead, ionising radiation), noise, electrocution, fumes, dust and changes in weather conditions.

The Occupational Safety and Health Regulations 1996

Some sections of the Occupational Safety and Health Regulations 1996 contain information relevant to the construction industry including:

- Part 3 Division 1: Cranes at construction sites, lowering gear on construction sites, conduits crossing thoroughfares at construction sites, portable ladders, construction diving work.
- Part 3 Division 2: general duties in relation to personal protective clothing and equipment.
- Part 3 Division 7: scaffolds, gantries, hoardings' barricades and formwork.
- Part 3 Division 8: work in confined spaces.
- Part.3.Division 9: Subdivision 1 - tilt up concrete and precast concrete elements, Subdivision 6 - excavation and earthworks and Subdivision 7 - demolition.
- Part 3 Division 11 - construction industry induction training.
- Part 3 Division 12 - construction industry consultation on hazards and safety management etc.
- Part 6: Certificate of Competency:

  Schedule 1 List of Australian standards.

  Schedule 2 Scaffolding.

A8: Industrial Falls

Introduction

Workplace falls (from height and ground level) in Australia and in other parts of the world are one of the main causes of fatalities and injuries. In the US, work-related fatalities as a result of falls are among the highest after vehicle accidents, machinery incidents, and homicides. There are more than 500 workers killed each year in the U.S. as a result of falls (Suruda et al., 1995). In 2007, 1000 workers were killed in the construction industry in the U.S, of which 15% were attributed to falls from height (Matthew, 2007).

In the UK, work-related fatalities due to falls from height were the lowest in 2006. However fatal fall injuries are still cause for concern and remain the third highest cause of work-related injuries (Barker, 2007).

The code of practice for the management and prevention of falls in the workplace was developed and approved by Safe Work Australia (2011) according to section 274 of the *Work Health and Safety Act* (the WHS Act) and the Work Health and Safety Regulations. This code of practice will be referred to by inspectorates when issuing an improvement or prohibition notice. Codes of practice are permissible in court events. In order to comply with this code of practice, workplaces may use their own generic methods or industry standards if their system is compatible with or more superior than this code of practice (Safe Work Australia, 2011). The code of practice applies to all stakeholders (e.g., employers, designers, importers etc.). The employers have an obligation under WHS Regulations to ensure, as far as reasonably practicable, that the health and safety of all people working for them is protected from any harm caused by their business and that they are protected by appropriate means (e.g., fall arrest system) if there is a risk of falling (Safe Work Australia, 2011).

According to regulations 34–38 of the code, in order to control the risk of falling, employers have a duty to identify hazards, assess risks, eliminate risks (as far as practically feasible) or minimise the risk of falling by means of a hierarchy of controls, and if needed, by evaluating or improving the control measures. Under the requirements of section 47 of the WHS Act, employers should, as far as practically feasible, consult on matters related to OHS with workers and if the workers have a health and safety representative, the consultation must involve that representative (section 48) (Safe Work Australia, 2011).

According to section 46 of the WHS Act, all those involved in OHS issues should be as far as practically feasible be consulted and cooperated with, and be part of coordinating OHS-related activities(Safe Work Australia, 2011). Despite improvements in OHS, a review of the literature indicates that work-related falls are still a cause for concern, mainly due to the lack of safety instructions and information provided by manufacturers and suppliers. Other areas of concern include: management commitment to health and safety, lack of written OHS policies, procedures and compliance, work method practices and unstable structures. In addition, there are concerns about working alone while at height, roof maintenance work and fragile roofing.

Management of the risk of falls in the workplace

Workplace falls are of concern for employers. There have been comprehensive studies undertaken since the 1980s in relation to falls and fall protection at workplaces (McCurley, 2013).As a result, employers are responsible for providing protective measures and rescue plans for employees working at height. To achieve this there is a need for effective pre-plan rescue procedures. It is the duty of the employer to authorise a pre-plan for rescue using on-site or off-site resources. This is to comply with the provisions of the regulations and protect workers from injury or death. The pre-plan must include rescue equipment, training, assignment of responsible employees, and ensure that 'the rescuers themselves do not become victims' (McCurley, 2013). Fall hazards must be identified, the risks assessed and control measures implemented and further assessed for their effectiveness, as follows:

Identification of fall hazards

- Inspect the workplace (checklist: surfaces, levels, structures, the ground, the working area, entry and exit, edges, holes, openings or excavations, hand grips);

- Review available information, including incident records (Safe Work Australia, 2011).

After the completion of a Job Safety Analysis (JSA) for the hazards of falls from height, and once all hazards have been identified, a written fall rescue procedure must be produced for each of the identified hazards. The fall rescue procedures must be drafted for personal escape, co-worker assistance and external assistance (McCurley, 2013).

Assessment of risks of fall

- Likelihood and severity of fall;
- Actions to be taken to control the risk and assessment of the effectiveness of control measures;
- How urgently the action needs to be taken (Safe Work Australia, 2011).

A risk assessment is pointless if the risks are already known. In addition, it is possible to use a generic risk assessment for similar hazards. There are a number of factors to be considered when assessing the potential risk of each fall hazards.

- The design and layout of elevated working areas and assessment of the fall distance;
- Assessment of the movement of people around the work area and consideration of the danger of falling objects;
- Plants and equipment should be in safe working condition;
- Planning of emergency procedures;
- Training applicable to the task should be provided and must be up-to-date to manage the job safety; and other concerns (Safe Work Australia, 2011).

Other contributory factors include time factors (e.g., day or night), environmental factors (e.g., weather conditions, lighting, and noise), work experience, medical condition and air pollution (McCurley, 2013).

Control measures

Organising a safe system of work at the planning stage can prevent many of the accidents and injuries which might be caused by a fall. The WHS Regulations have specifically outlined control measures (where it is reasonably practicable to do so) for the management of falls such as:

- Work should be carried out at ground level where possible, and with the proper protection provided wherever it has to be carried out at heighte.g., handrails, guard rails or parapet walls;
- Provision for fall prevention devices (e.g., guard rails).If this is not reasonably practicable, an industrial rope access system or provision of a fall arrest system is required (Safe Work Australia, 2011).

According to Regulation 37 of the Code of Practice for Management and Prevention of Falls in Workplaces, control measures must be effective, relevant to the work activity and must be correctly installed for the life cycle of the work to be carried out. For control measures to be effective, work procedures during planning stage should include and provide supervision, training, relevant detailed information, correct use of equipment, emergency and rescue procedures, inspection and maintenance of equipment (e.g., detailed assessment), actions to be taken on faulty equipment and the means of recording inspections and monitoring for suitability. In addition are the procedures of reporting fall hazards, incidents and the correct selection, use, maintenance and storage of equipment (e.g., fall arrest system), and consideration of other hazards such as electrical hazards (e.g., power lines) (Safe Work Australia, 2011).

With reference to Regulation 38 of the code, if the control measures are not efficient (as far as is reasonably practicable), there is a need for hazards and risks to be reviewed by OHS representatives. It is the responsibility of the person conducting a business to review the control measures.

In addition to control measures, other means of controlling the risk of falls include administrative controls such as:

- No-go areas;
- Permit systems;
- Organising and sequencing of work;
- Safe work procedures.

Safety matters must be taken into consideration during the design of plants (compliance with section 21 – plant safety), buildings, and structures where there is a potential for falls, for example, designing a permanent edge protection if there is a risk of fall, considering roofing materials, strength and slope. Other safety concerns include site layout plans (e.g., access road, provision of fall protection equipment) and consideration for future maintenance work (Safe Work Australia, 2011).

This code of practice covers the following areas for fall protection: work on the ground or on a solid construction, fall prevention devices (e.g., perimeter guard rails, safety mesh), work positioning systems (e.g., industrial rope access systems), fall arrest systems (e.g., industrial safety nets), ladders, administrative controls, emergency procedures for falls and design of plant and structures (Safe Work Australia, 2011).

More research is under way to establish the use of safety nets, purlin trolleys, safety air bags, cable base systems and harnesses during scaffold operations. This research proposal is under negotiation in the UK with the Health and Safety Executive (HSE). This research highlights the lack of technical guides for designers and contractors (Rowlinson, 2004).

The use of safety nets during industrial roof work is becoming very popular in the UK. Although safety nets are a very effective way of protecting workers from falls, they are not practical for all situations (Cameron, Gillan and Duff, Rowlinson, 2004).

The following sections will briefly review some of the fall prevention devices with reference to the Code of Practice for Management and Prevention of Falls in Workplaces (Safe Work Australia, 2011).

Fall protection devices

To prevent falls from heights of two metres or more, guardrails and toe boards are recommended, and fall arrest equipment is recommended if these are not possible (Rowlinson, 2004).

Fall arrest equipment is any equipment that is designed to prevent a fall during temporary work at height, and once in place does not require any further adjustment by workers using the device (Safe Work Australia, 2011).Rescue equipment is designed for different applications; it must be serviced after each use, and all of the parts must be compatible and comply with regulations and the manufacturer's instructions (McCurley, 2013).Personal protective equipment used for fall protection and rescue must comply with regulations, be appropriate for the job and consider the environmental factors (McCurley, 2013). According to Loudermilk (2003) the shortcomings in the use of fall protection on jobsites is mostly attributed to lack of worker training, suitable fall protection systems not being available, compliance with standards not achievable due to site and work circumstances, and hazards such as machinery being run beneath workers working at height.

Scaffolding

Metal scaffolding is used in Australia and is classified as light, medium or heavy duty. Regulation 225 of the code indicates that scaffolding and its supporting structure are to be inspected by an authorised person before use, after the occurrence of an incident, after repairs, and every 30 days. Training must be provided to workers using scaffolding.

The use of bamboo scaffolding is very popular in Hong Kong. The use of steel and bamboo scaffolding systems in Hong Kong has been studied by Fang et al. (Rowlinson, 2004). The positive characteristics of bamboo scaffolding included its light weight, very low cost and the availability of skilled labour. The disadvantages of bamboo scaffolding included its negative influence on construction safety due to its low strength, low fire resistance and its irregular and changeable shape. In comparison to bamboo scaffolding, metal scaffolding is safer to use. It is reliable and easy to erect. Bamboo scaffolding is cheaper compared to metal scaffolding, and for this reason both are appropriate for the Hong Kong construction industry (Rowlinson, 2004).

Examples of correctly assembled perimeter and mobile metal scaffolds are shown in Figure A 8 and Figure A 9.

Figure A 8**:** Perimeter scaffold

Source: Safe Work Australia, 2011

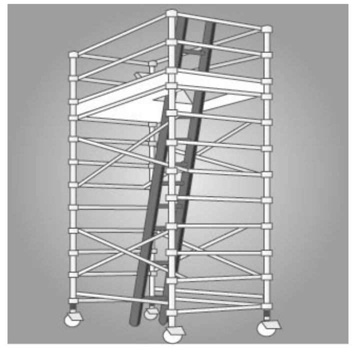


Figure A 9: Mobile scaffold

Source: Safe Work Australia, 2011

The relevant standards for scaffolding are:

- AS/NZS4576 and AS/NZS 1576;
- AS 1576.4:YEAR Scaffolding –Suspended Scaffolding;

Suspended scaffolding

Suspended scaffolding (Figure 9) is used for light duties in accordance with AS 1576.4 and it must be assembled by a person holding a licence for advanced scaffolding. Additional guidance and regulations for safe design, erection and other issues concerning suspended scaffolding and scaffolding are under development as a separate code of practice that is yet to be published (Safe Work Australia, 2011).

Elevating work platforms

Elevating work platforms (EWPs) should comply with AS 2550.10 and include scissor lifts, cherry pickers, boom lifts and travel towers. Workers operating a boom with a length of 11m or more are required to carry a special licence. Workers operating EWPs must be trained for each type as well as being trained in the proper use of fall arrest equipment and emergency and rescue measures. Examples of the boom type EWP and scissor-lift EWP are shown in Figure A.10 and Figure A.11 (Safe Work Australia, 2011).

The statistics show a high rate of incidents using suspended scaffolding. The main cause of these incidents is attributed to environmental conditions (e.g., wind, rain), mechanical and anchor failures. This creates a situation where the workers hang in their secondary protection equipment (e.g., vertical lifeline) waiting to be rescued while there is a risk of further injury due to the swinging of the scaffold. These kinds of rescue are more difficult for a rescue team, and if members of the public are gathered beneath the building, putting themselves in danger of falling objects, this also creates a negative psychological effect on rescuers. In such situations crowd control is recommended. Another hazard to the health of workers is coming into contact with bird excrement, which may be disturbed by their activities.Wearing suitable PPE is recommended (McCurley, 2013).

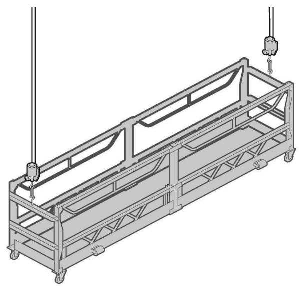


*Figure A.10**:** Light duty suspended scaffold*

*Figure A.11**:** Boom-type elevating work platform*

Source: Safe Work Australia, 2011

Mast climbing

Mast climbing WPs are used to lift workers and material to a temporary working position (Figure A.12) and they must comply with AS 2550.16(Safe Work Australia, 2011).

*Figure A.12**:** Scissor-lift elevating Work platform*

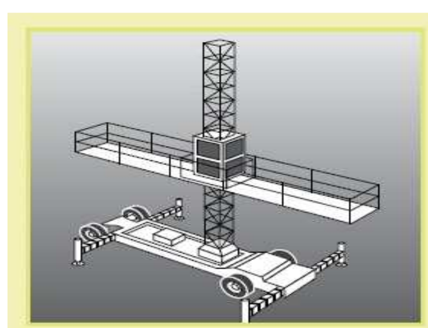


*Figure A.13**:** A typical mast climbing work platform*

Source: Safe Work Australia, 2011

Workboxes

Workboxes are designed to be supported by other mechanical devices (e.g., forklift, crane) to facilitate workers working safely at height. Workboxes and anchorage must be designed according to AS 1418.17, AS/NZS 1891.4 and AS 2550.1: which give the specifications in relation to the use of crane workboxes. Figure A.13shows a workbox fitted to a forklift which is engineered and designed in compliance with AS 2359. Construction and building designers must take into consideration maintenance work and cleaning of the structures during the design stage. Figure A.14shows the safe way of maintaining taller structures, a unit with a safety harness and restraint line. The relevant Australian standards for these types of units are AS 1418.13: and AS 2550.13: (building maintenance) (see Figure A.15).

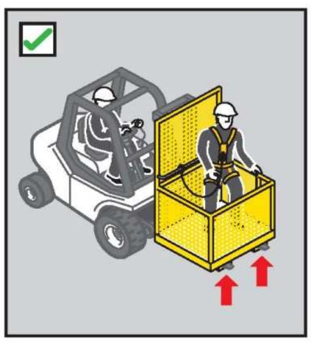


Figure A.14: Engineer-designed workbox

Source: Safe Work Australia, 2011

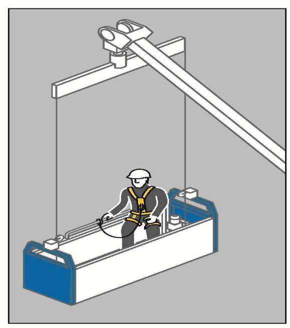


Figure A.15: Building unit maintenance

Trestle ladders

Trestle ladders are a type of scaffold suitable for use with light duty jobs (e.g., painting) and structures higher than 2m. Outriggers are used for some trestle ladder scaffolds in order to enhance stability (Safe Work Australia, 2011) (see Figure A.16).

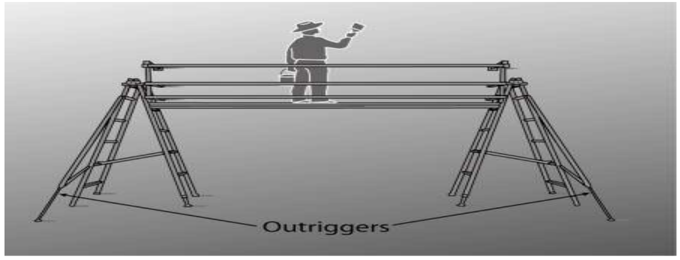


Figure A.16: Trestle ladder scaffold with guard rails and outriggers for stability.

Source: Safe Work Australia, 2011

Industrial rope access systems

Industrial rope access systems are used for workers to access working areas at height and they should comply with the guidance notes in AS/NZS 4488. Workers using these systems must be competent and experienced and have the appropriate training. Workers wearing a full body harness must not be working alone (Safe Work Australia, 2011), and before attaching the rope access lines, the anchorage points must be checked for their safe use by an expert. It is important to ensure that the different components of the fall arrest systems and safety harness are compatible and purchased from the same manufacturers (ACT WorkCover, 1997). Procedures for rescue, communication with supervisors and emergency situations must be planned in advance in case of accident occurrence. The area beneath the working area must be secured (e.g., signs, barricades) in case of falling objects or other concerns (see Figure A.17) (Safe Work Australia, 2011).

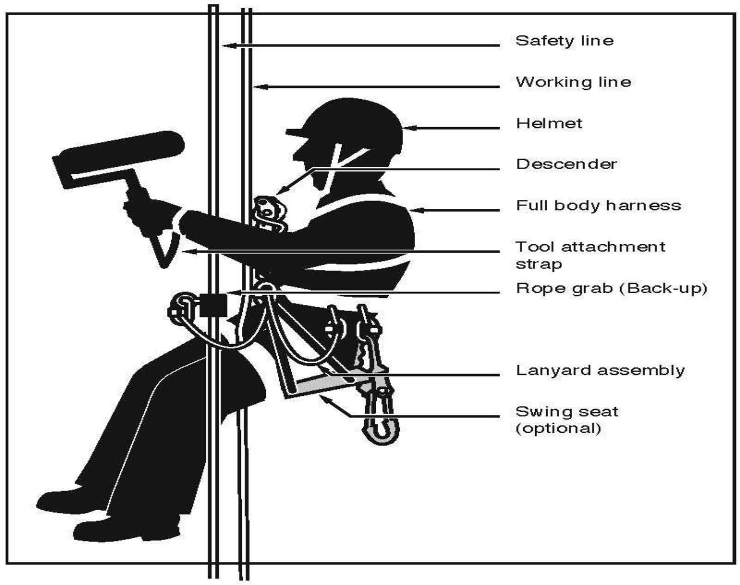


Figure A.17: Operator using an ascender in an industrial rope access system

Source: Safe Work Australia, 2011

Restraint technique

The restraint technique complies with AS/NZS 1891and consists of a harness, a lanyard and anchorage. The restraint technique' controls person's movements' and protects the person from an unprotected edge and a risk of falling. The use of the restraint system is suitable when it is not reasonably practicable to use other means of edge protection such as guard rails. The reason for this is that the use of the restraint technique requires greater experience and supervision (see Figure A.18) (Safe Work Australia, 2011).

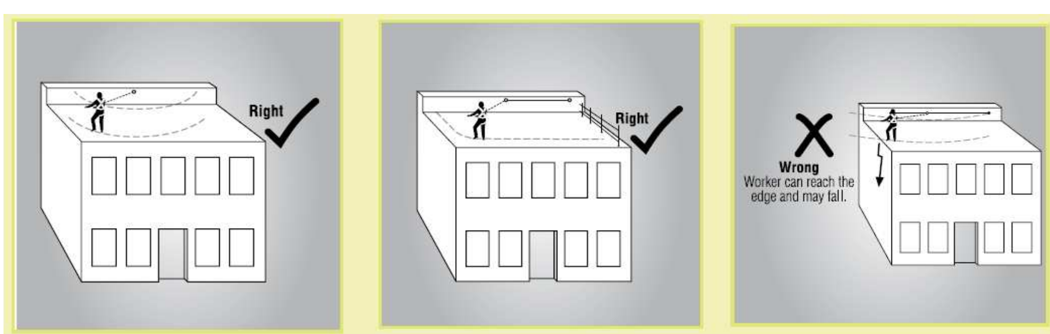


*Figure A 18**:** Restraint technique options*

Source: Safe Work Australia, 2011

A pendulum effect may occur as a result of the position of the anchor point or the length of the lanyard, leading to 'swing down' (Figure A.19) and 'swing back' (Figure A.20), causing the worker to hit the ground or the structure (Safe Work Australia, 2011).

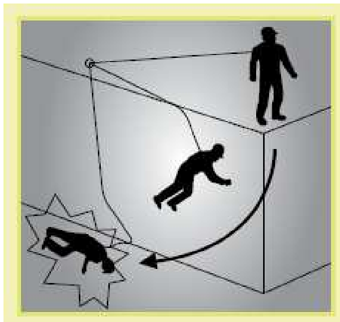


Figure A.19: Swing down

Source: Safe Work Australia, 2011

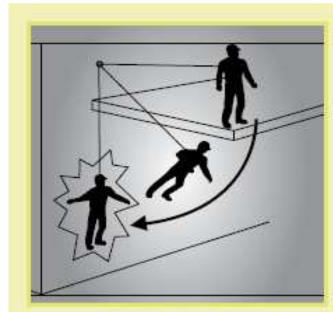


Figure A.20: Swing back

Fall arrests systems

Fall arrest systems are designed to reduce the impact of falls from height when it is not reasonably practicable to use other types of fall protection. Fall arrest systems must comply with AS1891:1983 and the anchorage points with AS/NZS 1891:4:2009. The factors to be considered for fall distance are:

- 'The worker's height;
- The height and position of the anchorage point;
- The length of the lanyard;
- Any slack in the horizontal life line;
- Any stretching of the lanyard or horizontal life line when extended by a fall;
- The length of the energy absorber when extended by a fall' (Safe Work Australia, 2011, p 30).

A fall distance of 6.5m is proposed to be the right distance for an effective arrest. 'Lanyards should not be used in conjunction with inertia reels as this can result in an excessive amount of free fall prior to the fall being arrested'(Safe Work Australia, 2011). (see Figure A.21). Depending on what the task is, it is a good practice for workers to wear a full body harness attached to a fall arrest line. The safety issues to be considered when using a fall arrest system are the fall distance, that the worker should not be working alone, impact with the structure, the lanyard should have the least amount of slack permitted, that the anchorage point must be as high as the equipment permits and any work activities above the anchorage point must be avoided. Extra care is needed for the use and selection of inertia reels since they are not designed for continuous support and they may not be safe and effective for all situations (e.g., a steeply pitched roof) (Safe Work Australia, 2011). The minimum tensile strength for lanyard, static lines and vertical lifelines must not be less than 22.2 KN and for self-retracting lifelines is 13.3 KN (ACT WorkCover, 1997).

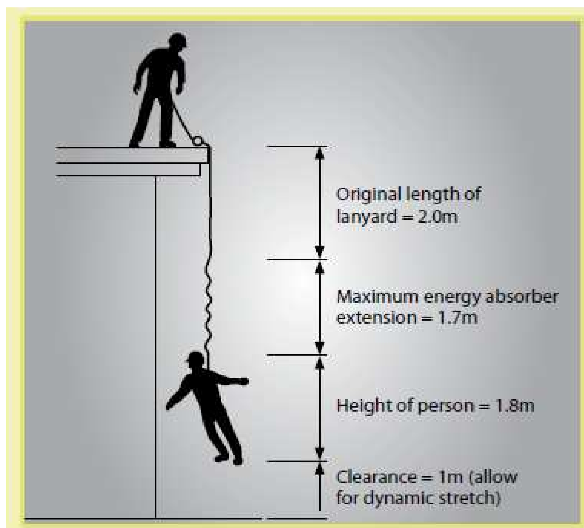


Figure A. 21: Total fall distance (Source: Safe Work Australia, 2011)

Rescue after a fall

When the decision is made to use a fall arrest system, the emergency procedures and rescue plans must also be planned in advance. Workers who are wearing a full body harness must be rescued promptly after a fall to prevent the occurrence of suspension intolerance (Safe Work Australia, 2011).

According to McCurley (2013), in any workplace where workers are expected to work at height, it is the employer's duty to plan post-fall rescue procedures and comply with regulations. The very start of the rescue should identify who is making key decisions and assessing the technical and medical capabilities of the workforce. According to the Occupational Safety and Health Administration (OSHA), an acceptable time between a fall and the rescue of a person is estimated at 15 minutes.

This is to say that after this period of time the risk of further injury is imminent. However in more serious situations such as when a person is unconscious or faced with the danger of suffocation or electrocution the timeframe in which rescue should take place is as short as four minutes. The post-fall rescue procedures must protect the worker from further injury and protect the rescuer or the rescue team from any harm during the rescue operation. This plan must be accompanied by job safety analysis. Considering that the situation in each workplace is different, there are some environments that need scrupulous lanning if there is a risk of falling. Examples include environments where people work in confined spaces, or with hazardous waste, or above water, or on remote worksites. The procedures for post-fall rescue must include:

- The immediate and other actions to be taken to make the site safe (lockout), to notify others (e.g., employer's representatives), and by whom these actions are to be carried out;
- Provision of medical and first aid amenities;
- Determination of appropriate rescue procedure for the situation at hand, such as:
  - Personal escape (this is the preferred option if it is possible): in this case worker training is required and there must be a backup plan if self-rescue fails.
  - Colleague-assisted rescue: where onsite co-workers respond promptly to the fall. They must have the necessary skills, be good communicators, only engage themselves in simple rescue situations, and be able to assess the safety of others and themselves before attempting the rescue. They must seek prompt help in difficult situations (e.g., confined spaces).It should be noted that many rescuers working in confined spaces have lost their lives while trying to rescue others.

If assistance from outside of the workplace is required, the capabilities of those providing the assistance, the time required to reach to the workplace, and their familiarity with the work activities and hazards that might have contributed to the fall must be assessed in order for the assistance to be effective, and must be carried out in a very short period of time. It is risky to depend exclusively on outside help in case of fall emergencies (McCurley, 2013).

Suspension intolerance

Suspension intolerance occurs when a worker falls and she or he is suspended in an upright, vertical position wearing fall arrest equipment. The time limit for a worker to stay in this position is less than five minutes (Safe Work Australia, 2011). This figure is also estimated as being within 20 minutes of the fall (Safe Work Australia, 2011). A study by the US Air Force indicates, that there is a time limit of 14.4 minutes to rescue a worker wearing a full-body harness after a fall before signs (e.g., tingling, numbness or nausea) of orthostatic shock (suspension trauma) appear (Christensen and Rupard, 2006).

In such a position the harness straps cause pressure on the veins of the legs, preventing the flow of blood from the legs to the heart. As a consequence, the heart rate decreases and the person faint, leading to renal failure and death. To reduce the effect of venous pooling (blood pooling in the lower parts of the body), the worker must move his or her legs. After the worker has been rescued, he or she must be put in a seated, squatting or crouching position (Christensen and Rupard, 2006).

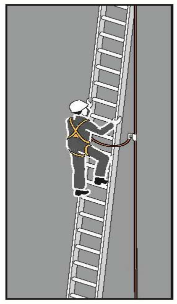
Other contributing factors are the vulnerability of the person, weather conditions and dehydration. Workers wearing fall arrest equipment must not work alone should preferably use a fall arrest system that keeps their legs horizontal in case of a fall, and should keep their legs high and their head horizontal if it is possible to do so (Safe Work Australia, 2011).

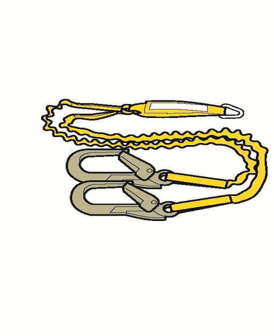
The studies by Federation Francaise de Speleologie found a direct correlation between being in a suspended position and being motionless and the death of healthy, uninjured persons (McCurley, 2013) Recent studies in the US by the National Institute for Occupational Safety and Health (NIOSH) confirm the results of earlier studies in relation to the effects of harness suspension, indicating that the ‘key to survival’ is to keep the legs moving and elevated (McCurley, 2013).Standing still in a suspended position while wearing a harness must be avoided if possible (McCurley, 2013).The signs of suspension trauma include breathing difficulties, anxiety, numbness in the legs and loss of consciousness (McCurley, 2013).A quick response should be arranged for any person suspended in a harness, especially if the person is unconscious, incapable of moving and shows ‘swelling of the face and hands, puffiness around the lips and eyes, shallow breathing, and extreme lividity’. The absence of any of these signs does not mean that there is no suspension trauma. The condition of the person must be kept under close observation during and after the suspension. Treatment after suspension trauma is by keeping the person in a seated and upright position. However the current protocols are to elevate the legs, and administer ‘high flow oxygen, and fluid replacement’ (treatment for shock) (McCurley, 2013).

Anchorage lines, rails and double lanyards

Other fall arrest systems include the anchorage lines system (see Figure A.22) or rails (which can be used as a permanent or temporary system), complying with AS/NZS 1891. These systems are appropriate for using when for climbing ladders, towers, tower cranes or building structures. Alternatively, a double lanyard (also known as a twin tail or Y lanyard) could be used. Figure A.23 shows that the worker is connected to the ladder and the structure at all times. A step platform and acceptable ladder use is shown in Figure A.24 and Figure A.25. Figure A.26 shows the incorrect use of ladders.

To prevent the side loading of connectors on the rails, ‘soft connections’ can be used such as ‘slings’ or ‘hooks rated to withstand side loading’(Safe Work Australia, 2011, p33). Other safety issues concerned with the use of the double lanyard are that ‘they should not be wrapped around the body or passed between the legs’ and the attachment point to the ladder or the structure must always be above the worker’s chest. Finally the ladder, the structure and double lanyard must be strong enough to take the impact caused by a fall. Due to their misuse and the potential for muscle injuries.hey are not recommended for regular use (Safe Work Australia, 2011).





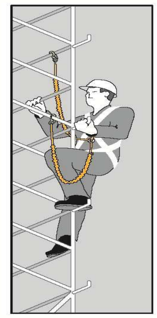


Figure A.22: An anchorage line system *Figure A.23: Double lanyard*

(Source: Safe Work Australia, 2011)

Figure A. 24: A step platform

(Source: Safe Work Australia, 2011)

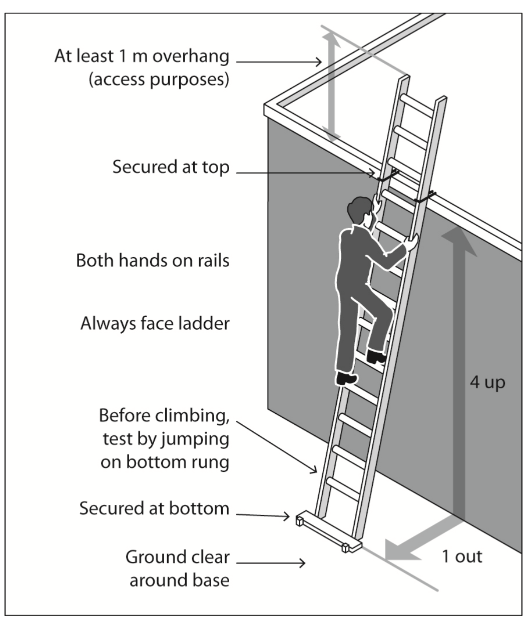


Figure A.25: Acceptable ladder use *(Source: Safe Work Australia, 2011)*

Figure A.26: Ladders used incorrectly *(Source: Safe Work Australia, 2011)*

Fixed ladders

The installation of fixed ladders should being accordance with AS 1657: YEAR *Fixed Platforms, Walkways, Stairways and Ladders—Design, Construction and Installation.* An example of a fixed ladder is shown in Figure A 27. Fixed ladders fitted with cages 'do not stop a fall' and may even be the cause of more injuries, especially when workers strike the back guard'on the way down'(Safe Work Australia, 2011, p 37).. The cage also delays the rescue operation. The angle of slope must be between 70 and 75 degrees to the horizontal and if in any case the angle increases above 75 degrees a 'permanent fall arrest system or a full body harness with double arm lanyard' must be worn by workers. Training must be provided to the rescue team before a fixed ladder is used. All kinds of ladders must be regularly inspected, repaired and replaced if faulty (Safe Work Australia, 2011, p 37).

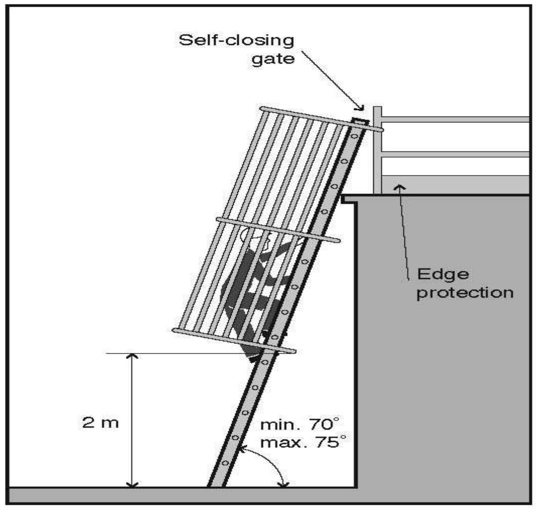


Figure A 27: A fixed ladder fitted with a ladder cage (Source: Safe Work Australia, 2011)

If a worker falls while using a ladder equipped with a cage and needs to be rescued, the rescuer must use a ladder equipped with a vertical lifeline, safety rail or a cable. It should be noted that vertical lifelines do not function correctly in ladders with cages. Therefore it can be argued that the use of ladder cages could cause an additional hazard to the user (McCurley, 2013).

Emergency system for falls

According to Regulation 80, emergency procedures must be planned and tested for their effectiveness before any task takes place that might entail the risk of a fall, or a fall arrest system is used. Relevant issues when planning for emergency procedures are:

- Location: assessment of how quickly medical facilities can be reached in case of an emergency;
- Communication: between workers working at height and supervisors in an emergency situation;
- Rescue equipment: the appropriateness of rescue equipment for the task;
- Capabilities of rescuers: training and expertise in using rescue equipment;

- First aid;
- Local emergency: documented details of emergency services and estimated time of response.

According to Regulation 42, business owners must provide first aid equipment and workers must have first aid training or to know who to approach in the event that first aid is needed (Safe Work Australia, 2011).

Every workplace should have an emergency plan that clearly designates what the employer and employees should do in an emergency situation. The written emergency plan must include at minimum, the following:

- The manner in which the emergency situation is reported;
- Procedures for the evacuation of employees who must leave the site and those employees who have responsibility for vital operations before they evacuate themselves;
- Who is responsible for the rescue and medical emergencies;
- What procedures are performed to account for all employees after the evacuation;
- Details of employees to be contacted in the future for an investigation or other issues concerning the emergency situation.

In addition to the above, employers must have the details of the available local resources, hospitals, ambulance and fire brigade (McCurley, 2013).

Anchorage

During the building and maintenance of structures, workers are constantly working at heights and are exposed to the risk of falling. Anchorage becomes a problem in situations where there is a need for the use of fall arrest or rescue systems during construction work. Ground-based scaffolds must not be used for anchorage unless they have been specifically designed and approved for this purpose. Cherry-pickers are the preferred option for rescues following falls. There are varieties of building anchorage available, including ‘eye bolts to davits, parapet clamps, and installed anchorages.’ Some anchorages are mounted on the building during construction and remain for future maintenance work (e.g., window cleaning). The strength rating of such anchorages should be noted in the building's 'service plan document,' stamped and dated by a qualified engineer and be referred to during establishment of the rescue plan (McCurley, 2013).

During the preplanning of rescue procedures, the position of the anchorage points must be identified. Anchorage points are either installed (engineer designed), or other points of anchorage can be chosen, such as strong structures, a strong tree or any heavy machinery. Engineer designed anchorage should consider the impact of the fall on the anchorage and the structure to which the anchorage is fixed. Anchorages are designed with different strengths ranging from 4.5 KN to 22.2 KN for non-certified anchorages (McCurley, 2013).

Crane safety

According to OHS legislation, crane owners, suppliers and their users have an obligation to assure the safety of mobile cranes. Cranesafe Australia is a third party voluntary program providing safety assessments for mobile cranes. The use of this program can assist the crane owners, suppliers and their users to meet their obligations to the OHS legislation (Fraser, 2007).

In 2003, the Western Australian government consulted extensively with the union and construction industry to bring about crane regulations including the following points:

- Cranes of up to 60 tonnes allowed one driver and one dogger/rigger;
- Crane above 60 tonnes may occupy one driver and two doggers/riggers;
- Crane must have 'Compulsory external rated capacity';
- Cranes must be equipped with lighting indicators and an 'audible alarm system';
- Efficient, effective and better ways of reporting damaged cranes;
- Better controls on licensing;
- Users of cranes to provide records of their competency and training (Fraser, 2007).

Other areas to be studied by stakeholders in relation to OHS, that is not covered in this research include;

- Equal opportunity;
- Workers compensation;
- Rehabilitation, injury management and return to work after injury;
- Permit to work system and Confined spaces;
- Electrical safety;
- Fire and explosion;
- Mobile plant and equipment safety;
- Machine guarding and
- Housekeeping.

Conclusion

The success of the goals set at the planning stage in any workplace depends on the structure of an effective OHSMS and the commitment of the employer, management and OHS committee towards health and safety. The decline in union membership and thus their 'right to enter workplaces and represent workers can have serious adverse effects on OHS' (Quinlan et al, 2010). Workers' awareness of and knowledge about workplace hazards plays a big role in their ability to protect themselves from accident, injuries, ill health and their ability to refuse dangerous tasks and situations. The refusal of work by workers in dangerous situations may put them in a position whereby they experience some form of discrimination by their employers. Therefore some legislative reforms (e.g., policies, regulations) are needed, for example a system whereby a workplace committee can report to a union or government entity rather than having to directly approach the employer.

There has been a debate and different views in the literature on how OHS performance can be measured. Lag indicators such as lost time injury frequency rates, injury frequency rates, incident rates and workers compensation statistics are attributed to system failures rather than successes. On the other hand, the review of the literature suggests that positive performance indicators (PPI) should be implementation-oriented (procedures, methods and resources) and also result-oriented (products, output, outcomes). Another important OHS issue is the question of excessive health and safety regulations being a burden on businesses, or whether exposure standards are so stringent that some businesses or industries might close or take their business outside Australia where OHS is not taken seriously and yet high productivity is achieved. In such situations the price is paid by workers with injuries, disease and fatalities. These kinds of issues must be the concern of international organisations (e.g., The World Health Organisation, the International Labour Organisation), which can intervene to promote better working conditions for these workers.

It must be also noted that workplace accidents/incidents are underreported; perhaps because workers are afraid of negative consequences (e.g., loss of bonus, being blamed by the employer).The main concern of a multidisciplinary OHSMS is awareness and education about OHS for the stakeholders in any workplace. The result is effective reduction in accidents, fatalities, injuries and ill health, consequently minimising costs to the workplace and social services and increasing productivity as well as protecting workers' health and wellbeing. Some of the main areas include:

- Awareness of workplace hazards;
- Understanding of the physical and mental abilities of the workforce considering their cultural and ethnic background;
- Stakeholders' awareness of their roles and responsibilities under OHS legislation and understanding of common law (duty of care);
- The importance of effective communication at all levels of the organisation;
- Workplace observation (e.g., tasks, work system, interaction between the workforce, equipment and environment).

Incentives in health and safety such as bonuses or prizes to be paid to individuals or groups are effective in medium to large organisations as long as they do not affect injury reporting (underreporting) by the workforce. These incentives will have a greater impact on the workers in small workplaces if they are paid to all workers when accidents and injuries are reduced (e.g., during the festive season). This kind of incentive promotes and is a good indicator of management dedication to OHS, and at the same does not create division among the workforce.

Issues that undermine OHS are the changes made to work organisations in the present time (e.g., downsizing, subcontracting, agency labour, piecework system of payment, casual workers, part time work, financial and productivity pressure). One silent issue is work-related stress, depression and mental health among the workforce at all levels. This matter has had very little coverage in the literature, especially regarding migrant engineers and workers, at all levels and in all industries. In conclusion, OHS is a scientific discipline and its importance, especially in relation to human factors, is yet to be seriously recognised.

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Appendix AA Section 1

The Act, Regulations, Codes of Practice, Guidance Notes and Australian Standards (OHS):

THE ACT: *The Occupational Safety and Health Act 1984* provides for the promotion, coordination, administration and enforcement of occupational safety and health in Western Australia. With the objective of preventing occupational injuries and diseases, the Act places certain duties on employers, employees, self-employed persons, manufacturers, designers, importers and suppliers. In addition to the broad duties established by the Act, it is supported by a further tier of statute, commonly referred to as regulations, together with lower tiers of non-statutory codes of practice and guidance notes.

Regulations: Regulations have the effect of spelling out the specific requirements of the legislation. Regulations may prescribe minimum standards. They may have a general application or they may define specific requirements related to a particular hazard or a particular type of work. Regulations may also be for the licensing or granting of approvals, certificates, etc.

Codes of Practice: A code of practice is defined in the Act as a document prepared for the purpose of providing practical guidance unacceptable ways of achieving compliance with statutory duties and regulatory requirements.

Codes of practice:

- Should be followed, unless there is another solution which achieves the same or better result; and
- Can be used to support prosecution for non-compliance.

Guidance Notes: A guidance note is an explanatory document issued by the Commission providing detailed information on the requirements of legislation, regulations, standards, codes of practice or matters relating to occupational safety and health.

Australian Standards (OHS)

The goal of OHSMS standards is to guide organisations to achieve a high standard of safety by elimination or reduction of injuries. However to achieve this it needs the commitment of the senior management and all of the workforce .These standards are generic in nature and are appropriate to accommodate the diversity of legal OHS in Australian jurisdictions. However care is needed for compliance, with the requirements in different jurisdictions. In addition they are suitable to all different sizes of the organisations, its geographical, cultural and social conditions, as well as ethical, legal and policy requirements.

- AS/NZS 4801:2001: It is in the interest of any organisation to implement a resourceful and effective OHSMS. This will not only reduce injury and illness and increase productivity and financial performance, it also fulfils the organisations' legal, moral and industrial relations considerations.
- AS/NZS 4804:2001: General Guidance which assists in meeting the legal requirements and upgrading the OHS performance of an organisation. It provides the resources and details required for setting up and continually improving OHSMS.
- NOHSC (National Occupational Health Safety Commission): 3021(1995): a guidance note for the best practice, management and rehabilitation of occupational injury and disease.
- AS/NZS 4801 (Audit Framework): this standard establishes the most important factors and framework for an independent external audit of the OHSMS of an organisation; however it can also be used for internal audit.
- AS/NZS ISO14001:1996: Environmental Management Systems Standards.
- AS/NZS ISO 9001:2000: Environmental Management System Specifications with Guidance for use and quality system standards.
- AS/NZS 4360 risk management, philosophies and methods.
- AS 1885: measurement of OHS.
- AS 1885.1: (part 1): National standard for workplace injury and disease recording.

- Managing Risks of Hazardous Chemical in the Workplace–Code of Practice July 2012.
- ISO 14000: Environmental Management.

Appendix AA Section 2

Code of Practice Managing Noise at Workplaces 2002

DEFINITIONS

A daily noise exposure level, LAeq, 8h of 85 dB (A); or

A peak noise level, LC,peak of 140 dB(C).

The 85 dB(A) exposure standard for noise in Western Australia is legally the maximum.

Peak noise levels, LC, peak, above 140 dB(C) can cause immediate hearing damage from a single event and must therefore be avoided.

'acoustic' (or acoustical) means containing, producing, arising from, actuated by, related to, or associated with, sound.

'acoustic calibrator' means a device for applying a sound pressure of known level to the microphone of a sound measuring system, for the purpose of calibration.

'administrative noise control measures' are work systems designed to substantially reduce exposure to noise, including the time exposed to noise. Examples are job redesign or rosters which are designed to reduce exposure to noise. Engineering noise control measures and the use of personal hearing protectors are not included.

'attenuation' means a reduction in the magnitude of sound.

'audiogram' means a chart or table relating a person's hearing threshold levels for pure tones to frequency.

'audiometric test' (or testing) means the measurement of the hearing threshold levels of a person by means of monaural pure tone air conduction threshold tests.

'A-weighting' refers to a standardised frequency response used in sound measuring instruments, specified in Australian Standard AS 1259.13. Note: Historically it was developed to model the human ear response at low sound levels. However A-weighting is now frequently specified for measuring sounds irrespective of level and studies have shown a relationship between the long term exposure to A-weighted sound pressure levels and hearing damage risk.

'C-weighting' refers to a standardised frequency response used in sound measuring instruments, specified in Australian Standard AS 1259.13. Note: Historically it was developed to model the human ear response at high sound levels. It is now used to measure peak noise levels.

‘competent person’, in the context of supplying information on noise levels generated by plant, means a person whom the manufacturer or supplier ensures has acquired knowledge and skills, through a combination of training, education and experience, enabling that person to correctly perform a specified task.

‘consultation’ means the sharing of information and exchange of views between employers, employees and/or safety and health representative(s) on health and safety issues. It includes the opportunity to contribute to decision-making in a timely fashion to minimise the risk(s) of exposure to excessive noise.

‘daily noise exposure level’ see definition for ‘LAeq, 8h’.

‘dB’ means the abbreviation for decibel. Also see definition for ‘decibel’.

‘dB(A)’ means A-weighted sound pressure level in decibels. Also see definition for ‘A-weighting’.

‘dB(C)’ means C-weighted sound pressure level in decibels. Also see definition for ‘C-weighting’.

‘decibel’ is the unit used to indicate the relative magnitude of sound pressure level and other acoustical quantities. The range of sound pressures commonly encountered is very large so a logarithmic.

‘LAeq,8h’(daily noise exposure level) means an 8 hour equivalent continuous A-weighted sound pressure level in decibels (dB(A)) referenced to 20 micropascals, that is to say, the steady noise level which would, in the course of an 8 hour period, cause the same A-weighted sound energy that would be caused by the actual noise during an actual working day, determined in accordance with Australian/New Zealand Standard AS/NZS 1269.11.

‘LC,peak’ means peak noise level, that is to say, C-weighted peak hold sound pressure level in decibels (dB(C)) referenced to 20 micropascals determined in accordance with Australian/New Zealand Standard AS/NZS 1269.11.

‘personal hearing protection program’ means a program for personal hearing protection and, where required, regular hearing testing, which is adopted where technical or economic problems delay, or make impracticable, the reduction of exposure to excessive noise by engineering or administrative noise control measures.

‘personal hearing protectors’ means a device, or pair of devices, worn by a person or inserted in the ears of a person to protect the person’s hearing.

‘plant’ includes any machinery, equipment, appliance, implement, or tool and any component or fitting thereof or accessory thereto.

‘reverberation’ means the persistence, by echo or reflection, of sound in an enclosure after the emission by the source has stopped.

‘risk’ means the probability of harm occurring to the hearing of a person.

‘sound’ means small fluctuations in the air pressure that result in a wave capable of exciting in a listener the sensation of hearing.

‘sound exposure meter (SEM)’, or noise dosemeter, means an instrument for measuring a person’s daily noise exposure levels by automatically integrating sound energy over a measurement period. The instrument is worn by the person concerned.

‘sound level meter (SLM)’ means an instrument consisting of a microphone, amplifier and indicating device, having a declared performance, and designed to measure a frequency-weighted and time weighted value of the sound pressure level.

‘sound power’ means the total sound energy radiated per unit time. The standard units are watts (W).

‘sound power level’ means the relative magnitude of sound power, customarily expressed in decibels referenced to 1 picowatt.

‘sound pressure’ means the alternating component of the pressure at a point in a sound field. The standard units are Pascals (Pa).

‘sound pressure level (SPL)’ means the relative magnitude of sound pressure, customarily expressed in decibels referenced to 20 micropascals.

‘tinnitus’ means ringing or other noises in the head or ears which can be caused by exposure to excessive noise. Tinnitus can become permanent and when severe may disrupt sleep, reduce concentration and lead to irritability and depression. Tinnitus may lead to increased absenteeism and decreased productivity. It can also affect general job satisfaction and contribute to adverse health effects, such as, stress.

‘Workplace’ means a place, whether or not in an aircraft, ship, vehicle, building, or other structure, where employees or self-employed persons work or are likely to be in the course of their work.

A2.6 A suggested proforma for the presentation of information on noise levels generated by plant is shown below. However, the information may be presented in any convenient way that will bring it to the purchaser’s attention. For example, a catalogue or operating instructions would be suitable, provided the information is complete.

LEGISLATION –RELEVANT SECTIONS OF THE OCCUPATIONAL SAFETY AND HEALTH ACT 1984 AND THE OCCUPATIONAL SAFETY AND HEALTH REGULATIONS 1996

Duties of employers

Duties of employees

Duties of manufacturers, etc.

Responsibilities of persons who require personal protective clothing and equipment to be used.

NOISE HAZARD IDENTIFICATION CHECKLIST

Description of work location:

____

Task at workstation:

____

Assessed by:

____

Safety and Health Representative:

____

Date:

____

Yes to any of the following indicates the need for a detailed noise assessment.

1 Is a raised voice needed to communicate with someone about one metre away?

2 Do people working in the area notice a reduction in hearing over the course of the day? (This reduction might not be noticed until after work.)

3 Do employees experience any of the following:

(a) ringing in the ears (tinnitus),

(b) the same sound having a different tone in each ear (diplacusis),

(c) blurred hearing?

4 Are any long term employees hard of hearing?

5 Are personal hearing protectors provided?

6 Are signs, indicating that personal hearing protectors should be worn, posted at the entrance or in the work area?

7 Have there been any workers compensation claims for noise-induced hearing loss?

8 Does any equipment have manufacturer's noise information (including labels) that indicates noise levels equal or greater than any of the following:

(a) 80 dB(A) LAeq,

(b) 130 dB peak noise level,

(c) 88 dB(A) sound power level?

9 Do the results of audiometry indicate that past or present employees have hearing loss?

10 Does the noise in any part of the workplace sound as loud or louder than 85 decibels using the scale Decibel Levels of Common Sounds.

The physics of sound

'Sound is a compression wave motion moving in an elastic medium such as air causing energy to be transmitted away from the source by means of a series of changes in pressure known as sound waves. It is also sensation produced at the ear by the impact of the wave motion on our hearing mechanism. Sound is thus a propagation of energy waves in an elastic medium' **(**Joubert, 2007, p 1).

Instrumentation and measuring parameters

- 'Various important specifications and parameters are laid down in standards with regards to equipment used to measure noise, these include:

- Integrating Functions
- Type
- Weighting Networks
- Detector Characteristics’ **(**Joubert, 2007, p 3).

Integrating Functions

- ‘Measuring exposure to noise sometimes means that the exposure of workers must be determined for the duration of a full workday or eight hours. When the noise level remains constant over the period, the noise exposure can be determined by means of the basic sound level meter but where the noise level varies a lot during the period concerned, an integrating sound level meter should be used.
- The integrating sound level meter integrates sound energy over a relatively long term and divides the measured values by the period of the measurement to provide an integrated reading of the sound pressure level.
- The latter reading is known as the equivalent noise level (Leq) and is defined as the continuous noise level which, over a given period, has the same total energy as the actual fluctuating noise’ **(**Joubert, 2007, p 3).

Types of sound level meters (SLM)

- ‘SLM are classed into four types according to accuracy and sensitivity
- Type 0 – usually used in laboratories and have the highest sensitivity. They are used to calibrate other sound level meters.
- Type 1 – High sensitivity and used for workplace measurements usually by consultants and have an accuracy of +/- 0.7 dB.
- Type 2 –are cheaper and less accurate than type 1 and are used by in-house occupational hygienists.
- Type 3 – least accurate type and should not be used at all for noise surveys’ **(**Joubert, 2007, p 3) and other types include:
- Sound Level Meter.

- Personal Dosimeter.
- Acoustical Calibrator.
- Measures in Decibels' (A weighted) **(**Joubert, 2007, p 4).

Weighting Networks

- Sound level meters are equipped with various weighting networks which can be selected by means of a switch and which results in the sensitivity of the instruments varying with frequency and sound intensity.
- The weighting network (A) effectively filters out all sound frequencies that the human ear cannot normally hear, and measures the sound intensities at the frequencies that the human ear can hear.
- Sound levels are always recorded with weighting network used e.g.:
- dB (A)' (Joubert, 2007, p 4).
- A – weighting is used for TWA.
- C – weighting is used for peak levels (LCpeak) (Joubert, 2007).

Detector characteristics

- 'Sound level meters have different detector-indicator characteristics F, S, and I or P (fast, slow, impulse or peak) which are built into the electric circuit and which can be selected alternatively to influence the action of the detector according to the time-varying characteristics of the sound that is being investigated.
- International and national standards usually prescribe the detector to be used in a particular situation, but in general the F-characteristic is used for measuring continuous noise or when the highest value during the period of measuring is used to measure fluctuating noise, and the I-characteristic for impulse noise' (Joubert, 2007, p 4).

Calibration of instrumentation

- 'Calibration of SLMs is imperative to ensure that they are giving accurate and reliable results.
- Calibration is carried out using an acoustical calibrator which is in itself calibrated by an accredited laboratory (every two years).
- The calibrator should be of the same type as the SLM being calibrated.

- Secondary calibration is carried out before and after each set of sound level measurements on site to ensure the accuracy of the instrument' (Joubert, 2007, p 4).

Noise dosimeter

- 'Workers sometimes move around a lot in a plant and are thus exposed to varying noise levels. For this reason portable personal dosimeters have been developed which give a more accurate reflection of the individual's exposure to noise' (Joubert, 2007, p 5).

Application of Standards

- 'Each state and territory applies the national standards in codes of practice.
- LAeq, 8h is determined in accordance with part 1 of AS/NZS 1269.1:2005 Occupational Management – measurement and Assessment of Noise Emission and Exposure.
- Which lays down specific requirements for aspects including:
  - Types of Noise Assessment
  - Instrumentation and Calibration
  - Noise Measurement Procedures
  - Suggested Noise Report format etc.
  - Managing Noise at Workplaces' (Joubert, 2007, p 5).

Precautions during measurements

When conducting a noise survey be aware of interference from:

- Electrical and magnetic sources which can interfere with the proper functioning of the SLM and give incorrect results;
- Background noise that may give false indication of the real noise level e.g., lawnmower being used outside during the noise survey;
- Wind or air movement which can affect the pressure sensitive microphone and give incorrect results. Use a wind guard over the microphone if air velocity is high;

- Intrinsic safety requirements of the workplace and the instrument specifications;
- Excessive vibration should be avoided and the SLM should be isolated from high vibration sources;
- Temperature, humidity and pressure can also affect the SLM and extreme conditions should be avoided or suitable precautions taken. Always read the manual of the SLM you are using prior to use' **(**Joubert, 2007, p 5)

Employees who are moving around at the workplace and are exposed to different levels of noise during an 8 hour shift must wear a sound level meter (e.g., noise dosimeter) L_{Aeq}. L_{Aeq} will give a total noise exposure of the employee during the shift.

An average daily exposure to noise of 85 decibels in Australia has been recommended. For peak noise, the national standard is a peak sound pressure level of 140 decibels. Other administrative controls are audiometric testing and the selection of hearing protection devices. It should be noted that the use of hearing protection devices is not a rigorous form of noise management' **(**Joubert, 2007).

Audiometric testing

Section 10 of the Health and Safety of Employment Act 1992 requires that audiometric testing be organised at the beginning of employment and every twelve months for workers who are exposed to high levels of noise. **(**Joubert, 2007).

Safety hearing devices

Personal protection devices should be used as a last resort and thedisadvantage with their use is hygiene.The earplugs in particular can cause ear infections as they might be inserted with dirty hands and are susceptible to other environmental effects such as high humidity. They are also inexpensive and easy to use. The main types of hearing protection are earplugs, earmuffs, canal caps and acoustic helmets. When hearing protection is used by workers, their interference with other protective clothing such as glasses or helmets must be considered. This might be uncomfortable for workers and might lead to accidents. All hearing devices must comply with AS1270and their selection should comply with AS/NZS1269.3: There are three methods:

1. Classification method ($L_{Aeq,8hr} \leq 110$ dB (A));
2. Octave-band method ($L_{Aeq,8hr} \geq 110$ dB (A));
3. SLC_{80} procedure.

The safety hearing devices must be checked regularly for their correct use, suitability, comfort of use, damage or wear, and every time they are used (Tranter, 2004).

Appendix AA Section 3

Vibration

Vibration is defined as an oscillation of a system around a central point, so in the case of whole-body vibration (WBV) it is the movement of a person's whole body, usually in a standing or seated position around a central neutral point in all directions, or in the case of hand-arm vibration (HAV), it is the movement of a person's hand-arm system around a central neutral point (Joubert, 2007).

Vibration is like noise in terms of amplitude, frequency and phase (Cole, 1992, cited in Bridger, 2003).Vibration is measured using accelerometers placed in the workplace or on seats where exposure measurement is required. Accelerometers are placed such that vibration can be measured in three translational axes (pitch, yaw and roll). Vibration in the vertical plane is usually weighted most highly when the outputs of the different accelerometers are combined (e.g., see ISO 2631-1: 1997) (Bridger, 2003).

According to Tranter (2004), acceleration is measured using a transducer or pick-up that is located at the source of the vibration. The most common type of transducer is a piezoelectric accelerometer.

Measurement of whole-body vibration is done using a tri-axial seat accelerometer that is usually moulded into a rubber pad. This is placed on the point where the vibration is generated and/or transmitted. For the measurement of hand and arm vibration, the accelerometer is mounted into a 'ring' shape and is slipped on the finger. The vibration is also measured in three axes, X, Y and Z.

More advanced methods of vibration measurement also exist, such as the fourth power vibration dose method for calculating vibration dose values. The fourth power vibration dose method is more sensitive to peaks than the basic evaluation method due to using the fourth power instead of the second power of the acceleration time history as the basis for averaging. The fourth power vibration dose value (VDV) $m/s^{1.75}$ (Joubert, 2007).

Measurement methods for WBV

WBV is measured internationally in accordance with ISO 2631-1:1997 (E) Mechanical Vibration and Shock – Evaluation of Human Exposure to Whole-body Vibration Part 1 General Requirements. The Australian standards are directly based on this, as AS/NZS 2607.1 2001 Evaluation of Human Exposure to Whole-body Vibration Part 1: General Requirements (Joubert, 2007).

Measurement method for HAV

HAV is measured internationally in accordance with ISO 5349 *Mechanical Vibration – Guidelines for the Measurement and the Assessment of Human Exposure to Hand-Transmitted Vibration*, on which the Australian standards are directly based as AS/NZS 2763:1998 *Vibration and Shock – Hand Transmitted Vibration Guidelines for Measurement and Assessment of Human Exposure*.

Musculoskeletal injury arising from WBV is already a recognised occupational disease in some countries in Europe and HAV is also a compensable condition (Joubert, 2007).

Vibration frequencies

The number of cycles that occur in one second determine the frequency, expressed in cycles per second or Hertz (Hz).Usually vibration differs from noise in that it is the relatively low frequencies that are of interest for whole-body vibration (WBV) (1–80 Hz), and higher frequencies of 30–1000 Hz for hand-arm vibration (HAV)(Joubert, 2007).

The whole-body vibration hazard (specific challenges)

There is a very unclear dose-response relationship for vibration and so it has been difficult to set single digit exposure limits, and ranges of exposure or guidance limits have had to be used in the past.

WBV is a ‘generalised stressor’ impinging on many organs and systems in the body simultaneously and it is difficult to attribute specific effects to exposure, and therefore not easy to see cause and effect or implement controls (Joubert, 2007).

Appendix AA Section 4

Lighting

Units of measurement

Lighting compliance or design requirements are in accordance with the AS1680 series for interiors and workplaces. The energy output of light is quantified in industry according to the following:

- Luminous intensity

  This is the output energy from the light source measured in candela (cd).

- Illuminance

  Illuminance is the quality of light when it falls on any surfaces, reflectance from surfaces and glare. It is measured by luxmeter (lightmeter), the unit is lux, and the assessment is in accordance with AS1680.1. The luxmeter must have a great degree of accuracy. The minimum number of measurements for 10% accuracy is given in Appendix B of AS1680.1.

- Luminance

  This is the light energy reflected from any surfaces and the unit is candela/m^2 (cd/m^2).

- Luminous flux

  'The flux emitted by one candela uniform point source within a unit sold angle. The unit is the lumen (lm)' (Tranter, 2004, 279).

Appendix AA Section 5

‘Skin’ notations for chemical hazards

Some chemicals may have a skin notation which indicates the possibility of significant dermal absorption. That is the airborne exposure standard may not offer adequate protection because the chemical readily penetrates the skin. This is designed as ‘*SK’* or ‘*SKIN’*. Controls aimed at minimising skin contact and skin absorption should thus be implemented (Joubert, 2007).

Biological exposure indices (BEI)

Physiological uptake of hazardous chemical exposures may vary from person to person. The aim of biological monitoring is to assess total absorption by the body from all routes of exposure. The definition of biological monitoring is the measurement and evaluation of a hazardous substance or its metabolites in a person’s body tissues, fluids or exhaled air (Occupational Safety and Health Regulations 1996 (WA)).For lead exposure it is usually obtained through taking biological samples from the worker such as blood, urine, hair, exhaled breath etc., and analysis is usually carried out to detect the levels of chemical itself in the sample, or the metabolites of the chemical. BEI’s are usually set in legislation for specific chemicals in order to gain a better understanding of worker exposure and early detection of excessive exposures (Joubert, 2007).

Appendix AA Section 6

Measuring the thermal environment

Dose

The dose of a hazardous substance or physical hazard is generally expressed with the following equation:

Dose = concentration (level) x duration of exposure

It is a fundamental principle on which occupational hygiene exposure standards are based (Joubert, 2007).

Time weighted average (TWA)

TWA is based on the different tasks a particular person may perform over the course of a shift (Bates, 2007).Time-weighted average (TWA) concentration is the average airborne concentration of a substance during an eight hour working day and five day working week to which most workers can be exposed repeatedly day after day without adverse effects or ill health. TWA exposure limits are based on:

- Eight hour shifts (not directly applicable to extended shifts, and require recalculation for longer exposure);
- Five day working week;
- Exposure-free periods of 16 hours for body recovery and metabolism and elimination of chemicals;
- Averaged out exposure over the eight hour period.

Allowances are made for peaks in exposure above the TWA level (known as excursions) if no maximum limit is set, but these generally should not exceed the TWA exposure level by more than three times for not more than 30 minutes per day and excursions should never exceed the TWA by more than five times(Joubert, 2007).

National exposure standards

The workplace exposure standard is the level of exposure to a particular substance or physical hazard which should not cause adverse health effects or undue discomfort to most people (Bates, 2001).

Time-weighted level (TWL)

TWL is defined as the maximum sustainable metabolic rate that euhydrated, clothed, acclimatised individuals can maintain in a specific thermal environment, whilst maintaining a safe deep core temperature. It has been developed using published experimental studies of human heat transfer, and established equations for heat and moisture transfer through clothing. Clothing parameters can be varied and the protocol can be extended to unacclimatised workers. The protocols are designed specifically for self-paced workers and do not require estimation of actual metabolic rates in the workplace, a process that is subject to considerable error. The index has been introduced into several large industrial operations and has resulted in a substantial reduction in the incidence of heat illness. TWL has applications for professionals from both the human and engineering sciences as it allows not only thermal strain to be evaluated, but also allows the productivity decrement due to heat (seen as a reduced sustainable metabolic rate) and the direct impact of various strategies using improved local ventilation or refrigeration on worker performance to be quantitatively evaluated. The result of these studies has been published (Brake and Bates, cited in Bates, 2007).

Short-term exposure limit (STEL)

The short-term exposure limit is the maximum concentration of a substance to which a worker may be exposed for 15 minutes without suffering irritation, chronic or irreversible damage to tissue, or narcosis to a sufficient degree to increase workplace accidents, impair self-rescue or impair work performance. It is set for substances that cause discomfort, irritation, narcosis or tissue damage from short-term exposure, e.g., ammonia, chlorine gas (usually gases and vapours).STELs supplement the TWAs, and about 140 substances in Australia have STELs (Joubert, 2007).

STEL criteria

- No more than four excursions to the STEL are allowed per day;
- Allow at least 60 minutes between STEL excursions;
- The overall eight hour TWA must not be exceeded (Joubert, 2007).

Peak exposure limits

The peak exposure limit is known as peak limitation in Australia and is the maximum allowable concentration of a substance to which exposure should never be exceeded even instantaneously. It is also known as the ceiling concentration (USA) or maximum allowable concentration and is used for fast acting substances, irritants and corrosives e.g., formaldehyde, hydrocyanic acid and chlorine. There are 42 substances with peak limitations in Australia (Joubert, 2007).

Wet bulb globe temperature (WBGT)

This index is calculated by measuring the natural wet bulb globe temperature and dry bulb temperature. The calculated WBGT values are compared to reference values corresponding to different metabolic workloads to establish whether the environment is excessive given the task being performed. The value is a time weighted average (TWA) based on the different tasks a particular person may perform over the shift (Bates, 2007.

Dry-bulb temperature (DBT)

Dry-bulb temperature (DBT) is the temperature of the constituent gases of the air. Although DBT indicates the thermal state of the air, other factors have an equally important effect on heat gain or loss (Bates, 2007).

VO2 (aerobic capacity)

Exercise physiologists and sports scientists have used the term ‘VO2 max’ to describe an individual’s capacity to utilise oxygen (aerobic capacity). The VO2 max has traditionally been estimated by having subjects run on a treadmill or pedal a bicycle ergometer while their oxygen uptake is measured. The running or cycling speed is increased in an incremental manner and oxygen uptake is measured approximately every 3–5 minutes after the subject has adapted to each new work rate. As might be expected, it is observed that oxygen uptake increases as the work rate is increased (Bridger, 2003).

Basal metabolic rate

The basal metabolic rate (BMR) is the rate of energy consumption necessary to maintain life (Bridger, 2003).

Appendix B

The Figures and Tables in Appendix B are from chapter 4.

Figures

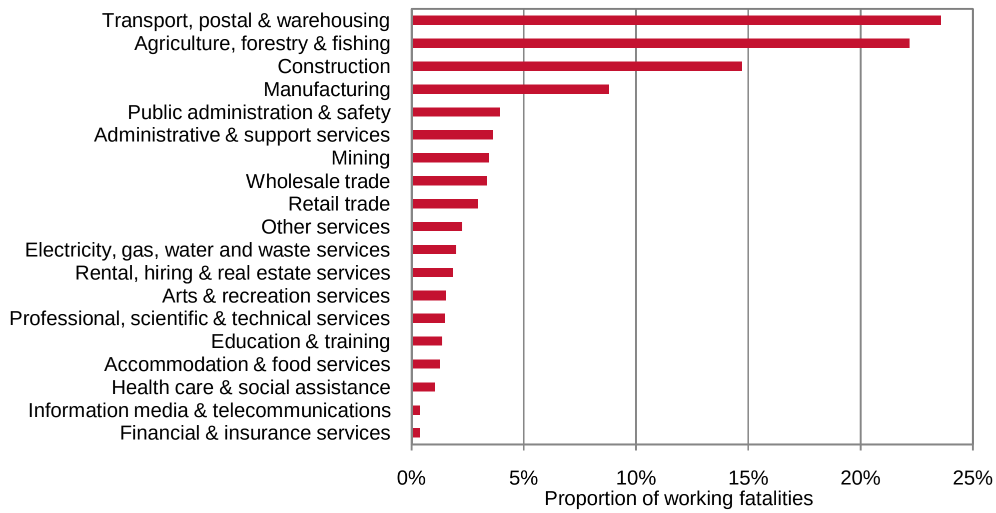

Figure B.1: Worker fatalities: by industry Australia, 2003–04to 2009–10 combined (Safe Work Australia, 2012)

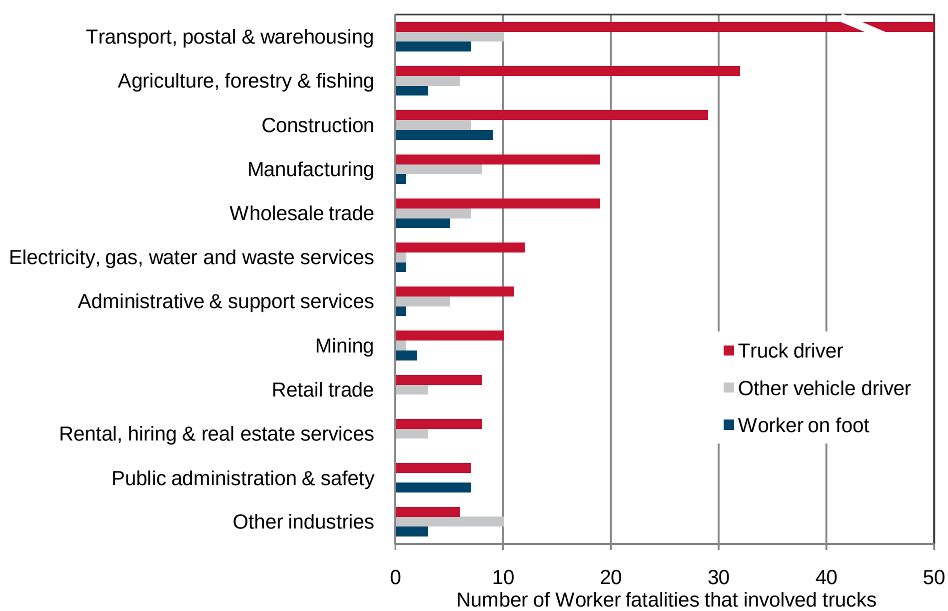

Figure B.2: Work-related fatalities: by vehicle type, Australia, 2003–04 to 2009–10 combined (Safe Work Australia, 2012)

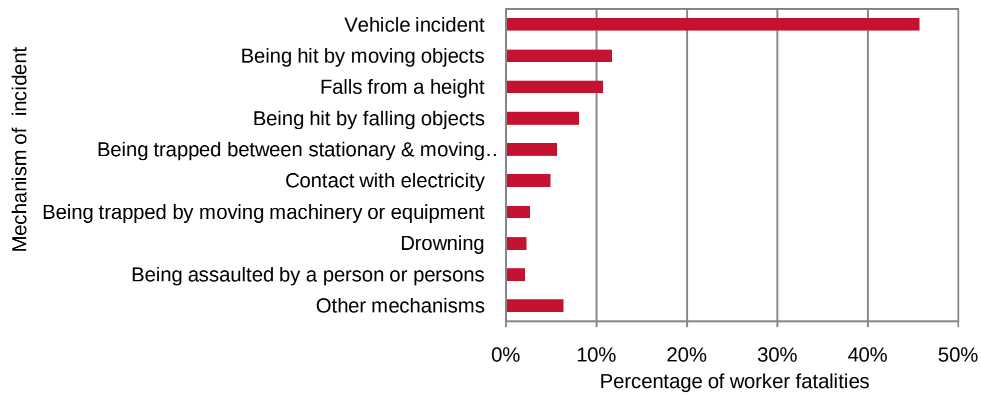

Figure B.3: Worker fatalities: Mechanism of incident, Australia, 2003–04 to 2009–10 combined *(Safe Work Australia, 2012)*

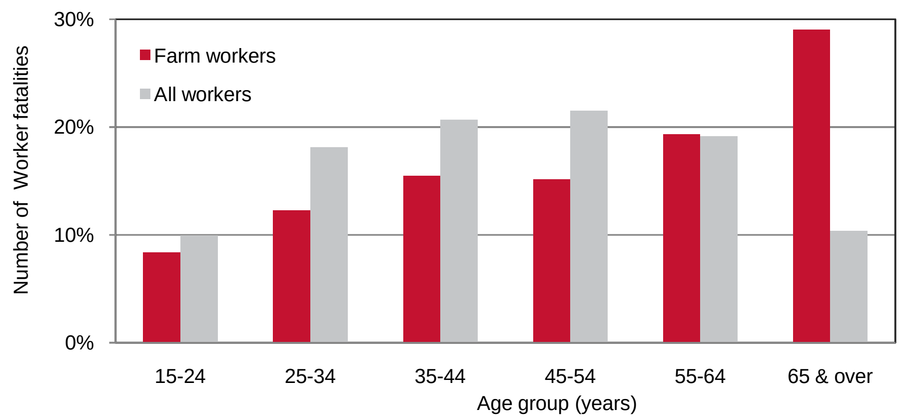

Figure B.4: Worker fatalities on farms: age group, Australia, 2003–04 (Safe Work Australia, 2012).

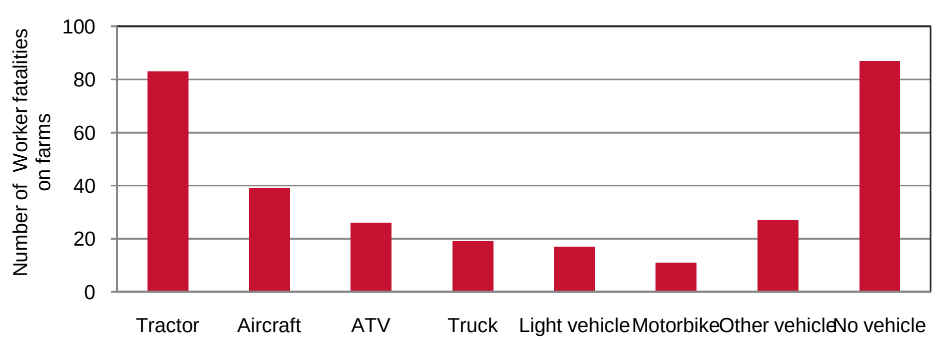

Figure B.5: Worker fatalities on farms: Australia, 2003–04 to 2009–10 combined (Safe Work Australia, 2012)

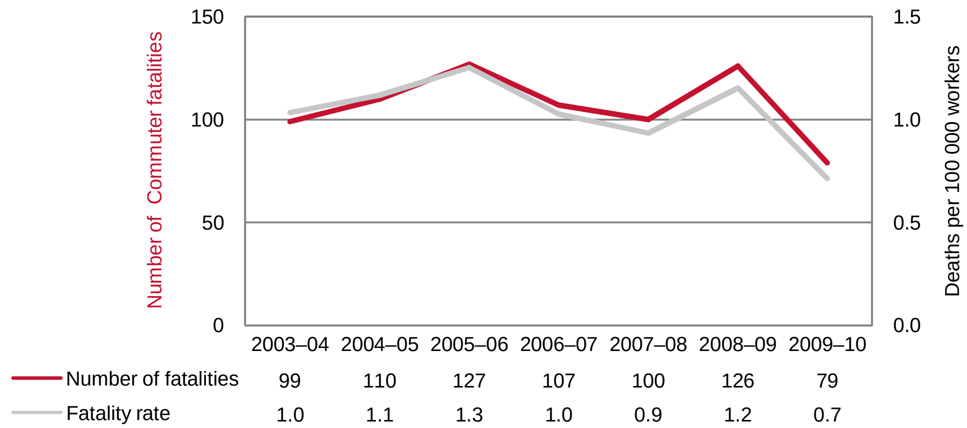

Figure B.6: Commuter fatalities: Australia, 2003–04 to 2009–10 (Safe Work Australia, 2012)

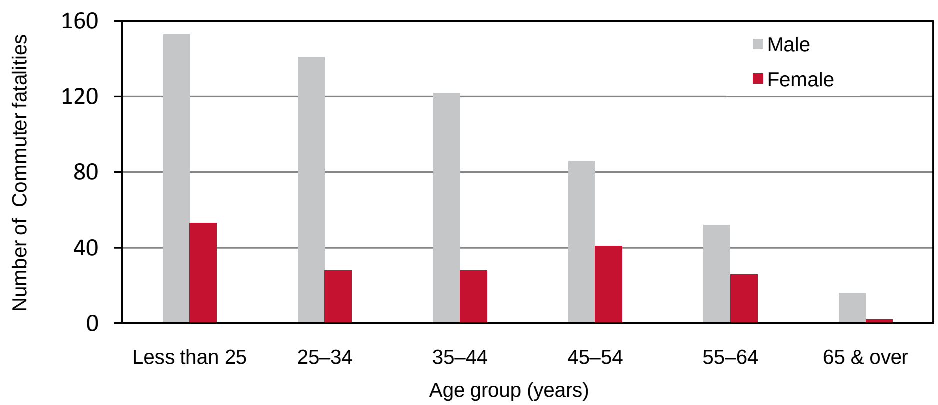

Figure B.7: Commuter fatalities: Australia, 2003-04 to 2010 combined (Safe Work Australia, 2012)

Figure B.8: Work-related fatalities in W.A. from 2000-2001 to 2012-2013(State of the Work Environment, 2013)

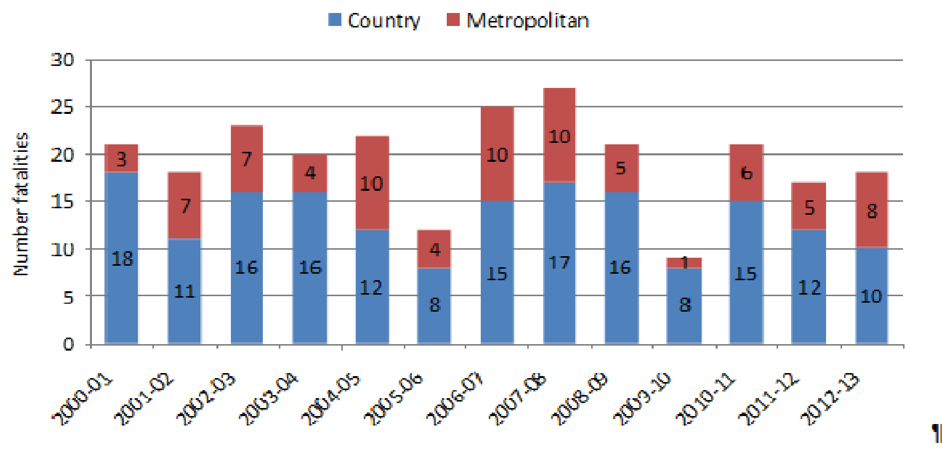

Figure B.9: Traumatic work-related fatalities by WA region (State of the Work Environment, 2013)

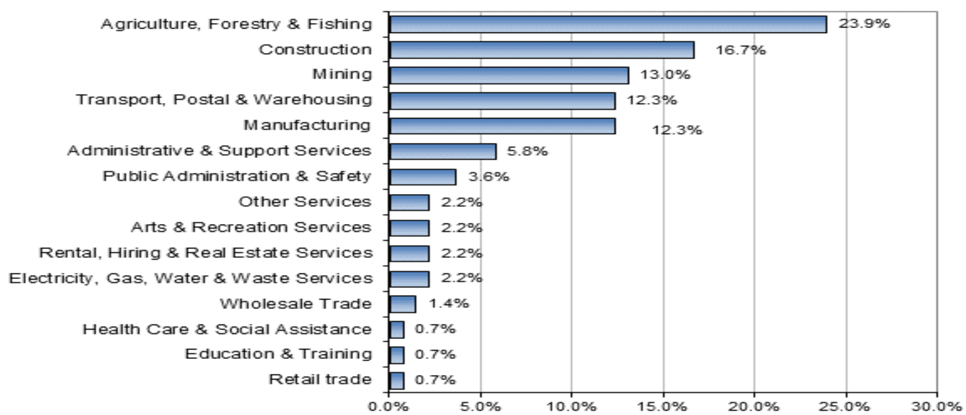

Figure B.10: Work-related fatalities by industry 2006-2007 to 2012-2013 (State of the Work Environment, 2013)

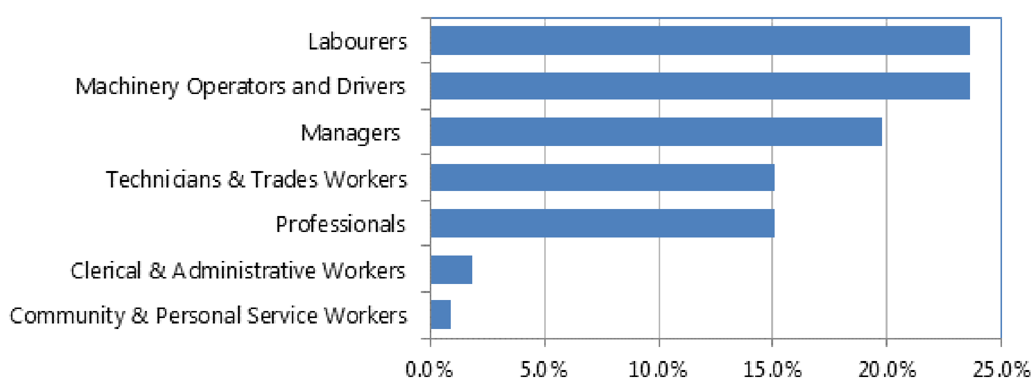

Figure B.11: Work-related fatalities in WA 2006-07 to 2012-013 by major occupation group

Source: State of the Work Environment

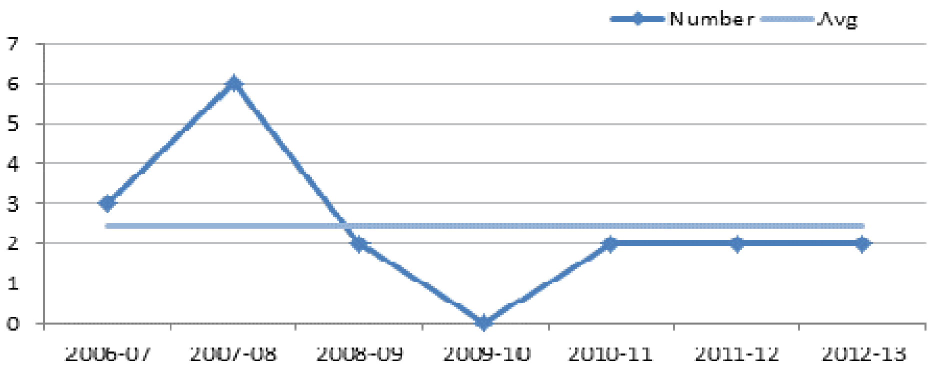

Figure B.12: Truck driver work-related fatalities

Source: State of the Work Environment

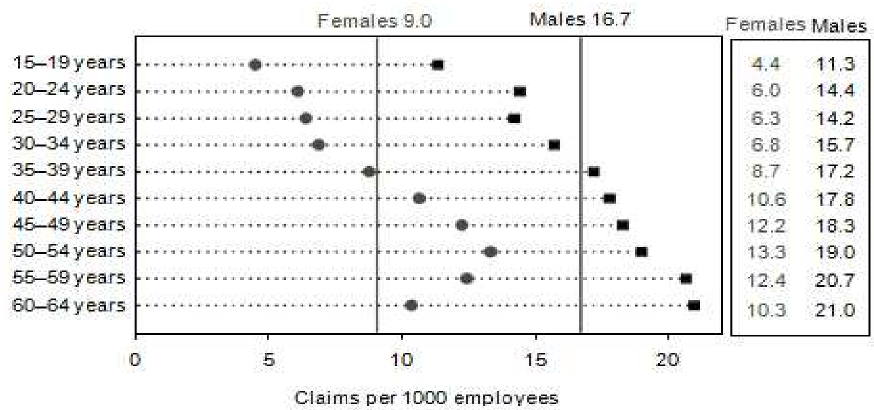

Figure B.13: Serious claims: incidence rate by sex and age, 2008–09(Safe Work Australia, 2011)

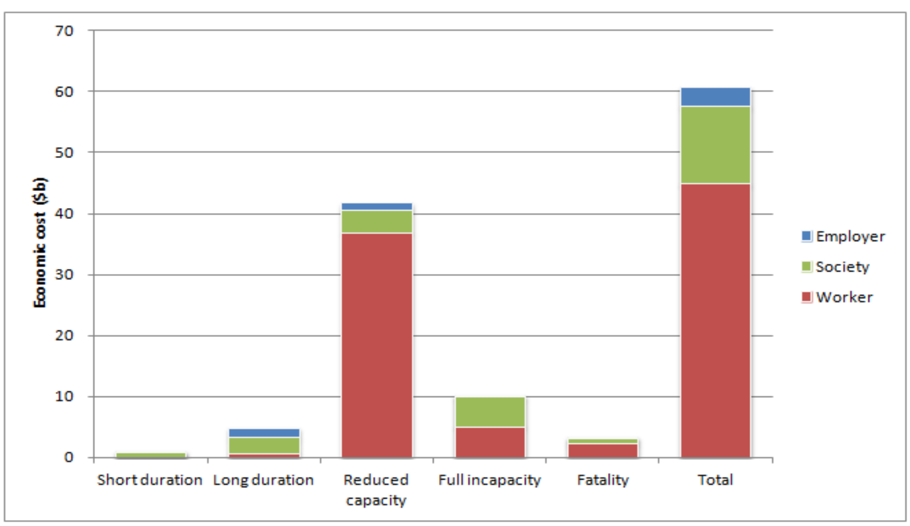

Figure B.14: Distribution of total costs of work-related accidents Australia, 2008–09 (Safe Work Australia, 2008-09)

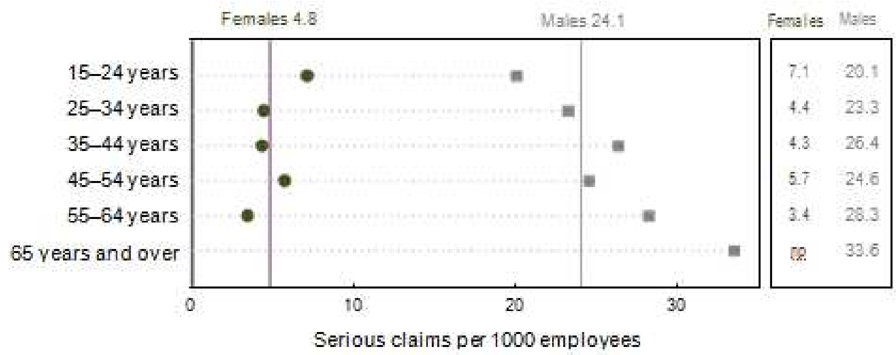

Figure B.15: Construction: incidence rate by sex and age, 2008–09 (Safe Work Australia, 2011)

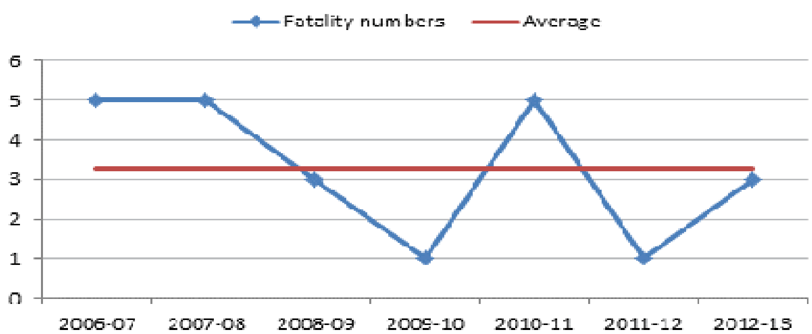

Figure B.16: Construction fatalities Western Australia 2006-07 to 2012-13 (State of the Work Environment, 2013)

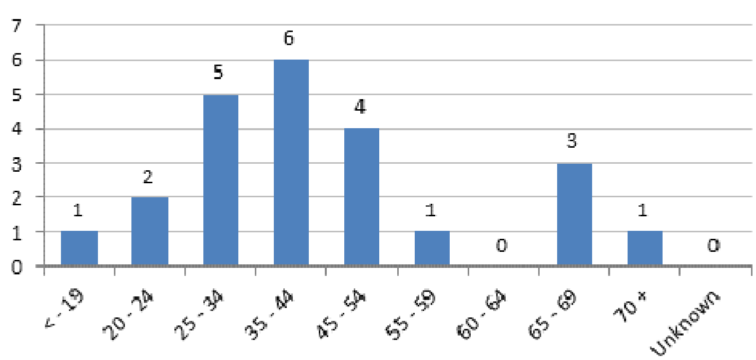

Figure B.17: Construction work-related fatalities by age group 2006-2007 to 2012-2013

Tables

The Tables in Appendix B are from chapter 4.

Table B1: Mental stress claims: 2003-04 and 2004-05 combined

Industry	Number of claims			%	Frequency rate(a)	
	Males	Females	Total		Males	Females
Health & community services	805	2 675	3 480	21.1	122	135
Education	920	2 145	3 065	18.6	116	151
Personal & other services	1 050	750	1 795	10.9	177	181
Government administration & defence	605	840	1 450	8.8	74	120
Retail trade	460	800	1 260	7.7	23	51
Property & business services	450	640	1 090	6.6	20	44
Transport & storage	805	210	1 015	6.2	70	67
Manufacturing	550	340	895	5.4	20	43
Accommodation, cafes & restaurants	270	360	630	3.8	42	57
Finance & insurance	130	460	585	3.6	22	77
Wholesale trade	200	170	370	2.2	19	48
Construction	240	50	285	1.7	13	29
Cultural & recreational services	105	120	225	1.4	31	42
Communication services	50	65	115	0.7	14	38
Mining	55	15	65	0.4	15	34
Agriculture, forestry & fishing	30	35	65	0.4	6	24
Electricity, gas & water supply	45	15	60	0.4	19	36
Total mental stress claims(b)	**6 760**	**9 695**	**16 455**	**100.0**	**40**	**87**

(a) Calculated as the number of claims per 100 million hours worked.
(b) Includes mental stress claims for which industry was not stated.

Source: compendium of workers' compensation statistics

Table B2: Notification by mechanism of incident (scheme) 2011-12

Mechanism of incident	Incident type					
	Death	Employee incapacity	Dangerous incident/ Dangerous occurrence	Serious injury or illness/ Serious personal injury	Total	% of all notifications
Being hit by moving objects	4	1	516	334	855	21%
Vehicle incidents and other	27	3	400	301	731	18%
Mental stress	6	10	339	290	645	16%
Falls, trips and slips of a person	2	2	206	401	611	15%
Heat, electricity and other environmental factors	1	0	361	76	438	11%
Chemicals and other substances	0	0	221	75	296	7%
Hitting objects with a part of the body	0	1	53	187	241	6%
Body stressing	0	12	74	120	206	5%
Biological factors	0	1	30	42	73	2%
Sound and pressure	0	0	57	5	62	1%
All mechanisms of incident	40	30	2257	1831	4158	100%

Source: Australian Government Safety, Rehabilitation and Compensation Commission .Compendium of WHS and Workers' Compensation Statistics: December 2011-2012

Table B3: Fatalities caused by work-related diseases and accidents, year 2000 (ILO, 2003)

	Economically active population	Total employment	**Global Estimates Total Work-related Fatalities**	**Global Estimates** Fatal Accidents	Fatal accidents reported to the ILO
ESTABLISHED MARKET ECONOMIES	409'141'496	380'833'643	**297'534**	16'170	14'608
FORMERLY SOCIALIST ECONOMIES	184'717'127	162'120'341	**166'265**	21'425	8'665
INDIA	458'720'000	419'560'000	**310'067**	48'176	211
CHINA	708'218'102	699'771'000	**460'260**	73'615	17'804
OTHER ASIA AND ISLANDS	404'487'050	328'673'800	**246'720**	83'048	5'631
SUB-SAHARAN AFRICA	260'725'947	10'540'604	**257'738**	54'705	1'675
LATIN AMERICA AND THE CARIBBEAN	193'426'602	114'604'962	**137'789**	29'594	6'998
MIDDLE EASTERN CRESCENT	112'906'300	48'635'240	**125'641**	28'019	1'876
WORLD	**2'732'342'624**	**2'164'739'590**	**2'001'717**	**354'753**	**57'468**

Table B4: Worker fatalities: industry of employer, Australia, 2003–04 to 2009–10 (Safe Work Australia, 2012)

Industry of workplace	Year						
	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10
Agriculture, forestry & fishing	41	38	33	26	26	45	28
Construction	23	18	25	29	38	27	21
Manufacturing	7	6	20	18	18	13	16
Transport & storage	9	21	18	23	26	18	13
Mining	11	9	11	13	4	16	6
Property & business services	0	4	1	1	2	4	4
Retail trade	3	2	7	3	3	6	4
Wholesale trade	1	1	1	3	3	5	4
Accommodation, cafes & restaurants	1	2	2	4	0	2	3
Government administration & defence	1	7	6	2	3	4	3
Personal & other services	7	4	5	6	1	4	1
Communication services	2	0	2	0	2	1	0
Cultural & recreational services	0	5	0	7	3	1	0
Education	2	1	3	1	0	0	0
Electricity, gas & water supply	3	4	3	1	2	4	0
Finance & insurance	0	0	0	0	0	0	0
Health & community services	1	1	1	0	2	0	0
Private residence	*4*	*1*	*3*	*5*	*1*	*1*	*6*
Industry unknown or not applicable	*2*	*2*	*2*	*7*	*0*	*0*	*2*
Total	**118**	**126**	**143**	**149**	**134**	**151**	**111**
Fatality rate(b)	1.2	1.3	1.4	1.4	1.3	1.4	1.0
Fatalities due to public road & air crashes	1	11	4	11	18	23	15
Total excluding public road & air crashes	117	115	139	138	116	128	96
Fatality rate(b) excluding public road & air crashes	1.2	1.2	1.4	1.3	1.1	1.2	0.9

Table B5: Worker fatalities: state/territory of death, Australia, 2003–04 to 2009–10 (Safe Work Australia, 2012)

State/territory of death	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10
				Non-traffic incident			
New South Wales	56	43	66	64	52	46	38
Victoria	32	34	30	41	36	34	31
Queensland	45	43	51	44	47	48	38
Western Australia	29	19	15	25	34	30	14
South Australia	16	9	18	9	11	19	9
Tasmania	7	8	8	9	8	7	3
Northern Territory	7	4	6	1	6	6	6
Australian Capital Territory	1	2	2	1	0	2	0
Australia	**193**	**162**	**196**	**194**	**194**	**192**	**139**
				Traffic incident			
New South Wales	31	33	33	30	28	35	23
Victoria	26	21	24	31	16	21	15
Queensland	8	18	23	26	31	25	14
Western Australia	7	10	3	13	8	7	15
South Australia	2	4	4	1	6	0	5
Tasmania	2	2	3	2	4	7	3
Northern Territory	3	3	1	2	4	2	2
Australian Capital Territory	0	0	0	1	1	0	0
Australia	**79**	**91**	**91**	**106**	**98**	**97**	**77**
				All Worker fatalities			
New South Wales	87	76	99	94	80	81	61
Victoria	58	55	54	72	52	55	46
Queensland	53	61	74	70	78	73	52
Western Australia	36	29	18	38	42	37	29
South Australia	18	13	22	10	17	19	14
Tasmania	9	10	11	11	12	14	6
Northern Territory	10	7	7	3	10	8	8
Australian Capital Territory	1	2	2	2	1	2	0
Australia	**272**	**253**	**287**	**300**	**292**	**289**	**216**

Table B6: Worker fatalities: state/territory, Australia, 2003–04 to 2009–10 combined (Safe Work Australia, 2012)

Industry	**New South Wales**	**Victoria**	**Queens-land**	**Western Australia**	**South Australia**	**Tasmania**	**Northern Territory**
			Number of deaths while working				
Transport, postal & warehousing	151	94	113	43	28	13	7
Agriculture, forestry & fishing	102	88	106	48	27	33	17
Construction	89	54	81	26	16	4	8
Manufacturing	56	47	27	24	8	5	1
Retail trade	27	14	8	6	1	0	0
Wholesale trade	26	15	15	5	1	1	0
Public administration & safety	21	15	16	7	3	7	6
Administrative & support services	21	7	22	10	4	1	3
Mining	7	5	15	25	11	1	2
Other industries	78	53	58	35	14	8	9
Total	**578**	**392**	**461**	**229**	**113**	**73**	**53**
			Percentage				
Transport, postal & warehousing	26%	24%	25%	19%	25%	18%	13%
Agriculture, forestry & fishing	18%	22%	23%	21%	24%	45%	32%
Construction	15%	14%	18%	11%	14%	5%	15%
Manufacturing	10%	12%	6%	10%	7%	7%	2%
Retail trade	5%	4%	2%	3%	1%	0%	0%
Wholesale trade	4%	4%	3%	2%	1%	1%	0%
Public administration & safety	4%	4%	3%	3%	3%	10%	11%
Administrative & support services	4%	2%	5%	4%	4%	1%	6%
Mining	1%	1%	3%	11%	10%	1%	4%
Other industries	13%	14%	13%	15%	12%	11%	17%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table B7: Fatalities due to traffic incident and mechanism of incident, Australia, 2009–10 (Safe Work Australia, 2012)

Traffic incident status and Mechanism	**Truck driver**	**Truck passenger**	**Car driver**	**Worker on foot**	**Total**
Traffic incident	**39**	**2**	**11**	**1**	**53**
Hit by moving vehicles	*1*	*0*	1	*1*	*3*
Vehicle incident	*38*	*2*	10	*0*	*50*
Not a traffic incident	**10**	**0**	**0**	**7**	**17**
Fall from a height	*2*	*0*	0	*0*	*2*
Hit by falling objects	*2*	*0*	0	*3*	*5*
Hit by moving objects	*1*	*0*	0	*3*	*4*
Vehicle incident	*2*	*0*	0	*0*	*2*
Other mechanism	*3*	*0*	0	*1*	*4*
Total	**49**	**2**	**11**	**8**	**70**

Table B8: Worker fatalities: mechanism of incident, Australia, 2003–04 to 2009–10

Mechanism of incident	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10
Vehicle incident	120	123	124	122	146	135	100
Traffic incident	*72*	*86*	*80*	*98*	*94*	*87*	*73*
Aircraft crash	*20*	*15*	*22*	*5*	*15*	*20*	*15*
Rollover	*11*	*12*	*7*	*7*	*16*	*10*	*7*
Falls from a height	24	25	32	38	28	33	24
Buildings & other structures	*12*	*3*	*9*	*5*	*4*	*8*	*5*
Ladders	*1*	*3*	*5*	*6*	*8*	*6*	*4*
Horses	*2*	*4*	*2*	*5*	*2*	*1*	*1*
Trucks, semi-trailers & lorries	*1*	*3*	*2*	*3*	*1*	*3*	*1*
Scaffolding	*1*	*1*	*1*	*3*	*1*	*3*	*3*
Being hit by moving objects	45	21	35	31	32	36	23
Hit by vehicle	*22*	*12*	*23*	*19*	*25*	*23*	*15*
Being hit by falling objects	16	26	22	26	24	22	18
Contact with electricity (electrocution)	11	18	19	15	9	9	13
Being trapped between stationary & moving objects	20	12	18	26	9	13	9
Being trapped by moving machinery or equipment	4	6	5	10	11	8	7
Drowning/ immersion	8	3	3	7	6	13	3
Being assaulted by a person or persons	10	6	8	8	2	4	2
All other mechanisms	14	13	21	17	25	16	17
Total	**272**	**253**	**287**	**300**	**292**	**289**	**216**

Table B9: Commuter fatalities: by occupation, Australia, 2003–04 to 2009–10 (Safe Work Australia, 2012)

Occupation	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10
	Number of commuter deaths						
Technicians & trades workers	18	24	28	26	24	29	18
Labourers	22	22	35	22	23	31	16
Community & personal service workers	7	15	7	8	10	8	12
Machinery operators & drivers	14	14	19	17	15	21	11
Professionals	15	12	12	6	14	16	9
Sales workers	2	7	8	10	4	7	4
Managers	8	12	9	9	3	5	4
Clerical & administrative workers	12	3	8	9	6	9	3
Unstated	1	1	1	0	1	0	2
Total	**99**	**110**	**127**	**107**	**100**	**126**	**79**

Table B10: Commuter fatalities: by industry of employer, Australia, 2003–04 to 2009–10 (Safe Work Australia, 2012)

Industry of employer	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10
	Number of commuter deaths						
Manufacturing	15	13	27	22	17	31	11
Retail trade	6	11	10	7	8	10	9
Construction	9	9	19	8	12	15	8
Public administration & safety	3	13	7	5	4	8	7
Accommodation & food services	6	10	7	9	7	6	5
Agriculture, forestry & fishing	7	6	7	7	4	11	5
Health care & social assistance	12	6	1	6	3	7	5
Mining	2	3	4	4	3	6	4
Transport, postal & warehousing	7	5	8	13	5	4	4
Other services	1	3	2	5	4	4	3
Rental, hiring & real estate services	0	3	0	3	2	1	3
Administrative & support services	7	6	9	8	8	6	2
Wholesale trade	5	7	7	2	5	3	2
Education & training	5	3	5	2	7	4	1
Professional, scientific & technical services	9	2	5	1	4	6	0
Other and unknown industries[(a)]	5	10	9	5	7	4	10
Total	**99**	**110**	**127**	**107**	**100**	**126**	**79**

Includes Electricity, gas, water & waste services; Arts & recreation services; Rental, hiring & real estate services; Financial & insurance services; and Information media & telecommunications

Table B11: Bystander fatalities: by age group, Australia, 2003–04 to 2009–10 (Safe Work Australia, 2012)

Age group	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10
Under 15 years	15	12	11	25	17	10	15
15–24 years	4	4	7	1	6	14	4
25–34 years	6	8	5	4	6	6	5
35–44 years	7	10	2	5	4	4	4
45–54 years	4	5	2	12	8	3	3
55–64 years	7	6	10	3	4	3	5
65 years and over	8	10	13	9	10	4	6
Total	**51**	**55**	**50**	**59**	**55**	**44**	**42**

Table B12: Bystander fatalities: mechanism of incident and breakdown agency, Australia, 2003–04 to 2009–10 combined (Safe Work Australia, 2012)

Mechanism of incident/ Breakdown agency	Number of deaths	Percentage
Vehicle incident	190	53%
Truck	*95*	27%
Car or other light vehicle	*38*	11%
Aircraft	*25*	7%
Bus	*10*	3%
Other	*22*	6%
Being hit by moving objects	67	19%
Truck	*30*	8%
Car or other light vehicle	*21*	6%
Drowning/immersion	34	10%
Drowned in farm dams	*13*	4%
Fell from working watercraft	*9*	3%
Drowned in swimming pools	*7*	2%
Falls	24	7%
Being hit by falling objects	16	4%
All other mechanisms	25	7%
Total Bystander deaths	**356**	**100%**

Table B13: Work-related fatalities by industry division 2006-07 to 2012-13 (State of the Work Environment, 2013)

Industry (ANZSIC 2006)	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	Total
Agriculture, Forestry & Fishing	3	6	4	5	4	5	6	**33**
Mining	4	2	6	2	2	2	0	**18**
Manufacturing	2	3	3	0	4	2	3	**17**
Electricity, Gas, Water & Waste Services	0	2	1	0	0	0	0	**3**
Construction	5	5	3	1	5	1	3	**23**
Wholesale Trade	0	0	0	0	0	1	1	**2**
Retail trade	0	0	0	0	1	0	0	**1**
Accommodation & Food Services	0	0	0	0	0	0	0	**0**
Transport, Postal & Warehousing	2	6	2	1	2	2	2	**17**
Information Media & Telecommunications	0	0	0	0	0	0	0	**0**
Financial & Insurance Services	0	0	0	0	0	0	0	**0**
Rental, Hiring & Real Estate Services	1	0	0	0	1	1	0	**3**
Professional, Scientific & Technical Services	0	0	0	0	0	0	0	**0**
Administrative & Support Services	2	2	2	0	1	1	0	**8**
Public Administration & Safety	1	1	0	0	0	2	1	**5**
Education & Training	1	0	0	0	0	0	0	**1**
Health Care & Social Assistance	0	0	0	0	0	0	1	**1**
Arts & Recreation Services	2	0	0	0	1	0	0	**3**
Other Services	2	0	0	0	0	0	1	**3**
Total	**25**	**27**	**21**	**9**	**21**	**17**	**18**	**138**

Table B14: work-related fatality categories in WA: 2006-07 to 2012-2013(State of the Work Environment, 2013)

	*Electrocution**	*Falls from height**	*Forklifts*	*Tractors*	*Mobile plant* (incl tractors)*	*ATV*	*Aircraft*	*Cranes*
2006-07	3	2	1	0	3	0	0	0
2007-08	0	3	2	1	5	0	5	1
2008-09	1	3	0	0	3	1	3	0
2009-10	0	4	0	0	1	0	3	0
2010-11	0	7	1	1	1	1	1	0
2011-12	0	0	0	1	3	0	1	2
2012-13	1	0	0	1	3	0	0	0
Total	5	19	4	4	19	2	13	3

*Denotes a WorkSafe priority area

Table B15: Serious claims: by industry and sex, 2008–09(Safe Work Australia, 2011)

Industry	Females	Males	Total	Females	Males	Total
Manufacturing	3320	19190	22510	8%	22%	17%
Health& community services	12930	3255	16185	30%	4%	13%
Construction	395	14345	14740	1%	17%	11%
Retail trade	6225	6770	12995	15%	8%	10%
Transport & storage	1135	9730	10865	3%	11%	8%
Property& business services	2815	6270	9085	7%	7%	7%
Education	2940	3480	5205	7%	4%	5%
Government administration & defence	1190	5155	6420	3%	6%	5%
Wholesale trade	3250	2795	6345	8%	3%	5%
Accommodation, cafes & restaurants	1690	4065	6045	4%	5%	4%
Personal& other services	3575	1630	5760	8%	2%	4%
Agriculture, forestry & fishing	865	3420	4285	2%	4%	3%
Cultural& recreational services	930	1590	2520	2%	2%	2%
Mining	165	2230	2395	0%	3%	2%
Communication services	305	950	1255	1%	1%	1%
Finance& insurance	790	285	1075	2%	0%	1%
Electricity, gas & water supply	50	590	640	0%	1%	0%
Total[a]	**42660**	**86075**	**128735**	**100%**	**100%**	**100%**

a Includes claims for which Industry was not stated.

Table B16: Serious claims: by occupation and sex, 2008–09(Safe Work Australia, 2011)

Occupation	Females	Males	Total	Females	Males	Total
Labourers& related workers	7485	19875	27360	18%	23%	21%
Tradespersons & related workers	1725	22945	24670	4%	27%	19%
Intermediate production & transport workers	2260	21295	23555	5%	25%	18%
Intermediate clerical, sales & service workers	11 430	3975	15405	27%	5%	12%
Professionals	8505	5815	14320	20%	7%	11%
Associate professionals	4130	5480	9610	10%	6%	7%
Elementary clerical, sales & service workers	5380	4030	9410	13%	5%	7%
Managers& administrators	915	1985	2905	2%	2%	2%
Advanced clerical & service workers	680	215	895	2%	0%	1%
Total	**42660**	**86075**	**128735**	**100%**	**100%**	**100%**

Table B17: Economic costs borne by the employer, worker and the community (Safe Work Australia, 2008-09)

Conceptual group	Total (T)	Employer (E)	Worker (W)	Society (S)
Production disturbance costs	Value of production (inc. overtime)	Overtime premium Employer excess payments Sick leave	Loss of income prior to RPR[a], net of compensation, welfare and tax	Compensation and welfare payments transferred to worker for temporary loss of wage; tax losses prior to RPR;
	Staff turnover costs	Staff turnover costs	Zero	Zero
Human capital costs	Present value of earnings before incident minus earnings after incident	Zero	Loss of income after RPR, net of compensation, welfare and tax	Compensation and welfare payments for lost income earning capacity; tax losses after RPR
Medical costs	Medical and rehabilitation costs incurred as a result of the injury	Threshold medical payments	Gap payments Private health insurance payments	Compensation medical payments Public health system payments
Administrative costs	Legal costs	Real legal costs incurred plus fines and penalties	Real legal costs incurred	Real legal costs incurred Deadweight costs of enforcement minus fines and penalties credit
	Investigation costs	Employer investigation costs	Zero/negligible	Real costs of running the compensation system (including investigation of claims)
	Travel costs	Zero/negligible	Travel costs net of compensation & concessions	Compensation for travel costs Travel concession
	Cost of funeral today minus present value of future cost	Zero	Net costs of bringing forward funeral	Compensation for funeral costs
Transfer costs	Real deadweight costs of transfer payments (welfare and tax)	Negligible	Zero (accounted for in netting other items)	Deadweight costs of welfare payments (DSP, SA, Mobility Allowance, Rent Assistance) Deadweight costs of tax losses
Other	Carers	Zero	Carer costs net of carer payment/allowance	Payments to carers plus deadweight cost
	Aids, equipment and modifications	Zero	Aids etc (net cost after reimbursements)	Reimbursements for aids etc plus deadweight cost

Source: Access Economics P/L 2004 Report on 'The Costs of Work-related Injury and Illness'
a RPR time to return or permanent replacement of injured worker

Table B18: Definition and labeling of severity categories (Safe Work Australia, 2008-09)

Category label	Severity Category	Definition
Short absence	Less than 5 days off work	A minor work-related injury or illness, involving less than 5 working days absence from normal duties, where the worker was able to resume full duties.
Long absence	Five days or more off work and return to work on full duties	A minor work-related injury or illness, involving 5 or more working days and less than 6 months off work, where the worker was able to resume full duties.
Partial incapacity	Five days or more off work and return to work on reduced duties or lower income	A work-related injury or illness which results in the worker returning to work more than 6 months after first leaving work.[a]
Full incapacity	Permanently incapacitated with no return to work	A work-related injury or disease, which results in the individual being permanently unable to return to work.
Fatality	Fatality	A work-related injury or disease, which results in death.

[a] We assume cases in this category result in a return to work on reduced duties or income, with a resumption of normal duties. This category includes permanent incapacities for which a minimal duration of absence from work occurred and therefore the worker was able to return to work in some capacity, or for which a return to work in some capacity is possible.

Table B19 Work-related injuries (non-fatal) by duration of absence and nature, 2008–09 (Safe Work Australia, 2008-09)

	Time period	No compensation	Compensation	Total
Injuries	0–4 days	122 600	163 000	285 600
	5+ days	58 200	96 500	154 700
	Total	181 000	259 700	440 700
Disease	0–4 days	22 200	29 500	51 700
	5+ days	84 700	34 280	119 010
	Total	106 900	63 800	170 700
All incidents	0–4 days	144 800	192 500	337 300
	5+ days	143 100	131 000	274 000
	Total	287 900	323 500	611 300

Source: NDS data and ABS 6324.0, Work Related Injuries Survey, December 2009
[a] Totals are rounded to the nearest 100

Table B20: Estimates of disease morbidity due to work-related exposures, 2008–09[a] (Safe Work Australia, 2008-09)

Disease	Morbidity estimate
Neoplasm [b]	5 000
Asthma [c]	3 000
Respiratory disease [c]	23 000
Heart disease [de]	30 000
Total	61 000

[a] Morbidity estimates are reported to the nearest 1000 cases

[b] Fritschi and Driscoll, Cancer due to occupation in Australia, Aust NZ J Public Health 2006; Vol.30.

[c] Australian Safety and Compensation Council, Occupational Respiratory Diseases in Australia,, April, 2006.

[d] Australian Institute of Health and Welfare, Cardiovascular Disease: Australian facts 2011, March, 2011.

[e] Australian Safety and Compensation Council, Work-related cardio-vascular disease Australia, April 2006.

Table B21: Average costs for work-related incidents, Australia, 2008–09(Safe Work Australia, 2008-09)

		Short absence	Long absence	Partial incapacity	Full incapacity	Fatality	Average
Employer	Injury	630	7 950	16 160	16 970	25 000	3 930
	Disease	770	9 910	12 170	14 800	63 350	9 670
Worker	Injury	140	3 160	453 410	1 438 420	1 300 000	46 090
	Disease	190	3 210	446 250	1 213 290	796 380	163 530
Community	Injury	1 930	16 840	59 830	1 582 680	725 000	19 630
	Disease	2 710	10 060	35 020	835 990	217 190	27 200
All	Injury	2 700	27 950	529 410	3 038 070	2 050 000	69 650
	Disease	3 670	23 170	493 440	2 064 070	1 076 920	200 400

Source: ASCC Estimation of indirect cost items (see Appendix 1 for more detail)
[a] Unit costs are rounded to the nearest $10.

Table B22: Total cost and average cost for work-related injury and illness, Australia, 2008–09(Safe Work Australia, 2008-09)

	Injury		Disease		Total	
	Total Cost ($ billion)	Unit cost ($ per incident)	Total Cost ($ billion)	Unit cost ($ per incident)	Total Cost ($ billion)	Unit cost ($ per incident)
Employer	1.7	3,900	1.4	8,200	3.1	5,100
Worker	20.3	46,100	24.5	143,500	44.8	73,300
Community	8.7	19,700	4.0	23,400	12.7	20,800
Total	**30.7**	**69,700**	**29.9**	**175,200**	**60.6**	**99,100**

Table B23: Cost of work-related injury and illness, by location of workplace, 2008–09(Safe Work Australia, 2008-09)

Jurisdiction	Total Cost ($ million)			Economic cost %	Distribution (%)			Unit Cost
	Injury	Disease	Total	GSP/GDP[b]	Costs	Cases	Workforce	$/case
Australian Capital Territory[c]	900	800	1 700	6.2	2.8	2.4	1.8	114,100
Queensland	7 600	6 300	13 900	5.3	23.0	21.1	20.5	107,500
Tasmania	700	500	1 200	5.1	2.0	2.0	2.1	98,900
South Australia	2 000	2 100	4 100	5.0	6.7	7.7	7.2	87,100
New South Wales	11 100	9 200	20 300	4.9	33.5	35.1	31.4	94,700
Victoria	4 600	8 500	13 100	4.3	21.6	20.8	25.0	103,200
Northern Territory	300	300	600	3.5	1.0	1.0	1.1	97,700
Western Australia	3 400	2 300	5 700	3.1	9.5	9.9	10.8	94,300
Australia	**30 700**	**29 900**	**60 600**	**4.8**	**100.0**	**100.0**	**100.0**	**99,100**

[a] Units are rounded to the nearest $100 million
[b] Source: ABS State Accounts (Catalogue No. 5220.0), November 2010. Compared with 2009–10 estimates of reference year chained volume measures of GDP and GSP.
[c] In this analysis Commonwealth Government cases and costs are included in the ACT estimate. Workforce numbers have been adjusted to account for this.

Table B24: Cost of work-related injury and illness, by industry of workplace, 2008–09[a] (Safe Work Australia, 2008-09)

Industry division	Total Cost ($ million)			Distribution (%)			Unit Cost
	Injury	Disease	Total	Costs	Cases	Workforce	$/case
Manufacturing	4 400	4 200	8 600	14	16	9	85,900
Health and Community Services	3 300	3 700	7 000	11	12	11	97,700
Construction	3 400	3 000	6 400	11	9	9	110,600
Retail Trade	2 200	3 100	5 300	9	8	11	115,200
Transport and Storage	2 500	2 200	4 700	8	7	5	105,800
Property and Business Services	2 400	2 300	4 700	8	11	9	71,700
Education	1 700	2 400	4 100	7	6	8	103,700
Government Administration and Defence	1 600	1 700	3 300	6	7	10	78,000
Personal and Other Services	1 400	1 500	2 900	5	5	4	104,600
Wholesale Trade	1 700	900	2 600	4	5	4	93,600
Accommodation, Cafes and Restaurants	1 300	1 000	2 300	4	4	7	94,500
Agriculture, Forestry and Fishing	1 200	900	2 100	3	3	3	126,100
Mining	1 100	700	1 800	3	2	2	170,000
Cultural and Recreational Services	800	600	1 400	2	2	2	106,100
Finance and Insurance	600	700	1 300	2	1	4	157,100
Communication Services	500	600	1 100	2	1	2	175 200
Electricity, Gas and Water Supply	600	400	1 000	2	1	1	147,400
Australia	**30 700**	**29 900**	**60 600**	**100**	**100**	**100**	**99,100**

[a] Units are rounded to the nearest $100 million

Table B25 Summary of industry characteristics, 2008–09 (Safe Work Australia, 2011)

Industry	Persons employed in workforce[a]	Proportion of workforce	Employee jobs 2008–09[b]	Proportion of Employees in industry[c]	Incidence rate 2008–09p[d]
Agriculture, forestry & fishing	367 900	3%	169 861	49%	25.2
Transport & storage	517 800	5%	435 466	88%	25.0
Manufacturing	1 073 100	10%	962 406	94%	23.4
Construction	987 200	9%	676 223	71%	21.8
Personal & other services	402 500	4%	346 377	84%	16.6
Wholesale trade	454 400	4%	421 716	93%	15.1
Mining	176 200	2%	163 057	99%	14.7
Health & community services	1 122 400	10%	1 155 845	94%	14.0
Government administration & defence	489 000	5%	529 035	99%	12.1
Accommodation, cafes & restaurants	520 100	5%	534 818	93%	11.3
Cultural & recreational services	282 700	3%	292 678	83%	8.6
Retail trade	1 545 000	14%	1 515 447	90%	8.6
Property & business services	1 281 300	12%	1 160 747	85%	7.8
Education	788 500	7%	806 171	96%	6.5
Electricity, gas & water supply	102 300	1%	102 044	99%	6.3
Communication services	194 200	2%	234 504	90%	5.4
Finance & insurance	391 300	4%	378 116	96%	2.8
Total	**10 695 500**	**100%**	**9 884 511**	**88%**	**13.0**

aT h e fullnumberofpersonsemployedintheindustryincludingself-employedworkersbasedonABSLabourforcesurveyquarterlyestimates. bThe number of jobs worked by persons classified as Employees in the industry (see Explanatory note 11).c Thenumberofpersonsemployedintheindustryclassifiedas Employees (see*Employee*intheGlossary)asaproportionofthetotalworkforce. dThe number of serious claims per 1000 employee jobs.

Table B26: Fatality breakdown by subdivision Western Australia 2006-07 to 2012-13 (State of the Work Environment, 2013)

ANZSIC 2006 Subdivision	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	Total
Building Construction	0	0	0	0	1	1	0	2
Construction Services	4	3	2	1	3	0	2	15
Heavy & Civil Engineering Construction	1	2	1	0	1	0	1	6
Total	5	5	3	1	5	1	3	23

Table B27: Construction fatalities by mechanism of incident2006-2007 to 2012-2013

Mechanism of incident	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	Total
Being hit by falling objects	0	1	1	0	0	0	1	3
Being hit by moving objects	1	1	1	0	1	1	1	6
Being trapped between stationary & moving objects	1	1	0	0	0	0	0	2
Being trapped by moving machinery or equipment	0	1	0	0	0	0	0	1
Contact with electricity	1	0	0	0	0	0	1	2
Fall from height	1	1	1	1	4	0	0	8
Insect & spider bites & stings	1	0	0	0	0	0	0	1
Total	5	5	3	1	5	1	3	23

Source: State of the Work Environment

Appendix C and Appendix D

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