# Safer Construction: From Concept to Completion

# A Literature Review

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## EXECUTIVE SUMMARY

The highly fragmented and high-risk operational nature of the Australian building and construction industry contributes to the deaths of approximately 50 construction workers per annum.[1] These fatality rates are three times the national workplace average. What is more, injury rates in this industry are 50% higher than those experienced other sectors.[2] Construction workers are also 2.4 times more likely to be killed at work than in any other industry in Australia.[3] Although these health and safety statistics are "comparable to the United States (US) and Europe", they are "double that of the United Kingdom".[4]

### Causes of Construction Accidents

Falling has been identified as the leading cause of fatalities in construction operations. In order to minimise fall-related accidents and injuries, the international literature advocates that non-slip flooring, handrails, guardrails with safety lines and belts, harnesses and safety nets should increasingly be used onsite.

Unsafe site conditions, continuously changing worksites, multiple operations and crews working in close proximity are recognised as other common causes of construction-related deaths and injuries.

Secondary causes of construction accidents have been associated with management system pressures such as financial restrictions, lack of commitment to safety, policy, standards, knowledge and information, restricted training and task selection and poor quality control systems. Construction accidents have also been linked indirectly to social pressures, particularly group attitudes, trade customs, industry traditions, attitudes to risk-taking, workplace behaviour norms and commercial or financial pressures experienced by contractors. The poor health and safety performance in construction is further exacerbated by the highly fragmented nature of operations, in addition to time and budgetary pressures.

The ageing population, a shortage of skilled labour and high worker turnover in the construction industry also increases the potential for accidents and injuries to occur. The combination of new and unskilled construction workers, work intensification inherit in this sector and the effects of worker stress, exhaustion and fatigue also heighten the risk of injury. In addition, older construction workers are at a higher risk of suffering from work-related conditions and chronic diseases linked to ageing. In acknowledgement of these accident causation factors, the existing research suggests that it is necessary to consider the cost benefits of optimum worker health and that regular medical surveillance should be conducted.

Despite these accident prevention strategies, both practitioners and scholars have acknowledged that increased supply chain integration, coordination and communication, in addition to innovative health and safety initiatives, are required to enhance construction health and safety performance. At the same time, the operating context of SMEs must be considered. With limited economic and human resources available, the maintenance of trust and a continual dialogue between stakeholders is deemed crucial. In cases where owners or managers retain a central focus, the bulk of the literature affirms that OHS efforts must be

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[1] Parliament Senate Committee and Campbell 2004.
[2] Cole 2002.
[3] Cole 2002.
[4] Wild 2005, 25.

relevant, low cost and practically applicable. In view of these factors, the literature suggests that the following comprise best practice frameworks for construction OHS.

**Best Practice Frameworks**

The literature suggests that partnerships between those involved in concept, design, construction planning, construction work, maintenance and demolition are essential to enhancing construction OHS performance. Clients should also assume a more prominent role in driving safety by setting safety objectives, selecting 'safe' contractors and participating in safety management during construction. Furthermore, the embedding of five principles into safety and risk management initiatives are advocated; a) transparency, b) rationality, c) accountability, d) targets and outcomes, e) consistency and cost benefit proportionality.

***Government Regulations***

Government regulations appear to be required with respect to improving OHS performance. Studies suggest that best practice in this area pertains to the development of policies that require safety planning for design and construction, the development of a safety information bank of construction accidents and prevention methods, and a shift away from preliminary and routine construction safety audits and inspections towards the employment of competent safety engineers. The literature advocates the introduction of fines for non-compliance, with the revenue generated used to fund a safety information database that is accessible to all supply chain constituents.

***Demonstration of Management Commitment and Involvement***

Prior research reveals that the level of management commitment and involvement in OHS largely dictates safety performance. Best practice with respect to high levels of management commitment and involvement includes the following attributes:

- Giving safety a high priority in company meetings and planning activities;
- Personal involvement in safety activities by top-level managers;
- Safety officers retaining relatively high rank and status within the organisation;
- Open two-way communication between labour and management on safety issues;
- Communication of the importance of safety inspections, environmental control and general housekeeping;
- Emphasis of safety training for employees at all levels; and
- Distinct promotion of safety awareness within the organisation.

The literature also suggests that excellent safety performance requires that safety be considered a priority and on a par with cost and time. Personal responsibility for safety improvements is deemed crucial, as is minimising and correcting unsafe working conditions and communicating and demonstrating a genuine concern for safety by key personnel. These initiatives should also be supplemented by the requisite safety equipment, standardised work procedures and workable safety regulations.

***Contractor Selection Criteria***

At the procurement level, poor safety performance is best explained by contractor selection based on principles of cheapest price/lowest cost. Studies have shown that both tenders and contracts fail to consider safety costs. In response to this, the research reveals a trend towards best-value procurement. This occurs when contractor selection criteria include intangible considerations such as environmental preservation and consideration, social and economic sustainability, credibility and reputation, life-cycle operation and maintenance costs, maintainability aspects, demolition and replacement aspects and other factors such as health and safety, security benefits to the local economy, and flexibility with regard to alternative usage and upgradeability.

***Contractual Specification of Safety Obligations***

Best practice in safety also involves contracts that clearly outline the contractual responsibilities of both contractors and subcontractors. Contractual specifications must establish specific guidelines in order to control expected hazards by naming the person responsible for overseeing the contractor's performance. Potential contractors must be required to prepare and submit an acceptable project hazard prevention plan that a) defines supervisory and employee safety training, b) identifies specific published safety standards and hazard prevention requirements and c) lists qualifying requirements for eligible contractors with a view to ensuring that bidders are restricted to those whose past performance demonstrates care, competence and safety. In addition, the literature suggests that both contractors and sub-contractors should perform all onsite inspections as outlined in the pre-approved site-specific environmental health and safety plan and (what is especially important) ensure that the program is implemented by competent individuals.

***Designing for Safety***

At the design stage of construction, safety by design appears to be critical to enhancing OHS performance. Designers must work and communicate with the principal parties of a construction project such as supervisors or clients and ensure that the following safety considerations are reflected in site plans and designs:

- Site remediation and methods;
- Provision of amenities/services;
- Site security/access;
- Excavation;
- Adequate ground conditions and type of control medium (e.g. batters, trenchboxes, shoring);
- Silica content;
- Machinery types best equipped to mitigate dust; and
- Stable structures during deconstruction or reconstruction.

Best practice in designing for safety also requires designers to retain a solid understanding of OHS and incorporate this into their designs. In order to bring about this solid OHS knowledge, designer training should be both competency- and experience-based and encompass the following dimensions, viz. theoretical safety knowledge, industry experience and interstate or inter-country experience. Refresher training courses should also be a regular undertaking by design practitioners. The literature also advocates increasing safety education in tertiary courses and making design-for-safety tools and guidelines readily available.

The following safety initiatives are proposed in order to enhance safety at the design state of operation, viz. design reviews, design documents that consider worker safety across the design process, reviews of contractor safety plans or submittals, the inclusion of safety as a priority in regular site operations conducted and site inspections by designers. Designers are also encouraged to assist owners with regard to aspects of procurement and safety.

In addition, structured review processes that facilitate interrogation of design are also critical to improving OHS. These reviews involve eliciting safety issues and concerns from multiple stakeholders such as clients, architects, electrical and mechanical engineers, builders, end-users, end-user maintenance authorities and core product or service representatives. These stakeholders are requested to review designs and identify potential safety issues and provide suggestions for improvement. To assist in risk identification, initiate processes for developing solutions and to enhance the rigour of the planning process, trained facilitators are required for to lead the group and stimulate discussion.

Finally with respect to design, coordination among designers and architects is also facilitated through design administrator programs. In these programs, a design administrator is responsible for generating and administering a building components library, to which database designers may add information. This system tracks and follows up all communication among all the design parties yet also administers pending changes and tracking change proposals. The design administrator also conducts regular meetings in order to discuss designers' comments on any proposed changes, review pending changes and monitor work progress.

***Safety Plans and Programs***

Safety plans and programs are another component of best practice in OHS. These sorts of plans and programs are beneficial since they allow different construction parties to agree collaboratively on a plan of action for safety. They operate on the premise that OHS issues would be better managed if program standards, implementation criteria and monitoring responsibility were clearly defined before any work is contracted.

These documents allocate responsibility for safety to authorised persons, require competent individuals to conduct regular site visits and audits and document the faults and corrective actions in a safety logbook. The literature advocates that these plans should be submitted with tender documents and be reviewed and refined at regularly intervals at different stages of the construction process. Regular performance appraisals should also be conducted in order to determine the effectiveness of safety initiatives.

At the construction planning stage, that is, before any work is performed onsite, employers should undertake risk assessments with a view to identifying specific dangers that workers may encounter. In order to mitigate the potential for harm to occur, the provision of protective safety equipment and other risk minimisation actions should be carried out. Contractors should also provide safe work statements that address medium to high risks that are likely to be encountered. These statements should be reviewed by all construction parties before the commencement of work onsite.

Active worker involvement in developing these safety programs and plans is also fundamental to enhancing OHS performance. As construction workers are at immediate exposure to potential hazards, they are best positioned to identify safety issues and develop practical solutions. This practice also increases worker morale and perceptions of management commitment to safety. Before worker involvement in safety program development, safety audits and identification of solutions, workers should also undergo behaviour-based training and be educated about safety programs. Workers selected to participate in the development of safety plans, programs and policies should also demonstrate trust in management goals.

Safety programs should also be supplemented by regular onsite meetings and safety committees. These safety committees should be comprised of representatives from different construction parties. Such committees not only encourage interaction between parties but also help to improve trust and communication. Furthermore, they promote effective accident prevention strategies. Regular onsite meetings that focus on the identification of OHS problems and the development of accident prevention strategies and solutions are also useful in this regard.

***Safety Training and Education***

Both practitioners and scholars agree that safety training and education is critical to OHS performance. The literature suggests that safety training must be specific to the problem areas and safety situations that frequently surface within an organisation and construction project. Thus a generic model of safety training is impractical and unnecessary. However, training should provide an overview of basic OHS theory and first-aid procedures. Training material should also include the indirect, personal and emotional costs of accidents, the criticality of good safety performance, the safety objectives of the organisation, legal obligations and the contractual relationships with clients.

In addition to this background information, worker training initiatives should focus on improved hazard and danger recognition, the enforcement of the use of fall protection systems, the regular inspection and test of protection systems and tools.

Studies have shown that a safety training flowchart enhances OHS performance. This flowchart reflects the relationships among the various dimensions of health and safety training. Once the need for training has been identified and specific training needs have been listed, learning objectives, activities, materials and specifications should be developed. Pre-training evaluation data should be collected. Furthermore, the training should be evaluated and necessary improvements made.

Worker training should be conducted before the commencement of onsite work. Refresher training should also be required periodically. Specific training instruments and tools consist of:

- Audience participation;
- Audience questions and comments;
- Personal stories;
- Use of props and objects;
- Pictures and examples;
- Experimentation on the part of the training facilitator;
- Competitions that mostly revolve around the topic, are challenging and establish their purpose upfront; and
- Practical elements where participants actively develop an item of practical significance.

Construction workers should also be 'inducted' to their jobsite and briefed about the key safety issues and prevention strategies before an onsite work is performed.

In addition to these training and education tools, positive and negative reinforcements for the enhancing of onsite safety should be built into the overall safety program. Positive reinforcements include monetary rewards, bonuses and job promotions. These positive reinforcements should be used with caution since they have the capacity to promote safety as a novelty and not as a necessity. Negative reinforcements such as management criticism and warnings also have the potential to enforce safety practices and should be accompanied by close and strict supervision, in addition to fines for misconduct.

### *Provision and Use of Safety Equipment*

Although the provision and use of safety equipment is considered a form of best practice with respect to OHS, it is necessary to understand the limitations and potential obsolescence of items of safety equipment before their use. Maintenance must also be conducted regularly on this equipment.

### *Computer-based Safety Applications*

Studies have identified a role for computer-based safety tools that have the potential to be used in reviewing projects, identifying hazards, documenting suggestions to eliminate or reduce hazards and documenting and generating safety reports. This electronic safety database has been found to result in high levels of hazard identification. Computer-based safety tools also provide formal feedback methods. For functionality and accessibility purposes, these databases should operate within web browsers.

The use of technology, particularly the Internet, also provides a vehicle for OHS communication. Monthly email newsletters with OHS updates not only ensure that different construction stakeholders remain informed about safety developments, but also promote awareness of safety initiatives and issues. For onsite construction workers, the same information can be dispatched on paper.

### *Ongoing Safety Measurement and Evaluation*

The literature suggests that one single reliable measure of OHS is both non-existent and insufficient with regard to adequately evaluating safety. Rather, a combination of leading and lagging OHS indicators are suggested. The following comprise examples of these safety measurement mechanisms:

- Internal reviews;
- External audits;
- Monthly safety statistics such as lost-time injury rates and experience modification ratings;
- Regular examinations of compliance with documented work tasks and safety controls;
- Repeat detection and recording of medium- to high-risk hazards and comparison over time;
- Regular company/project specific workplace inspections that are measurable, achievable and realistic;
- Attitudinal surveys;
- Cautionary use of behaviour observation and observation criteria developed in collaboration with key construction parties;
- Frequent performance appraisals using numerical safety scoring systems;
- Perception surveys that establish baseline safety outlooks and provide diagnoses for areas requiring improvement;
- Benchmarking; and
- Balanced scorecards.

The literature suggests that the results of OHS evaluations be communicated actively to workers by means of posters and other devices. This practice not only increases worker awareness of safety but also demonstrates management commitment to OHS and facilitates communication, in addition to knowledge and information sharing.

# 1.0 INTRODUCTION

The highly-fragmented and high-risk operational nature of the Australian building and construction industry contributes to the deaths of approximately 50 construction workers each year (Parliament Senate Committee and Campbell 2004). These fatality rates are three times the national workplace average and injury rates in this industry are 50% higher than other sectors (Wild 2005; Cole 2002). Construction workers are also 2.4 times more likely to be killed at work than in any other Australian industry (Cole 2002). Although these health and safety statistics are "comparable to the United States (US) and Europe", they are "double that of the United Kingdom" (Wild 2005, 25).

In response to these alarming injury and fatality rates and a growing concern for health and safety at a federal level, particularly in the building and construction sector, this report provides an overview into the nature and practice of occupational health and safety (OHS) in the construction industry. By examining academic literature, industry publications, existing codes of conduct and best practice guidelines on OHS across the globe, this report considers the key issues faced by both government and industry in OHS reform. The report begins by providing a background to construction OHS and exploring the significance of the Cole Royal Commission as a main driver for OHS reform in construction. The role of safety and risk management in OHS is examined and contextualised within the construction supply chain, while the various roles and responsibilities for OHS within this supply chain are outlined. The concept of shared responsibility for safety is also considered. The next section continues this investigation into construction OHS by outlining specific roles and responsibilities for safety in construction projects for clients and project managers, in addition to as considering the key OHS issues in the procurement, design, construction and commissioning phases of operation. Contemporary issues and barriers to improvements in construction OHS are then identified and international and national best practice with respect to OHS is identified. Conclusions about construction OHS are then presented and best-practice frameworks drawn from internationally recognised sources are provided.

This summary and analysis of OHS issues in construction commences with an overview of the Australian building and construction industry and the way in which the nature of its operations contributes to unacceptable health and safety performance.

## 2.0 BACKGROUND TO CONSTRUCTION OHS

OHS issues in the construction industry are partly attributable to the fragmented nature in which the industry operates (Ringen et al. 1995). The "one-of-a-kind" nature of projects, with their temporary multi-organisations (Lingard and Rowlinson 2005, 5), results in constantly changing work assignments, worksites and employers (Ringen et al. 1995). Several trades often work simultaneously on one site and it is also common for each trade to be employed by a different contractor (Ringen et al. 1995). This "cyclical demand for contracted services" (Hislop 1999, 5), coupled with the shortage of skilled labour, creates staffing difficulties for construction companies and results in workers being contracted for multiple specialist tasks, being forced to work in a pressured environment and becoming responsible for their own health and safety (Ringen et al. 1995). Long work hours culminate in worker exhaustion, fatigue and burnout, which results in safety becoming neglected and a hazardous work environment ensuing (Hislop 1999).

The poor OHS performance in construction is further heightened by industry trends of downsizing, outsourcing of work, increasingly complex operating systems, equipment specialisation and potent chemical products (Hislop 1999). Industry downsizing has culminated in the practice of contracting out less desirable and more hazardous tasks (Hislop 1999). At the same time, pressures for greater work efficiency have resulted in contracted employees being subjected to greater health and safety risks than those directly employed (Hislop 1999). Compared to other industries, the uptake of technology and innovation in the construction industry has been slow, while litigation focusing on injury claims has increased (Hislop 1999). In order to offset the increased costs of settlements, Hislop (1999) claims that construction companies are transferring risk rather than promoting hazard identification and resolution processes. This is a notion reflected in the findings of the 2003 Royal Commission into the Australian building and construction industry.

### 2.1 The Cole Royal Commission

In order to address the flaws in the building and construction sector that have resulted in OHS failures, the Australian Royal Commission into the Building and Construction sector (the Commission) was established in 2003. Headed by Commissioner Terrence Cole, the inquiry investigated claims of malpractice and misconduct in the Australian building and construction sector. The Commission found that the industry is characterised by an entrenched culture of legislative disregard, to the extent that existing workplace relations laws are very much ineffective (Cole 2003). In specific terms, the Commission identified 400 separate findings of unlawful conduct by individuals, unions and employers and potential breaches of 20 Federal and State Acts (Cole 2003). Furthermore, it was reported that government regulatory bodies retained inadequate structures to enforce both legislation and universal behaviour standards (Cole 2003). In 2003, the Royal Commission and the then Employment and Workplace Relations Minister Tony Abbott noted that, for the building and construction industry to change, structural and cultural reform would be necessary (Mercer and Norington 2003). In specific reference to OHS, the Commission noted that

> *The powerful competitive forces in the construction industry too often work against occupational health and safety. The industry strives to complete projects on budget and on time. Too often safety is neglected. There must be cultural and behavioural change. That can come about by harnessing the competitive forces in the industry to work for occupational health and safety.*
>
> (Cole 2003, 41)

In addition to the cultural and behavioural issues identified by Cole (2003), the poor OHS performance in the Australian construction industry is also explained by the disregard for authority and regulations inherent in this sector (Lingard and Rowlinson 2005). There is thus a fundamental need for attitudinal as well as behavioural change (Feehely and Huntington 2002).

In response to this identified need for structural and cultural reform, and despite previous failed efforts to reform the conduct and culture of the building and construction industry, the Commission provided 212 recommendations to assist in the improvement of safety, taxation law compliance, industrial law enforcement and employee entitlement protection (Cole 2003). In its quest to promote a "fairer, safer and more decent [construction] industry", the Commonwealth Government has embarked on a series of reforms that focus on improving practices in the building and construction sector (Department of Employment and Workplace Relations 2003, 2). As a further consequence, a Building and Construction Industry Improvement Bill (Building Law) has been initiated in order to focus on the following policy areas:

- The introduction of a building Act to govern workplace relations;
- The creation of an enforcement body governed by the Australian Building and Construction Commissioner;
- The appointment of a Federal Safety Commissioner responsible for improving occupational health and safety;
- Increased penalties for legislative breaches;
- Processes to empower parties affected by unlawful industrial action to claim damages;
- Leveraging Australian Government purchasing power to initiate reform and adherence to a new Australian Government Building Code;
- Aid for employee entitlement protection;
- Encouragement of training, traineeships and apprenticeships; and
- Reducing opportunities for tax evasion and fraudulent phoenix company activities.

(Department of Employment and Workplace Relations 2003)

These proposed legislative changes are designed to enhance the culture of the building and construction industry (Department of Employment and Workplace Relations 2003; 2005). The claimed benefits are based on the premise that building cost components are embedded into all goods and services and that cultural and structural improvements to the Australian building and construction sector is likely to reduce costs for consumers, whilst at the same time improving economic productivity (Department of Employment and Workplace Relations 2003; 2005). Lower construction costs for schools, hospitals, office buildings and roads are expected, in addition to increased work practice efficiencies that will generate lower goods and services costs for Australian consumers (Department of Employment and Workplace Relations 2003; 2005).

When one considers that the commercial building and construction industry was valued at $50 billion in 2003-2004, employs in excess of 775 000 people and accounts for approximately 6.8% of Australia's GDP per annum, improvements in workplace practices in this sector are estimated to generate $2.3 billion annually, lead to a 1% increase in GDP and a 1% decrease in the cost of living for all Australians (Department of Employment and Workplace Relations 2005). Safer building sites are also predicted to result, most notably with respect to reduced worker death and injury rates (Department of Employment and Workplace Relations 2005). These expected outcomes are particularly salient given the "hazardous nature" of the construction industry, which causes considerably more injuries and fatalities than those experienced in other sectors (Lingard and Rowlinson 2005; Wild 2005; Cole 2002).

### 2.2 Challenges in Implementing Cole's Recommendations

Despite the claimed benefits of the new OHS legislative framework, concerns have been raised about whether rigorous implementation is possible (Sydney Morning Herald 2003). In specific terms, it has been stated that "History and political reality suggest the chance of that [rigorous implementation] are not great" (Sydney Morning Herald 2003). Furthermore, in view of previous failed efforts to reform the "conduct and culture" of the building and construction sector, effective implementation of the new policies has been recognised as complex and difficult (Sydney Morning Herald 2003). The difficulties are further heightened by a lack of national uniformity in construction-related OHS regulations and the different regulatory influences of federal and state spheres of government. Of particular interest is that, by adopting a British model of OHS regulation based on the 1878 Factories Act and 1901 Act and recommendations of the 1972 Robens Report, existing legislation demonstrates international convergence with UK practices. Although it has provided a National Occupational Health and Safety Commission (NOHSC) to provide advice to Commonwealth, State and Territory governments, Employer Organisations and Trade Unions and develop legally unenforceable regulations and codes of practice, the Australian federal government absolves itself of direct responsibility for the development and enforcement of OHS legislation. It delegates this control to individual States and Territories. As a consequence, disparity in OHS legislation exists in Australia since different government departments in each state retain responsibility for the development and enforcement of OHS policy. These consistency issues could prove problematic in implementing new OHS policies across Australia.

Acknowledging that there is a "limit to what can be achieved by legislation and regulation", especially with respect to addressing the underlying problems caused by the "attitudes, capacities and performance of people", Cole (2003) concluded that expanding laws and adding to what he perceived as a mass of already confusing legislation could potentially be "counter-productive" (Cole 2003, 36). He reinforced the conclusions drawn from the Robens Report (1972) that "all-pervading psychological effects" could arise from workplace OHS rules and legislation being seen as "a matter of detailed rules imposed by external agencies" (Cole 2003, 36). Cole (2003, 35-36) described the existing plethora of OHS legislation as "intrinsically unsatisfactory", agreed with the findings of the 1972 review of the UK building and construction sector (viz. the Robens Report) and identified the root of these entrenched problems as excessive and ineffective legislation. He determined that the cultural and behavioural problems identified by the Robens Committee some 30 years ago still continue today and that this practice stems from the "haphazard mass of ill-assorted and intricate detail" of laws that have accumulated from over a hundred years of "practical empiricism" (Cole 2003, 35-36).

### 2.3 Overcoming the Challenges: Prioritising OHS

In addition to legislative reform and cultural and behavioural change, Cole (2003) recommended encouraging and implementing a respectful work environment where health and safety is integrated into construction practices. Aside from acknowledging that deadlines and cost had become paramount to safety and that OHS should not necessarily militate against competitiveness, Cole advised (in recommendation 17) that safety should become as equally important as budgetary and time constraints (Cole 2003, 41-43). As a consequence, Cole (2003, 43) gave OHS precedence on the reform agenda by advocating the implementation of a national system "as a matter of priority" and calling for prompt activation of this national system in recommendation 20. Furthermore, Cole (2003) outlined the importance of national uniformity with regard to construction OHS. He noted that, while nine out of ten OHS statutes related to the construction industry, nearly 90 regulations were also aligned with construction safety. In view of this, Cole (2003) outlined the impracticalities of having countless codes of practice, standards and guidelines established by different states, construction companies and representative groups. He concluded that a national system that reflected each administrative regulation, many of which are complex and sometimes contradictory, would be difficult to establish. Despite these difficulties, Cole (2003) claimed that a nationally uniform OHS system would be beneficial, especially since existing inconsistencies in state and federal OHS regulations have caused confusion and controversy for different industry groups, particularly with respect to complying with sometimes conflicting guidelines.

### 2.4 Industry's Response to Cole's Recommendations

Industry responses to the recommendations put forward by Cole (2003) have been mixed. The Australian Chamber of Commerce and Industry (2003) indicated support for the recommendations. Indeed, this peak body was of the opinion that all 212 recommendations should be at least considered. It was also reported in *The Australian* that Lindsey Fraser, the Assistant National Secretary of the Construction, Forestry, Mining and Energy Union (CFMEU), was supportive of a National Code and viewed it as an "important step" towards safety reform (Kelly 2004). Cole's recommendations continue the UK-based principles of an integrated approach to accident and illness prevention through regulator enforcement, advisory provisions and teamwork, which is also advocated by Robens (1972), Egan (1998) and Latham (1994).

In contrast, Ebsworth and Ebsworth (2003) questioned aspects of the Commission's findings that relate to the deeply entrenched flaws of the construction sector. Ebsworth and Ebsworth (2003) were hesitant to concede that overall changes could successfully be implemented and questioned the willingness of stakeholders to jeopardise their financial positions, especially in view of time constraints. Furthermore, the changes were not agreed upon by all stakeholders involved. Indeed, the CFMEU saw that the outcomes and recommendations of the Cole Inquiry were "politically motivated" and focused specifically on "union conduct" (Roberts 2003, 2). In a response paper to Cole prepared by Tom Roberts, the CFMEU Senior Legal Officer, it was claimed that the Royal Commission set out with a pre-defined agenda to erode the powers and "influence" of construction unions, specifically the CFMEU (Roberts 2003, 2). Moreover, the CFMEU held that the recommendations would contradict Australia's obligations to the International Labour Office (ILO) and would contravene international industrial law by "fly[ing] in the face of international standards" (Roberts 2003, 2). The CFMEU claimed that the Cole Inquiry Recommendations were tantamount to removing union involvement in workplaces and that recommendations to implement an authoritative monitoring system could create "a dangerous extension of executive power and an incursion into the civil rights of Australian construction workers" (Roberts 2003, 2).

### 2.5 Developing a Way Forward: A Code of Conduct

Despite the mixed reactions by industry groups to Cole's recommendations, there appears to be some consensus that a code of conduct into construction OHS would be beneficial. The ILO (1992, 2) defines a code of practice as "a document offering practical guidance on the policy and standard setting in occupational safety and health for use by governments, employers, workers and any other persons involved in the construction process in order to promote safety and health at the national level and at the level of enterprise." Durham et al. (2002) argued that a uniform national system could minimise confusion with respect to the roles and responsibilities of different construction parties. According to these authors, the economic benefits arising from a homogenous, national system would provide gains in terms of the time and resources expended in order to address different and often conflicting codes and regulations. Despite these benefits, Durham et al. (2002) suggest that, under the Australian constitution, the Commonwealth government may lack the authority to moderate a single regulatory system and therefore. There is thus a high likelihood that power may be transferred to the ILO, particularly under ILO Number 155 (*Occupational Safety and Health*). (Durham et al. 2002, 25). Doubts still exist regarding whether the Federal Government should or indeed could assume complete control of OHS regulation and whether it would be able to enforce such legislation (Durham et al. 2002).

In support of the above, Durham et al. (2002) noted that legislation is both easier to interpret and enact if accompanying codes of practice are provided. The authors cite sections of the Victorian WorkCover OHS regulations as a template for effective regulatory reform and suggest that these regulations incorporate a combination of "information, education and communications" (Durham et al. 2002, 20). The regulations are also supported by a combination of positive incentives, such as financial rewards, deterrent measures, in addition to enforcement through inspections and significant penalties for breaches (Durham et al. 2002). Durham et al. (2002) also note that the effectiveness of a national code of practice is determined by its relevance to the industry to which it is applicable. These authors maintain that, for a code of this nature to be both realistically practical and representative of industry concerns, influential parties in the building and construction sector should be involved in the development process of the code.

### 2.6 Summary

This section has provided a background to OHS in construction. The cyclical nature of the Australian building and construction sector has been explored and drivers for change have been examined. Issues pertaining to OHS legislation in the construction industry have been identified and a role for a nationally uniform code of practice in construction OHS has surfaced as a high level priority, although the way in which this might be implemented remains problematic. To guide the development of this code, the next section explores existing safety and risk management practices in the building and construction sector.

## 3.0 SAFETY AND RISK MANAGEMENT

Hislop (1999, 3) suggests that safety extends beyond "craftsmen wearing hard hats on construction sites" to a "philosophy that identifies and eliminates job site hazards throughout the lifecycle of a work project" and "discourages work practices that place individuals at risk of injury." This philosophy also involves the integration of safety into daily work processes and the promotion of an environment in which all parties to the construction project have a stated role and responsibility for managing safety (Hislop 1999).

Occupational injuries and fatalities are not "chance events" and can be prevented through effective health and safety management (Lingard and Rowlinson 2005, 4). Lingard and Rowlinson (2005) postulate that the same type of work-related deaths, injuries and illnesses periodically occur in the construction industry and that the industry fails to learn from its mistakes and does little to prevent them reoccurring. Durham et al. (2002), in addition to Lingard and Rowlinson (2005), contend that this preventative inactivity may be attributable to the organisation, structure and management methods that are manifest in the building and construction sector. These authors maintain that the high rate of accidents and injuries inherit in this industry stem from the highly hazardous operational nature of construction work and the present inadequacies with regard to managing these risks. These factors are thought to militate against the identification of OHS problems and therefore impede the implementation of innovative solutions (Lingard and Rowlinson 2005). Despite this tendency, Ringen et al. (1995) maintain that OHS issues can be prevented, provided that effective risk and safety management practices exist.

### 3.1 Risk

OHS management is underpinned by the concept of risk. Kirchsteiger (2005, 34) defines risk as the "possibilities that technological activities or natural events lead to consequences that affect what humans value." While Ridley (1990) and Viner (1996) state that risk management is a three-stage process, Matthews (1993) elaborates further. He explains that risk management involves the identification of hazards in the work environment, the assessment of the risks posed by the hazards and the selection of appropriate risk controls according to a risk control hierarchy. This hierarchy is said to operate on the notion that control measures that aim to target hazards at their source and act on work environment are more effective than controls that aim to change espoused worker behaviour (Holmes et al. 1999). In view of this requirement to control hazards at their source, Kirchsteiger (2005) claims that clear risk identification and assessment and subsequent risk minimisation actions are fundamental for effective OHS risk management. Hislop (1999) supports this view by stating that the underlying cause of most "safety-related losses" is the "absence of a systemic process to identify and mitigate workplace hazards and unsafe work practices." To aid effective risk and hazard identification, Kirchsteiger (2005) proposes that the following five principles be embedded into risk management initiatives:

- Transparency – extensive and open consultation, clear and comprehensive regulations;
- Rationality – legislative decisions mostly based on objective decisions, explicit assumptions and value judgements;
- Accountability – clearly defined responsibilities for action;
- Targeting – precisely stated specific objectives, outcomes and groups affected;
- Consistency – new legislation consistent with existing legislation; and
- Proportionality – legislation implementation costs proportionate to benefits gained from risk reduction.

The application of these five principles in OHS risk management in the Australian building and construction sector is difficult given the highly fragmented operational context in which a “lack of integration, coordination and collaboration [exists] between the various functional disciplines” involved in a construction project (Tucker et al. 2001, vi). This is further exacerbated by the failure of construction supervisors and management to communicate effectively the importance of safety on the continued economic viability of construction organisations (Hislop 1999), let alone incorporate principles of transparency, rationality, accountability, targeting, consistency and proportionality. The time-sensitive and highly pressured work environment of the construction industry, where work assignments are often behind schedule, workers suffer from fatigue as a result of being contracted for multiple specialist tasks, coupled with the focus on profits and outcomes (Ringen et al. 1995; Hislop 1999), contributes to the low priority currently given to OHS. To further complicate matters, in literature where OHS is considered a priority, the use of the terms ‘hazard’ and ‘risk’ vary according to the particular constituent considered in the construction supply chain, as is outlined in the next section.

### 3.1.1 The Construction Supply Chain and Risk Perceptions

Each constituent in the construction supply chain differs in their understanding of risk. For instance, Australian and Canadian based studies have shown that small business employers consider OHS hazards to be created by employees and therefore consider risk control the employee’s responsibility (Holmes 1995; Holmes and Gifford 1997; Eakins 1992). According to Dejoy (1985), this occurrence is best explained by attribution theory whereby employees and supervisors retain different opinions of the causes of workplace accidents and the way in which safety performance problems should be addressed. He suggests that self-protective and self-other biases exist in three areas of safety management, viz. individual risk perception, supervisor responses to safety incidents, and management influence on safety climate.

#### 3.1.1.1 Attribution Theory and OHS

Given that supervisors retain responsibility for performing safety inspections and hazard audits, investigating accidents and recommending corrective actions, providing safety training to workers and motivating members to adopt safe work practices, Dejoy (1985) argues that supervisor bias may be inherent in risk assessments and that the concerns of other stakeholders are often not considered in hazard and risk identification. As a consequence, self-other attribution and self-serving bias are believed to exist, a factor which causes the number of accidents assigned to behavioural causes to be grossly overestimated (Dejoy 1985). Numerous opportunities exist for attribution bias to exist in OHS initiatives, especially when accident reports are completed by supervisors in the same department in which the incident occurred (Dejoy 1985). Dejoy (1985) claims that biased supervisor attributions have the capacity to influence safety initiatives in a negative fashion, to the extent that safety-related problems become exaggerated rather than mitigated. The attribution bias of supervisors is believed to initiate inappropriate safety policies and program decisions that decrease overall program effectiveness and concomitantly increase organisational conflict. Dejoy (1985, 67) illustrates this issue of attribution bias in OHS programs in the following statement:

> *Incorrect attributions by top management regarding accident causation can lead to inappropriate safety policies and programs that magnify rather than correct the problem. A safety problem created by unrealistic production deadlines may be responded to with stepped-up enforcement or unnecessary training. Further, these incorrect attributions may be imposed on lower level supervisors and set up a*

*situation where the first-line supervisor is caught between satisfying the boss and not magnifying the existing problem.*

On account of the fact that supervisors are too involved in hazard identification and risk appraisal to be sufficiently objective, upper-level managers have been observed to retain a heightened bias towards internal attributions (Brown 1984). The rationale behind this is threefold:

- The further removed the observer is from the work station, the more difficult it is for him/her to understand external factors involved in the job or empathise with workers;
- High-level managers are unlikely to have extensive experience in performing floor-level jobs and this lack of experience creates a predisposition towards internal attributions; and
- Upper-level managers often compare groups of workers rather than individual workers and develop internal attributions.

(Brown 1984)

#### 3.1.1.2 Reducing Attribution Bias

In order to reduce attribution bias (particularly the internal bias of managers), Dejoy (1985) suggests that safety programs that facilitate two-way communication between workers and managers and that involve direct participation by management in safety activities may help to reduce the administrative distance between workers and managers. In a similar fashion, a strong commitment to safety training is also thought to reduce internal attribution bias (Dejoy 1985). In addition to these areas, Dejoy (1985) suggests that the following practices further minimise the existence of attribution bias:

- Investigation of workplace accidents by a qualified objective source who is outside the workgroup and not directly associated with line management;
- Dissemination of summaries of all accident investigations to workers and managers;
- Careful consideration of possible sources of bias when developing safety messages;
- Developing a program that reports and analyses near-miss and minor loss accidents in order to initiate proactive preventative action;
- Supervisory training programs that educate supervisors about the various types of attributional biases likely to surface in supervisor-subordinate interaction and remedies; and
- Manager awareness of the complex and multi-causal nature of accidents and the criticality of safety integration into the total management system.

Lingard (2002) explored the effects of first aid training on Australian construction workers' OHS motivation and risk-control behaviour. First aid training was observed to reduce worker self-other bias whilst creating worker acknowledgement that their own behaviour is an important factor in the avoidance of OHS accidents, injuries and illnesses. First aid training was also observed to reduce individual perceptions that workers would miraculously be exempt from any OHS accidents, injuries and illnesses (Lingard 2002). Additional benefits of first-aid training involved increased realistic worker perceptions of the probability of accidents occurring in the workplace and enhanced worker motivation in order to avoid accidents, illnesses and injuries (Lingard 2002).

In examining employer and employee perceptions and understandings of risk and risk control in OHS in small blue-collar businesses in Victoria (Australia), Holmes et al. (1998) also concluded that risk control is paramount. After an analysis of data from 87 employers and 81 employees involved in an investigation into the Victorian painting industry that asked respondents to rank ten OHS risks and provide a rationale for the ranks specified, Holmes et al. (1998) demonstrated that perceived qualities of risk and risk control in OHS were mediated by the social context of work. In specific terms, it was observed that personal control of risk interpretations were influenced by the employment status of respondents (Holmes et al. 1998). The findings revealed that OHS management and promotion programs should reflect the diverse and complex risk perceptions and social understandings of risk for both employers and employees (Holmes et al. 1998).

The pertinence of risk control in construction OHS also surfaced in Holmes et al.'s study (1999) into employee and employer meanings of risk control in OHS. This study involved a sample of small businesses engaged in the trades of concreting, plumbing, electrical and carpentry within the Australian construction industry. Similar to the findings of Dejoy (1985) and Holmes et al. (1998), the authors concluded that the controllability of risk is important in risk attribution. They observed that, where the perception exists that a threat to safety is uncontrollable, a "fatalistic resignation to [risk] exposure" may develop (Holmes et al. 1999, 257). These authors also pointed out that the perceived degree of effort required to control OHS risks appears to be influential with respect to establishing concepts of risk control (Holmes et al. 1999). Risk attribution was also observed to be associated with cost-benefit analyses and the biases of individuals who believe that they are exempt from risk as a result of a 'it won't happen to me' mindset (Holmes et al. 1999).

Tesh (1981) also argues that perceptions and understandings of risk heavily influence conceptions of risk-control strategies. It has been suggested that effective technical risk evaluation may be hindered when workplace actors do not have a shared understanding of risk and its control (Holmes et al. 1999), particularly when disparity exists among key construction parties with regard to the source of the potential hazard (Holmes and Gifford 1997) and the cost and benefits of risk controls (Viner 1996). When one considers that the construction sector is highly fragmented with various trades, contractors and subcontractors working on multiple sites, such disparity poses a particular concern (Walker 1996a; 1996b). The time and cost constraints of competitive tendering imposed within this amalgam of different firms pursuing distinct agendas further exacerbates the complexities of ensuring that a shared understanding of risk exists among the various parties working on a construction project (Lingard and Rowlinson 1994; Russell et al. 1992).

In order to ensure that a shared understanding of risk management exists, Kirchsteiger (2005) recommends a participatory approach to risk management. This approach involves all stakeholders working collaboratively with a view to characterising and assessing risks and then integrating risk assessment practices into a risk management program (Kirchsteiger 2005). The success of this participatory approach is dependent on whether the needs of all stakeholders are accommodated. Success, therefore, is not always guaranteed. As governments, industry and the public often maintain opposing views with respect to risk assessment and management, Kirchsteiger (2005) is of the opinion that multiple stakeholders should be involved in the risk management process. A better understanding of risk and management practice is argued to result from this undertaking, particularly if governments and other organisations within the same industry, in addition to the general public, comprise key participants in this process (Kirchsteiger 2005). The inclusion of these stakeholders in the risk management process is justified by governments being confronted with increasingly complex issues and being constrained by limited budgets, while the general public is becoming more risk averse as affluence levels rise and poverty and other threats diminish. Industry-based stakeholders should also be included since they are directly affected as a result of reduced operational freedom and capacity to improve competitiveness (Kirchsteiger 2005).

In order to minimise attribution bias in construction OHS and maximise the control of risk in these settings, Ringen et al. (1995) propose that, in the planning stage of a project, it is critical to assign responsibility for health and safety. At the same time, coordination among subcontractors and tradespeople must also be established. Ringen et al. (1995) appears to advocate an integrated approach to OHS and risk management where a shared responsibility for OHS exists among the supply chain constituents.

## 4.0 OHS AND RISK MANAGEMENT: DEVELOPING A SHARED RESPONSIBILITY

According to Hislop (1999), construction safety is not the responsibility of the contractor alone. His view is based on the premise that unsafe work practices have both direct and indirect costs for organisations. Direct costs include those that result from accidental equipment damage or personal injuries such as lost production time, insurance costs, penalties for breach of OHS legislation and litigation costs. He also identifies indirect costs as those that incur indirect financial impacts resulting from schedule disruptions, increases in insurance and workers compensation premiums. In view of this redistributive impact of poor safety performance, both Hislop (1999) and Durham et al. (2002) agree that all parties associated with a construction project should be accountable for safety. Benefits of effective hazard identification and control and consequent safety promotion are argued to ensue from this multi-stakeholder approach (Hislop 1999). In a similar vein, the European C*onstruction Site Directive* also emphasised the importance of developing communication networks throughout the construction process and establishing "responsibilities of the parties involved in the construction phase" (Bluff 2003, 10).

In its 1992 code of practice 'Safety and Health in Construction', the ILO outlined the responsibilities of different groups that influence a construction project. The ILO (1992, 5) advised that the national laws of different countries should include the input of "clients, designers, engineers and architects", who all have a duty of care to include safety considerations in their contribution to a project. Section 2.1.7 of this code prescribed that national OHS regulations should be part of the "general duties" of different participants in the construction process. The ILO recommendations are mirrored by the UK's Health and Safety Executive (HSE), which has released a code of practice for good working relationships and shareholder responsibility entitled "Respect for People (RfP)". In an acknowledgement of the lack of responsibility taken by different parties involved in a construction project, recommendation 30 of the Cole Report recommended more comprehensive input across the board, coordination of safety procedures and designating OHS tasks as the responsibility of the "Principal Contractor" or "site host" (Cole 2003, 52). A need for safety to be considered in all aspects of the design and construction process was also highlighted (Cole 2001).

The Robens Report calls for more input from employees and employers in the "management and control of risks to health and safety at the workplace level" (Durham et al. 2002, 18). Motivated by poor outcomes from external agencies charged with monitoring safety, the report advocated self-regulation (Durham et al. 2002, 18). Self-regulation also includes "joint employee-employer committees to deal with OHS at the workplace level" (Durham et al. 2002, 18). The concept of greater internal staff participation and self-regulation has been pursued in Australia through the implementation of employee-elected health and safety representatives (Durham et al. 2002). The ILO's 'Safety and Health in Construction' guidelines also discuss employee-elected representatives. Sections 2.1.5a and b of *General Duties* consider the benefits of "safety and health committees, representative of employers and workers" and recommends that elected or appointed "worker safety delegates" be employed.

Durham et al. (2002) also advocated the general implementation of a "duty of care" that would be imposed on those who are involved and have an impact on the processes and outcomes of a construction project, as outlined in the Robens Report. In a similar fashion, the UK Federal Government's Health and Safety Executive (HSE) has undertaken the *Respect for People (RfP) Code of Good Working Health and Safety Practices*, which outlines the importance of different groups involved in a construction project and states that they should work cooperatively in order to develop high safety standards. The title of the publication is an accurate representation of what the document is hoping to provide, that is, an outline of a model workplace that encourages respectful relationships between all parties involved in the construction process. The RfP campaign is aimed at developing “partnerships that secure on-site working conditions and respect for the communities where work is carried out” (HSE 2005, 1). Furthermore, the campaign has established specific guidelines for influential members of a construction project. The RfP also links the responsibility of safety to all members involved in the construction process in order to encourage mutual responsibility for safety.

A need for planning and coordination of stakeholders involved with a construction project, in addition to the integration of health and safety considerations into the various stages of the construction process, has been identified by Safe Site, an independent construction representative group (Safe Site 1999). Safe Site promotes these means as the most effective safeguards to “avoid injury and minimise costs” (Safe Site 1999, 6). Safe Site emphasised that job size should not influence safety levels since the basic systems of OHS are vital, irrespective of project size. Safe Site (1999) reinforces the mantra that everyone involved in construction is responsible for safety, including clients/principals and designers/advisers, particularly architects, engineers, employee consultants, head contractors, employees and subcontractors.

Briscoe et al. (2004) hold that the multi-stakeholder approach to construction safety described by the ILO (1992), Hislop (1999), Durham et al. (2002), Bluff (2003), Cole (2001; 2003), HSE (2005) and Site Safe (1999) should be underpinned by principles of supply chain management. Briscoe et al. (2004) analysed associations between clients, the environmental factors that affect their businesses, procurement decisions and possible levels of supply chain integration by means of a comparative case study research design. These authors observed that “integration is strongly reliant on the philosophy of supply chain management” and that supply chain integration is dependent on information flow and systems and collaboration (Briscoe et al. (2004, 193). They concluded that, despite the existence of systems and processes to encourage relationships, organisations still lacked efficient and effective information flows and communications. The authors noted that high levels of coordination, commitment and collaboration within the supply chain generate better integration and that longer term associations amongst the different constituents provide close alignment and improve communication. The use of ICT systems and interpersonal and professional relationships was also observed to facilitate supply chain integration by providing information flow improvements and encouraging trust among the different construction parties (Briscoe et al. 2004). The research revealed that environmental factors, departmental and organisational structures, management experience and market conditions strongly impact on procurement choices and the degree to which supply chain integration might be achieved. In order to reap the benefits of faster construction, facilitate a better understanding of client needs and project objectives, improve communication and promote active involvement in value engineering exercises, Briscoe et al. (2004) emphasise the importance of involving suppliers early in the construction process.

Kumaraswamy and Dulaimi (2001), who contend that procurement innovations have the potential to enhance construction productivity, explored the concepts of supply chain integration and procurement innovation. These authors examined a cross-section of innovative construction procurement and operational arrangements in manufacturing and defence industries and assessed their relevance and potential to enhance construction industry practices. Kumaraswarmy and Dulaimi’s research (2001) revealed that innovative procurement and operational systems should be developed synergistically and linked to technological developments. They argue, furthermore, that effective supply chain integration is reliant on constituents maintaining a focus on innovative product or service development.

Kumaraswarmy et al. (2004) also considered the role of innovation in integrated procurement and operational systems in the Australian, Hong Kong and Singaporean construction industries. The authors identified a salient role for innovation in procurement and operational systems, in addition to educational training, professional development and cooperative learning and technological systems. They also suggest that macro-level integration of these areas is necessary for strategic alignment and the development of sustainable synergies that will ultimately foster greater collaboration through the supply chain.

Dainty et al.'s study (2001) into the feasibility of supply chain alliances in the UK construction sector involved semi-structured interviews with SME sub-contractors. The research revealed that various impediments to supply chain integration exist and are attributable to the historical fragmentation of project delivery systems and the contractual and adversarial nature of construction project relationships. SMEs mistrusted other supply chain constituents and did not believe that integrated supply chains could provide mutually beneficial outcomes (Dainty et al. 2001). Instead, SME companies maintained that existing supply chain management techniques seek to enhance the profitability of the main contractor at the expense of other companies in the supply chain. In order to minimise these barriers to enhanced supply chain collaboration and integration, the authors note that main contractors need to address integration and partnership issues with smaller companies, in addition to client organisations. They suggest that leading companies agree to share the benefits of greater integration with their supply chain partners. With a view to enacting this change, the authors maintain that a long-term time orientation is necessary and that tools that will facilitate supply chain relationships at key project interfaces is required. By contractually emphasising equality in obligations and responsibilities at each level of the supply chain, Dainty et al. (2001) argue that this process will facilitate better supply chain relationships across the construction process. The authors also claim that short-term subcontractor integration efforts should be influenced by client procurement approaches in the sense that organisations demonstrating excellent supply chain management principles in their primary business area should extend these skills to their own supply chain management practices.

Saurin et al. (2004) examined the effectiveness and ease of use of a safety planning and control model that focused on integrating safety management into the production planning and control process of construction projects. These authors observed that effective safety integration and implementation requires a hierarchical decision-making structure, constraint analysis, regular planning meetings and assignment of work packages based on quality criteria. Saurin et al. (2004) suggest that constituents such as clients, managers, subcontractors and workers be involved in the decision-making process and that safety planning and control should be systematic and continuously applied throughout the entire construction project. Systematic integration of safety management into other core managerial processes such as design, human resource management and cost management were also identified as essential for effective safety management (Saurin et al. 2004).

Despite the need for increased supply chain integration, coordination, communication and collaboration with respect to OHS, Hislop (1999) claims that a typical model for safety management is both non-existent and unnecessary. This argument is based on the premise that all organisations and projects are distinctly structured and that one generic model cannot be both practical and effective. Rather, it seems that, although key issues in construction OHS can be examined and remedies suggested, it is up to the individual project constituents and stakeholders to develop a tailored safety management plan. In order to aid the development of this plan, the next section considers some of the key OHS issues in the project procurement, design, construction and commissioning stages of operation and puts forward some roles and responsibilities for OHS and risk management within these streams.

## 5.0 FROM CONCEPT TO COMPLETION: SAFETY ROLES AND RESPONSIBILITIES

In the US, Toole (2002) conducted telephone and written surveys of architects, engineers, general contractors and subcontractors in order to clarify the roles of designers and construction professionals with respect to site safety. Toole (2002) argued that construction site safety should comprise the following critical components, viz. determining safe means and methods, setting a safe pace of construction, determining what safety equipment will be used, and monitoring for unsafe conditions and for unsafe acts. He found that four factors explain why widespread agreement does not exist with regard to the respective site safety roles of construction entities. These are as follows: a) detailed expectations about site safety roles are not written into project contracts, governmental standards or other referential material, b) conflict exists between the rhetoric and reality of the operations of OHS agencies, c) the influence of recent salient court decisions and d) recent literature advocating increased safety obligations for design safety professionals (Toole 2002).

Toole's research (2002) points out that construction safety remains the concern of all individuals and organisations involved in construction projects and that all parties to a construction project must communicate their expectations of site safety roles throughout the duration of a project. His research concluded that the capacity of architects/engineers, general contractors and sub-contractors to influence onsite construction safety differ according to their respective professions. Toole (2002) found that, under the traditional design-bid-construct project structure, while subcontractors heavily influenced the root causes of accidents, general contractors retained a moderate ability of influence. On the other hand, architects/engineers exercised little influence over the root causes of accidents. From his research, Toole (2002) advocates that site safety expectations should not only be practical in nature and reflect the influential abilities of each construction party but also should be project and company specific. Toole (2002) also emphasises the importance of each of the different construction parties with respect to establishing realistic and shared expectations about the safety role that each entity can fulfil. Shared expectations of safety outcomes and processes are also argued to assist in the prevention of onsite construction accidents (Toole 2002).

In view of Toole's (2002) finding that safety roles and responsibilities must be shared across all phases of a construction project, the following sections discuss the role of the clients and project managers in construction OHS. Safety issues in the project procurement, design, construction and commissioning aspects of a construction project are also examined, along with the roles and responsibilities of key stakeholders in each of these areas.

### 5.1 Clients

In consideration of the fact that construction industry clients are the key drivers of performance improvement and innovation (Briscoe et al. 2004), both Briscoe et al. (2004) and Wild (2005) postulate that clients are best positioned to demand safety processes and outcomes. The Australian National Health and Safety Commission defines the client as the "person who commissions design work for a structure" (NOHSC 2005, 6). The ILO (1992) elaborates further. It holds that the client is responsible for appointing another company or individuals to oversee and coordinate OHS management (ILO 1992, 9-10). In a similar fashion, the European Union's *Construction Site Directive* regards the client as being responsible for safety. If the client has hired a 'project supervisor' to coordinate a project, this party then assumes responsibility for organising safety procedures and associated undertakings (Bluff 2003, 10-11). Most member states of the European Union consider the client and project supervisor to be responsible for safety (Bluff 2003, 10-11). Furthermore, the majority of the European Union member states concur that the client can influence the safety outcomes of a project by a) the "financial specifications and contract negotiations" that can determine employment conditions and b) the allocation of funds needed to implement safety measures in a comprehensive fashion (Bluff 2003, 10-11).

In Australia, the Federal Government's Building Industry Taskforce, which was operational until 2005, envisaged that the client should occupy a pivotal role in "driving industry improvements" (Building Industry Taskforce 1997, 6). The Taskforce was of the opinion that the client could improve OHS by applying "even more stringent criteria to identify, encourage and reward better performers" (Building Industry Taskforce 1997, 6). This is derived from the notion that clients have the option to select business partners, contractors and other industry players that have a positive safety reputation and can adopt safe business practices (Building Industry Taskforce 1997, 6).

Huang and Hinze (2006a) referred to clients as owners. These authors examined the role of owners in construction safety and the impact of this role on safety performance. Their research focused on project characteristics, selection of safe contractors, contractual safety requirements and owner participation in safety management during the execution of a project. The authors found that owners possess the capacity to influence project safety performance in a positive fashion. Furthermore, it is asserted that the owners of large construction projects participate more actively in safety management at each stage of the project, such as project design, contractor selection, contract development and construction. Petrochemical owners, in particular, were observed as the most proactive in their management of safety (Huang and Hinze 2006a). In addition, Huang and Hinze's research (2006a) also identified seven factors essential for enhancing project safety performance, these being

1. High owner commitment to safety
2. Safety enforcement and follow-up through training and encouragement for workers to report unsafe acts
3. Recognition of onsite hazards and near-misses and formal documentation of these
4. Clearly defined personal accountability for each construction party closely related to the performance evaluations
5. Continual safety communication
6. Careful development evaluation and modification of safety programs; and
7. Implementation that ensures consistency for all contracting parties, regular onsite safety inspections, constructability design reviews and safety culture.

In their bid to extend the role of owners in construction safety, Huang and Hinze (2006b) developed a guidance model that could be used to evaluate the impact of different owner practices on project safety performance. Their research revealed that the impact of owners in influencing construction safety is best assessed in view of the project characteristics, selection of safe contractors, contractual safety requirements and the owner's proactive involvement in safety management. Huang and Hinze (2006b) observed that owners with safer projects generally allocated higher funds to safety by balancing safety and cost during contract negotiations, employing full-time onsite safety representatives, funding safety recognition programs and supporting a safety orientation. They observed that owners can positively influence construction project safety by setting safety objectives, selecting safe contractors and participating in safety management during construction. As a consequence, these authors argue that owners should demonstrate their commitment to safety by providing adequate resources for safety initiatives, communicating safety in a timely manner, selecting safe contractors and participating actively in safety management. Huang and Hinze (2006b, 181) summarise the role of the owner in construction safety as:

> *"… to oversee and facilitate safety management on the project" not necessarily adopting a "leadership role for project safety management" but maintaining favourable safety attitudes and demonstrating physical involvement in safety to positively impact the "safety performance of general contractors and subcontractors."*

In addition to the client's role in construction OHS advocated by Huang and Hinze (2006b), Hislop (1999) argues that the client must establish safety as an integral project component before any onsite construction work is initiated. Hislop (1999) maintains that each contractor and sub-contractor develop safety programs at the tendering stage of operation and that clients should monitor the implementation of these programs following the commencement of onsite construction work.

## 5.2 Project Managers

The literature suggests that the role of project managers with respect to safety is concerned with developing a strong management commitment to safety and actively demonstrating this commitment to subordinates. Although planning and control failings have been identified as the major root causes of safety incompetence, it is recognised that management commitment to safety essentially dictates safety performance (Saurin et al. 2004). According to Wild (2005, 24), the poor safety performance of the Australian building and construction industry is "not a result of time, budget, competition issues" but is attributable to "a lack of commitment on safety". This view is supported by Hislop's observation (1999, 7) that OHS issues are inherent in varying commitments to safety across different construction operational strata: "Where senior management may in fact be strongly committed to safety, supervisory level personnel may well be the point of disconnect between management's commitment to safety and the regular application of safe work practices by workers".

### 5.2.1 Management Safety Commitment

According to Siu et al. (2004) the safety attitudes of management heavily impact those of workers. What is more, attitudes towards safety are more or less seen to predict occupational injuries (Siu et al. 2004). These authors observed that where management possessed a low regard for safety, workers focussed on being productive and generally disregarded safety as a priority (Siu et al. 2004). In a similar fashion, Geldart et al.'s longitudinal survey (2005) of OHS attitudes, practices and policies among Canadian worker and management representatives in the manufacturing sector revealed that management commitment, effective communication, worker involvement, attitudes, competence, and supportive and supervisory environments are critical factors with regard to establishing positive safety climates. Their study, based on data from 1990 to 2001, identified the following factors as essential components of enhancing OHS outcomes:

- Increased awareness of OHS issues;
- Upper management involvement in OHS; and
- Reduced delegation of OHS authority to workers.

In addition to management commitment to OHS, Mohamed's study (2001) into the relationship between safety climate and safe work behaviour in construction site environments in Australia revealed that the following factors were critical for positive safety climates:

- Demonstration of management commitment;
- Non-punitive approaches to safety; and
- Promotion of open OHS-related information exchanges.

Nishgaki et al. (1994) examined 35 cases of construction injuries between 1981 to 1985. These interviews with construction managers and workers revealed that many of the underlying causes of occupational accident recurrence were attributable to leadership, fellowship and the interaction between the two referred to as 'humanware'. Nishgaki et al. (1994) observed that the major causes of OHS failures were inadequate safety education, inadequate instruction, poor housekeeping and "wilful transgression". He noted that employer and employee attitudes to onsite safety occupy a central position in the uptake of OHS and concluded that management commitment is responsible for the majority of 'humanware' issues. In response to these factors, Jaselskis et al. (1996) argued that management should occupy a more active role in safety programs and, where possible, superintendents should have a significant role in determining project safety performance. Furthermore, Dejoy (1985) was of the opinion that safety programs are most effective when two-way communication between workers and managers exists. However, when one considers that high-level management is removed from onsite OHS conduct, management appears to lack the first-hand experience necessary to accommodate worker needs (Dejoy 1985).

Mohamed (1999) investigated the role of management commitment towards promoting a zero-accident culture and the impact of this on safety performance. By surveying medium and large organisations engaged primarily in construction and building industries, Mohamed (1999) found that, although organisations indicated commitment to reasonably high levels of safety management, this was not reflected in perceptions of safety performance and pro-activeness in implementing safety management initiatives. He also observed that a change in safety culture, namely redesigning the way in which organisations view and approach safety management activities, was long overdue. This is supported by Dejoy's finding (1985) that upper management perceptions of the causes of safety performance are based solely on safety records. Mohamed (1999) also noted that the processes of onsite hazard detection and management response to OHS issues required thorough analysis in terms of basic activities such as planning, detection, action and feedback to employees. In order to enhance the effectiveness of existing hazard detection and management approaches, the interaction between these four aspect listed directly above was also identified as another area requiring improvement.

Abudayyeh et al. (2005) randomly surveyed 40 of the top 500 US construction companies with a view to determining whether a relationship exists between management commitment to safety and the frequency of construction-related injuries and illnesses. These authors observed that safety managers have the opportunity to influence and enhance both the quality and safety of the work environment. The research revealed the following findings:

- Employees who work more than 50 hours per week incur more injuries and illnesses than those who work less hours;
- Construction companies with a safety budget that allows the safety manager to spend in excess of $1000 without seeking higher approval have fewer injuries and illnesses than those without;
- The presence of full-time construction personnel trained in first aid techniques contributes to fewer injuries and illnesses; and

- Organisations that adopt in-house safety programmes that extend standard OHS regulations benefit from fewer injuries and illnesses.

Abudayyeh et al. (2005) also observed that safety managers and teams have the capacity to improve their programs through engineering improvements to equipment, methods and materials and changing human behaviour in a positive sense by means of education and training. These authors identify a need for safety to become a culture and a value, with clear commitment from all levels of management demonstrated in the following forms:

- A safety budget in excess of $1000;
- An onsite safety manager who possesses appropriate safety knowledge, skills and ability in order to promote and maintain safety conscious, efficient workers;
- Continuous education, training, feedback and evaluation of results;
- A safety culture that encompasses all personnel from the worker to the supervisor, middle and upper management and enforces penalties for breaches;
- Employee safety empowerment;
- Continuous monitoring, feedback and improvement of worker performance; and
- Worker and employee involvement in policy making.

In addition to Abudayyeh et al.'s recommendations, Dejoy (1985) suggests that demonstration of management commitment to OHS can be manifested in the following practices:

- Safety matters being given high priority in company meetings and planning activities;
- Personal involvement in safety activities by top-level managers;
- Safety officers retaining relatively high rank and status within the organisation;
- Open two-way communication between labour and management on safety issues;
- Importance of safety inspections, environmental control and general housekeeping considered;
- Emphasis of safety training for employees at all levels; and
- Active and recognisable promotion of safety awareness within the organisation.

Thus the view exists that safety is an integral part of the management system and that accidents represent systems failures (Dejoy 1985). Acknowledging that accidents result from combinations of causes, both internal and external to employees, Dejoy (1985) suggests that a balanced approach to safety is required, this being one which emphasises control of situational and environmental factors, in addition to worker behaviour. He argues that successful safety programs exist when "management recognises that safety is a management function" and when "a pronounced bias toward internal attributions does not exist" (Dejoy 1985, 68). Cohen and Cleveland's study (1983) into the safety practices of organisations reveals that those organisations with exceptional safety records include safety in all performance evaluations across the organisation. According to Dejoy (1985), the inclusion of safety as a performance criterion not only rewards good safety performance but also clearly establishes safety as an important job consideration for managers and workers, which should result in holistic safety integration.

Levitt and Parker (1976) and Koehn et al. (1995) are of the view that the following management-focused strategies are effective in terms of reducing accidents and improving safety performance:

- Accepting personal responsibility for improving safety and minimising and correcting unsafe working conditions;
- Communicating and demonstrating a genuine concern for safety;
- Using of self-inspection programs;
- Allocating accident costs to projects;
- Creating a company safety account in order to fund accident prevention programs;
- Adopting an active surveillance program in order to collect and disseminate information about accident rates in each project;
- Evaluating field managers for promotions and salary increases in terms of accident records;
- Considering safety as equal to cost and schedule;
- Adopting a cost-reporting system that reflects the cost of accidents in weekly or monthly cost reports;
- Providing training for newly-hired workers that emphasises safe work methods and the possibility of job hazards; and
- Incorporating the cautionary use of incentives.

Gun and Ryan (1994) support the use of incentives in construction work. These authors observed that safety bonuses were weakly related to increased injury risks and that production bonuses slightly decreased risks of injuries. Furthermore, Nishgaki et al. (1994) postulate that management commitment to OHS should be supplemented with the provision of safety equipment, standard work procedures and safety regulations.

### 5.2.2 Safety Leadership

In addition to the demonstration of management commitment to safety, Carrillo (2005) postulates that project managers should concern themselves with safety leadership. According to this author, failed implementation of safety initiatives and results are not the result of a lack of management commitment to safety but that of mismanaged polarities, misunderstanding of the concept of polarity and the inability to speak intelligently about ethical dilemmas underlying polarities. Carillo (2005) defines polarities as paradoxes such as the trade-off between safety and production, or quality and cost. She suggests that addressing polarities requires individuals to firstly be aware of their existence and then acquire the skills needed to discuss and balance these situations in order to allow organisations to maintain high safety performance and productivity, quality and cost-effectiveness. Carrillo (2005) claims that safety leaders must understand the ethical and moral dilemmas that cause conflict between business and safety priorities and that those leaders with these abilities are better able to inspire and motivate employee safety commitment.

The effects of leadership dimensions, safety climate and assigned priorities on minor injuries in work groups was also focus of Zohar’s survey (2002) of 411 production workers in a US-based metal processing plant. This study implies that the effectiveness of safety programs depends on the priorities established by upper management. Zohar (2002) suggests that, in supervision-based safety models, behavioural safety depends on performance reliability, close monitoring and the provision of contingent consequences such as rewards and punishments. In contrast, leadership-based safety models were observed to operate on the premise that behavioural safety depends on leader-member exchanges whereby quality influences group communication and individual development (Zohar 2002). The author also notes that, although leadership and safety climate comprise salient areas of OHS, safety program effectiveness is dependent upon the priorities established by upper management.

### 5.2.3 Hazard Identification and Control

Hazard identification and control has been identified as another responsibility of project managers (Gun and Ryan 1994). In examining the role of management practice on safety across 98 worksites reporting severe and moderately severe injuries in South Australia, Gun and Ryan (1994) note that, under OHS legislation in most Australian states, management retains responsibility for identifying and controlling hazards at worksites and that organisations must develop procedures for conducting these tasks. In a similar fashion, Hislop (1999) suggests that OHS issues would be better managed if program standards, implementation criteria and monitoring responsibility were clearly defined before any work is contracted (Hislop 1999).

Acknowledging that hazard identification is fundamental to construction safety management, Carter and Smith (2006) investigated the hazard identification levels of three construction projects in the UK. These authors observed that construction projects within the nuclear industry identified 89.9% of all hazards, while projects within a railway context identified 72.8%. The research revealed that knowledge and information barriers, in addition to process and procedural barriers, prevented effective hazard identification. Lack of information-sharing across projects, lack of resources on smaller projects (such as industry publications and full-time safety departments) and reliance upon tacit knowledge comprised knowledge and information barriers to effective hazard identification (Carter and Smith 2006). Process and procedural barriers observed included a lack of a standardised approaches and undefined structures for tasks and hazards (Carter and Smith 2006). Carter and Smith (2006) advocate that these barriers should be eliminated by means of the documentation and sharing of tacit knowledge through a centralised database and the provision of clearly-defined structures for developing construction method and risk assessment statements. They define a construction method statement as a “discrete list of tasks that describe the work outlined in the scope of the method statement” that essentially focuses on defining specific tasks and explaining the manner in which they are structured (Carter and Smith 2006, 202). These authors also provide a generic definition of a task as a “package of work small enough to be distributed throughout many method statements without any significant distortion to the basic task description” (Carter and Smith 2006, 202). Likewise, the HSE (1998) explain that risk assessments involve careful examination of the work environment in order to identify potential causes of harm to individuals and permit evaluations of existing precautions. These assessments should also acknowledge areas where further harm prevention initiatives are required.

Manuele (2005) explored the effectiveness of risk assessments and hierarchies of control in OHS. He observed that hierarchies of control resolve unacceptable hazardous situations by sequentially establishing the actions to be considered in order of effectiveness. According to Manuele (2005), the safety-decision hierarchy is comprised of four stages, viz. problem identification and analysis, consideration of actions in order of effectiveness, decision and action and effectiveness measurement. The first stage (problem identification and analysis) involves hazard identification and analysis, in addition to risk assessment, while the second stage requires actions to be ranked from most effective to least effective (Manuele 2005). Stage two also involves eliminating the hazards and risks through system design and redesign, reducing risks by substituting less hazardous methods or materials, incorporating safety devices, providing warning systems, applying administrative controls such as work methods and training and providing personal protective equipment (Manuele 2005). While stage three involves making decisions and putting them into action, the last stage measures the effectiveness of the decisions and actions and reanalyses decisions as required (Manuele 2005). The research also suggests that risk assessments and hierarchies of control should encompass typical problem-solving techniques and to be effective, require strong management understanding, commitment and application.

### 5.3 Procurement

Traditional criteria for contractor selection have generally focussed on tender cost (Tookey et al. 2001). Kumaraswamy and Dulaimi (2001) claim that these types of construction procurement methods are problematic since they are unable to raise productivity levels beyond those stated in protocols and are incapable of managing complex multiple-goal, multi-disciplinary and multi-participant scenarios. Furthermore, these authors argue that existing procurement methods are not holistic in nature and therefore are unable to address parameters of efficiency and effectiveness in an adequate fashion.

According to Tookey et al. (2001, 22), “clients are recognising the importance of best value” and are selecting contractors on basis of capability. Their research implies that client objectives for contractor selection heavily dictate the criteria for selection. In selecting contractors, these authors summarise the core client objectives as obtaining the highest realistic quality, lowest realistic cost, minimum realistic time into service, high prestige for the building within affordability parameter and minimum conflict during the process. Other client expectations of contractors include active involvement throughout construction, final cost certainty, completion date certainty, value for money and the lowest possible tender (Tookey et al. 2001, 22). In a similar manner, Walker (1996b) contends that, with quality, cost and time being deemed critical to project success, these factors comprise important considerations in contractor selection. Bennet and Flanagan (1983) also support this notion by suggesting that clients should consider the contractor’s capacity to function and provide quality at the right price, their speed of construction, balance of construction and life-cycle costs, tax benefits, risk/uncertainty identification, design innovation, and client involvement throughout the duration of the project. In a similar manner, Holt (2001) asserts that contractor selection criteria should extend beyond lowest price and should include intangible considerations such as environmental preservation and social and economic sustainability. In this process, Holt (2001) is of the belief that contractor appraisals should adopt a project whole-of-life value approach in order to evaluate multiple facets of contractor performance. For contractors to acknowledge and fulfil these client expectations, Tookey et al. (2001) assert that generic types of best practice such as supply chain management, lean construction, investment in IT and partnering should be applied to construction projects.

As part of China’s national economic reforms, the Chinese construction industry is moving towards competitive procurement systems (Shen and Song 1998). Shen and Song (1998) explored the feasibility of competitive tendering practices in the Chinese construction industry by surveying large state-owned construction companies. The research indicates that there is a lack of consistency in procurement methods in the construction sector in China. In specific terms, tendering methods were found to range from open tendering, selective tendering, negotiation and domestic and international open tendering. Shen and Song (1998) found that the criteria for selecting tenders varied according to the scope and scale of the projects. Commonly used criteria for awarding tenders included best price, shortest construction time, reputation and credibility of the contractor (Shen and Song 1998). The authors note that, since relevant legislation and control measurements for construction procurement are yet to be developed in China, contractor quality, credibility and past reputation are often the key selection criteria. The authors observed that competitive tendering practices significantly contributed to improving construction effectiveness, productivity and management efficiency. This finding corroborates Song’s research (1998) that competitive tendering practices have the capacity to reduce project construction time by 10 to 40%. Shen and Song (1998) also observed that the competitive tendering process for construction projects in China is less transparent compared to Western nations and requires further development.

In the UK, as construction clients are increasingly demanding best value for procured services, the traditional lowest price contractor selection process is shifting towards the use of multiple selection criteria (Wong et al. 2000). By surveying 86 public and private sector construction clients, Wong et al. (2000) examined client preferences for lowest tender price and identified the project-specific criteria used to award tenders. The research revealed that both private and public sector clients considered tender price to be more important than project specific criteria. Although price dominated contractor selection, when price and project specific criteria received equal consideration, public and private sector clients differed in their view of the most important project specific criteria. The following table outlines the project specific criteria used by private and public sector clients in contractor selection:

**Table 1**
**Contractor Selection Criteria: Differences in Public and Private Sector Clients**

| Public Sector Clients | Private Sector Clients |
|---|---|
| ▪ ability to complete on time<br>▪ maximum resource/financial capacity<br>▪ ability to deal with unanticipated problems<br>▪ site organisations, rules and policies and OHS<br>▪ training or skills levels of craftsmen<br>▪ actual work quality achieved on similar works<br>▪ comparison of client's estimate with tender price<br>▪ finance arrangements<br>▪ proposed construction method<br>▪ quality and quantity of managerial staff<br>▪ quality and quantity of human resources<br>▪ experience with specific type of facility<br>▪ amount of key personnel for the project<br>▪ actual schedule achieved on similar works<br>▪ type of project control and monitoring procedures | ▪ ability to complete on time<br>▪ ability to deal with unanticipated problems<br>▪ quality and quantity of managerial staff<br>▪ types of project control and monitoring procedures<br>▪ actual work quality achieved on similar works<br>▪ amount of key personnel for the project<br>▪ actual schedule achieved on similar works<br>▪ maximum resource/financial capacity<br>▪ site organisation, rules and policies and OHS<br>▪ experience with specific type of facility<br>▪ quality and quantity of human resources<br>▪ comparison of client's estimate with tender price<br>▪ proposed construction method<br>▪ amount of decision-making onsite<br>▪ training or skill level of craftsmen |

Source: Adapted from Wong et al. (2000, 772)

It is interesting to note that, although the two sectors essentially identified the same criteria for contractor selection, they differed in the ranking of each dimension. For instance, the public sector criteria concentrated on cost, timeframes, management processes and procedures and dispute resolution. On the other hand, private sector clients place an emphasis on criteria related to timeframes, dispute resolution and accountability. Another key differential between the two sectors relates the public sector's nomination of finance arrangements as a criterion. On the other hand, the private sector included the amount of decision-making authority onsite as a factor for consideration. These differences may be explained by the unique nature and goals of each sector. According to Dibben and Higgins (2004), an increased emphasis on management accountability, transparency, efficiency and effectiveness exists in the public sector since financial resources or profits do not comprise the most important evaluation criteria (as they do in the private sector). Furthermore, the public sector distinguishes between clients and citizens and operates in a public environment where limited tolerance for mistakes exists (Dibben and Higgins 2004).

Wong et al. (2000, 772) observed, that although both private and public sector clients seek to acquire best "value" from their contractors, they are beginning to realise that this value is not necessarily contained in lowest price tenders. Although these authors identify a growing trend for best-value contractor selection in the UK and list the frequently used project specific criteria for contractor selection, these authors fail to explain the dimensions and weightings of each of these criteria.

Based on the notion that one of the key objectives in public sector construction projects should be to procure for best value and that best value procurement is reliant on sound contractor selection strategies, Palaneeswaran et al. (2003) developed a structured best-value based contractor selection framework for use in public sector construction projects. According to these authors, the core criterion for contractor selection has been cost, particularly in the Hong Kong public sector. Traditional criteria for contractor selection have also included time and quality parameters (Palaneeswaran et al. 2003). They suggest that, although the use of price as a key selection criterion is likely to result in financial savings, this strategy may not provide best value or economical returns. This is because of differences in performance levels of contractors or consultants under different operating conditions, non-price attributes that have the potential to increase considerably the procured value (such as capacity for faster construction and better quality) and unwelcome adjustments that may eventuate from contractors or consultants compensating for unrealistically low bids or improperly balanced risk allocations.

According to Choi (1999), since best value is an ambiguous concept, an agreed upon and usable definition may not exist. Palaneeswaran et al. (2003) reinforce this notion by suggesting that best value differs according to the particular viewpoints considered and that contractor selection should reflect this by including both intrinsic and extrinsic tangible and intangible aspects of best value. These might include cost savings and enhanced harmony and relationships. To manage these varying conceptions of best value in an effective fashion, Gransberg and Ellicott (1997) advocate that best value procurement should focus on selecting contractors that are most advantageous to the client, especially when price and other important factors are equally weighted. Palaneeswaran et al. (2003) also propose that client selection of contractors be based on the potential contractor's capacity to provide best value in terms of their time, budget, credibility and reputation, environmental consideration, life-cycle operation and maintenance costs, maintainability aspects, demolition and replacement aspects, in to other factors such as health and safety, security benefits to the local economy, flexibility for other usage and upgradability. These authors suggest that best value in public sector contractor selections should incorporate both 'hard' and 'soft' approaches with hard approaches focusing on desired deliverables defined in tangible benefits through specifications, plans and designs (Palaneeswaran et al. 2003, 428). According to the same authors, 'hard' approach deliverables should be controlled against value for money and public accountability by means of supervision, quality control, milestone-based or performance-based payments, liquidated damages and other contractual measures. Conversely, 'soft' approaches focus on improving product or service quality and eliminating or minimising issues of bad performance

(Palaneeswaran et al. 2003). These ‘soft’ approaches also promote strategies that incorporate incentives or disincentives with respect to partnering or alliancing arrangements (Palaneeswaran et al. 2003). Palaneeswaran et al. (2003) also suggest that ‘soft’ strategies reinforce both tangible and intangible benefits yet aim to achieve harmonious best value in the short and long term. They conclude that, for best-value-focused procurement to derive sustainable benefits in a harmonious manner, standard repeatable selection procedures should be established that include a) soft elements beneficial for enhanced communications, b) equitable risk sharing, c) greater mutual trust and effective pain or gain sharing mechanisms and d) incentives for close collaboration in achieving mutually aligned objectives.

As part of its strategy to improve the nation’s economy, the South African government is heavily investing in physical and social infrastructure (Gounden 1997). In order to coincide with this approach and promote construction SMEs, an Affirmative Procurement Policy was developed (Gounden 1997). The policy required contractors, suppliers and service providers to execute their contracts in accordance with a human resource specification, in addition to the existing requirements of these parties to construct, supply and provide a service that will comply with technical specifications (Gounden 1997). The specification contained in the new policy requires parties to define and establish goals for targeted medium-, small- and micro-enterprise participation in the performance of contracts in a manner that can be quantified, measured, verified and audited (Gounden 1997). The human resource specification also outlines the way in which contractors can realise these goals and comply with contractual requirements; it also provides clients with measures to remedy and penalise for non-compliance. Gounden (1997) notes that, for public sector procurement to be a catalyst for the integration of construction related SMEs into mainstream construction activities in South Africa, a consistent and standardised approach must be adopted by all tiers of government (Gounden 1997). Furthermore, the public sector needs to adopt a professional approach to construction procurement that includes effective management by suitably skilled built environment public servants, specialised training programs and policies (Gounden 1997). Gounden (1997) also points out that optimisation in public sector construction procurement as a measure to promote construction related SMEs is only possible when a range of enabling systems become fully operational.

In evaluating the construction procurement process in South Africa, Rwelamila et al. (2000) surveyed construction firm executives, contract managers, site managers, trade foremen and skilled tradesmen in the public sector of Botswana. In addition to inappropriate project organisational structures, these authors found that the default construction procurement system provided a poor relationship management system that did not reflect sustainability parameters. Contracts were awarded on the basis of price, while tenders were based on incomplete designs (Rwelamila et al. 2000). The authors concluded that the procurement processes used in Botswana were inappropriate and impeded the attainment of sustainable construction.

Tookey et al. (2001) examined procurement systems in the construction of cinema and bowling entertainment complexes, retail redevelopments, airport terminals, retail group superstores and hotel wing extensions in the UK. Their interviews with clients, contractors, quantity surveyors, architects and engineering consultants revealed that procurement systems are significantly more complex and variable than construction academics generally acknowledge. These authors concluded that, on account of the sheer variability of these systems, it is essentially impossible to classify them by means of any sort of rational positivist approach.

## 5.4 Design

According to Smallwood (1996), 50% of OHS issues are attributable to inadequate design. In view of this, the concept of considering safety in the design phases of construction (Gambatese 2003) is gaining momentum on a global scale (Behm 2005). Defined as "the consideration of construction site safety in the design of a project", safety by design involves modifying the permanent features of the construction project in order to ensure that construction site safety is considered, including safety in the site construction plans and specifications, the use of specific designs to accommodate safety suggestions and communicating the design risks with respect to the site and work to be performed (Behm 2005, 590). NOHSC (2005, 6) defines a designer as "the person who is responsible for planning and undertaking designs for structures and also coordinating other people who are involved in the design process". In 1985, the International Labour Office first identified the need for design professionals to be involved in safety planning. Article 9 of the General Conference of the International Labour Organisation, C167 Safety and Health in Construction Convention, 1988, maintained that designers and planners are accountable for including health and safety provisions in design. Extending this view, the European Foundation for the Improvement of Living and Working Conditions (1991) reported that 60% of fatal construction accidents result from decisions made upstream and that shortcomings in design and work organisation contributed to fatalities. In support of this statistic, Jeffrey and Douglas (1994) reviewed the safety performance of the UK construction industry and identified a strong relationship between design decisions and safe construction. Furthermore, Szymberski (1997) notes that construction safety should be an ideal consideration in the conceptual and preliminary design phases.

It has been argued consistently that it is beneficial to integrate safety measures into the entire development process of a construction project, including the design. Recommendations 24 and 27 of the Cole report (2003) propose that safety measures should compulsorily be integrated into the design and management of a construction project. Recommendation 24 suggested investigating the feasibility of adopting the UK Construction Design and Management (CDM) Regulations 1994, which places the onus on the "key duty holders". The UK CDM regulations regard the coordinator as a fundamental member of a construction team whose essential role is to monitor the application of OHS standards into the "design and planning" stages of a project (Bluff 2003, 11).

In 1992, the European construction industry guidelines were restructured in an effort to vastly improve OHS standards in the region, with the implementation of Directive 92/57/EEC. This Directive provided an outline of "minimum safety and health requirements at temporary or mobile construction sites", commonly referred to as the *Construction Site Directive* (Bluff 2003, 1). This directive is now adopted "in the law of all member states of the European Union and represents the most far-reaching regulatory initiative with respect to improving the amount of attention being paid to OHS in the design and planning of construction works" (Bluff 2003, 1). In the UK, the design and planning elements of the *Construction Site Directive* have been adopted, with some amendments, in the *Construction (Design and Management) Regulations 1994* (CDM regulations).

The designer has varied levels of responsibility across different European countries. Countries such as Sweden, Denmark, Finland, UK and the Republic of Ireland "designate specific responsibilities to designers" with reference to the inclusion of OHS in planning and design (Bluff 2003, 11). For example, in Germany, specific training requirements exist for different aspects to a construction project, these being design, preparation, operations, construction and OHS (Bluff 2003). This is similar to the training regimes currently in place in Belgium and

France, where training is both competency- and experience-based and includes the following components: theoretical safety knowledge, industry experience and interstate or inter-country experience (Bluff 2003).

In 2005, the construction branch of the Health and Safety Executive for Scotland, the North West and Newcastle upon Tyne released a design initiative report on the outcomes of the Take the Designer to Site Initiative, which focused on improving safety when working at heights (Franklin 2003, 3). The report detailed a successful response, with “continuing improvement in designer performance over the last 3 years” (Franklin 2003, 4). More specifically, designers exemplified good practices by working and communicating successfully with the principal parties of a construction project, such as supervisors or clients, and by developing overall good working relationships with project team members and successfully communicating with these members. The report commends designers for taking the initiative to learn about OHS and incorporate safety into their designs, which has helped to reduce the dangers involved in construction. In addition, the report criticised designers for the amount of useless paperwork they are accustomed to accumulate in including OHS in design processes and their lack of overall understanding with regard to OHS (Franklin 2003, 4).

An Issue Paper released by the Australian National Occupational Health and Safety Commission (NOHSC) entitled ‘Eliminating Hazards at the Design Stage (Safe Design): Options to improve Occupational Health and Safety outcomes in Australia” outlines the concepts and benefits of “Safe Design” (NOHSC 2003, 2). The Issues Paper addresses the need to integrate OHS across all phases of a construction project. This includes the “concept and planning phases with an emphasis on making choices about the design, method of manufacture or construction and/or materials used which enhance the safety of the designed-product” (NOHSC 2003, 4). The potential to integrate OHS at the earliest possible stages of a construction project is seen as the most effective method to ensuring safe practices. NOHSC presented data in the Issues Paper that targets poor design as a contributing factor to workplace accidents and fatalities and cited a “draft report” from November 2003. This draft report indicated that, out of the 43 fatalities “involving machinery and fixed plant” in construction industry between 1 July 2000 to 30 June 2002, 53.5% were certainly caused by poor design (NOHSC 2003, 26). Overall, when considering total workplace fatalities, it was found that, in the same two year period, 20% of all workplace fatalities resulted from “poor design” (NOHSC 2003, 6).

Furthermore, it was expressed that the inconsistencies in “OHS legislation between Commonwealth, state and territory jurisdictions, as well as differences between OHS statutes and regulations within a jurisdiction”, along with the variations between Australia and international design relations and “different regimes for regulating particular design-products”, were clear obstacles to improving safety in design (NOHSC 2003, 7). Specifically directed at the construction industry, NOHSC’s Issue Paper recommended the application of safe practices across the entire life-cycle of a construction project, including safety in the construction phase, during maintenance and for end-users (NOHSC 2003, 10). The Issues Paper identifies the “selection and coordination of multiple contractors engaged in construction and communication and the cooperation between the respective phases of design, planning and construction” (NOHSC 2003, 10).

Under the legislative framework and content of OHS regulations throughout Australia, the “principle contractor” has typically been regarded as ultimately responsible for the construction phase of projects. OHS in design has not been enforced as a part of law. The NOHSC Issues

Paper concluded, however, that the inconsistencies in legislation made it difficult to engender legislative change for safety in design at a national level (NOHSC 2003, 14). The NOHSC paper cited the Cole Inquiry recommendations for a national approach to OHS, which the Commission unequivocally supported (NOHSC 2003, 12).

The Issue Report discussed the problems caused by using “structural materials originating from overseas” that complied with different international requirements (NOHSC 2003, 15). Further to the Issue Paper recommending that Australia needed consistent safe design regulations and laws, NOHSC saw benefits in homogenising certain international OHS design standards (NOHSC 2003, 15). The NOHSC report discussed recommendation 24 of the Cole Inquiry, which advised that Australia “investigate and report on whether any measures in the Construction (Design and Management) Regulations 1994 (UK) should be adopted in Australia, whether in whole, or in part with variations” (Cole 2003, 45). As a consequence, a report was prepared in 2003 by the National Research Centre for OHS Regulation (NRCOHSR). This report looked into the feasibility of the adaptation of any components of the UK CDM Regulation and the European Union Site Directive and was prepared by Liz Bluff. Bluff (2003, 21-22) noted that:

> *…Rather than simply transplanting existing UK (or European) regulatory requirements into the Australian building and construction industry, this report argues that more effective prevention of occupational fatalities, injuries and disease can be achieved by designing regulation that specifically addresses Australian regulatory goals, seeks out the most effective forms of regulation to achieve these goals, and takes account of the successes and warnings from overseas' experience.*

The report outlines seven preliminary goals to assist with establishing a ‘framework.’ These are as follows:

1. Enhancing consideration of OHS matters in the design and planning of a wide range of construction works, and improving OHS for a range of persons who could be affected by these works;
2. Promoting the engagement of all parties with real control or influence in the design and/or planning of construction works in OHS risk management; identifying and eliminating or minimising probable risks “as early as possible in the design”, which may relate to choice of materials and methods, planning and organisation of work, selection and coordination of contractors;
3. Providing regulations in order to ensure acceptable OHS knowledge and capability on the part of those involved in design/planning decisions;
4. Verifying that key information is transferred from the design/planning phase to the principal contractor and other contractors engaged in the construction phase, and those engaged in subsequent work in, on or about the structure;
5. Ensuring that regulatory requirements are readily enforceable by timely identification of construction works in the design/planning phase that will enable inspectors to engage with clients, designers and developers before the commencement of construction works;
6. Promoting a regulatory regime that will be nationally consistency.

(Bluff 2003, 22)

The Royal Institute of Architects (RAIA) submitted a response to the NOHSC Issue Paper on safe design. The RAIA saw the need to clarify the “roles of specific industry participants and the distinct phases of the building process with respect to occupational health and safety" (RAIA 2004, 6). More specifically, the RAIA expressed concern regarding the use of "Eliminate" in the title of the Issues Paper. The RAIA viewed that it was "inaccurate and misleading in developing a sound understanding of the design and construction process" (RAIA 2004, 10). The RAIA submission included the concern regarding the variable role of an architect, which changes "with the type of project, method of procurement or scope of commission" (RAIA 2004, 13). More importantly, the RAIA dismissed the application or adaptation of the UK CMD system and identified the lack of evidence regarding the success of these regulations (RAIA 2004, 19). Furthermore, it was perceived that "design professionals would not be qualified to provide an appropriate OHS plan for a construction project (RAIA 2004, 17).

The RAIA agreed with the concept of a nationalised system for Australia, as is recommended in the NOHSC Issue Paper, since this would provide an opportunity to deliver a consistent regulatory structure. Overall, the RAIA agreed with "many observations and conclusions made" (RAIA 2004, 15). However, the Institute had a number of concerns, primarily with regard to phraseology and the incorporation of OHS in design provisions. In its current format, the RAIA was of the opinion that the recommendation to include OHS into the design component of a construction project was too ambiguous and, if put into practice in its current form, could obscure the role of designers. The RAIA concluded that the definitions of designers and their responsibilities needed further clarity. Indeed, it was noted that this recommendation would mean that designers would be held increasingly responsible for any type of accidents. Furthermore the RAIA (2004, 19) stated that it "absolutely disagrees that there is any demonstrated statistical link between workplace fatalities and injuries and [deficiencies] in architectural design".

The RAIA suggested that the NOHSC Issue Report lacked clarify in the distinction between "end user products", or those who gain access to the construction project subsequent to its design (RAIA 2004, 15). The Institute proposed conducting an investigation into the feasibility of adopting the *Building Code of Australia 1996* (BCA) as the vehicle for including OHS provisions in the construction process of a building or structure. In its current form, the BCA does not address safety minimisation during the construction process. Indeed, it primarily outlines the safety precautions that must be integrated in order to safeguard the finished building. The BCA requires that designers consider the position, location, circulation and access to safeguard against potential damage to the building and its surrounds. The BCA is currently integrated into all Australian States and Territory building legislations (Bluff 2003, 7-8). The BCA outlines the "technical requirements to be fulfilled in order to gain approval of a building proposal" (Bluff 2003, 7-8).

In 2001, the RAIA and the New South Wales (NSW) Work Cover Construction Hazard Assessment Review (CHAIR), together with the Australian Council of Building Design Professions (BDP), were named as supportive organisations with respect to integrating OHS throughout the construction process, including design. CHAIR specifically aims to coordinate members of a construction project involved with the design phase (Workcover New South Wales 2001, 1). The organisation holds that it is important to address safety at the design phase of construction.

Bluff (2003, 10) supported the notion of integrating OHS considerations into the "planning and coordination" of the construction process, thus necessitating the cooperation and input of designers. The author recommends promoting effective communication between people involved in the design process (Bluff 2003, 10). In addition, Durham et al. (2002, 9) noted that "many of the best controls for safety problems can be implemented effectively at the design and construction planning stages". The authors recommended, furthermore, that, as far as possible, "Safe design and safe construction methods should be established, shared and repeated" (Durham et al. 2002, 23). Durham et al. (2002, 9) also emphasised the importance of developing "partnerships between those involved in concept and design, construction planning, construction work, maintenance and even demolition". They also cited trials that have proved the effectiveness of safety improvements when incorporated at the design stage.

In Europe, the introduction of the 1992 Temporary and Mobile Construction Sites Directive resulted in designers retaining legislative responsibility for safety (Anderson 2000). As a response, the UK enacted Construction (Design and Management) Regulations in 1995 (Her Majesty's Stationary Office 1994). In addition, France developed regulations that mandated a holistic view of construction safety that included design (Behm 2005), while other European countries adopted similar legislation that places OHS responsibilities on design professionals (Gibb 2004). Despite the development of these regulations, their effectiveness in reducing construction fatalities, especially in the UK, has been difficult to determine (Gibb 2004; Maloney and Cameron 2004). It has also been hindered by lack of knowledge (Gibb 2004) and legislative disregard on the designer's part (Cosman 2004).

In Australia, state regulations require design professionals to consider the safe construction and commissioning of designs before the commencement of onsite work (Bluff 2003). Bluff (2003) examined the safe design regulatory obligations at federal and state levels in Australia and compared these practices to those existing in the UK. Bluff (2003) observed that a sound rationale exists for extending OHS statutes and regulations to those responsible for key decisions in the design and planning phases of construction projects. Bluff (2003) proposes that regulatory changes are required to ensure that those with real control and influence in the design and planning phases of OHS risk management are able to enhance OHS outcomes for workers in the construction, maintenance and repair, and end use and occupancy stages of construction.

Behm (2005) maintains that, since design professionals (viz. architects and design engineers) retain the most influential decision-making position with regard to improving safety performance, these actors are best positioned to improve safety performance in a proactive fashion. Despite this potential for accident and injury prevention, the construction industry has been slow to adopt safety by design as standard practice (Behm 2005). In the United States, no legal, contractual, economic and regulatory motivations for safety by design seem to exist, which means that OHS remains a low priority for the US construction sector (Behm 2005). According to Szymberski (1997), this lack of safety focus is attributable to the prevailing view of safety management that the implementation of safety preparations should be delayed until the construction phase commences. This contributes to an inability to design effectively for the elimination, avoidance and reduction of hazards.

Behm (2005) explored the relationship between safety by design and construction fatality rates. He examined 224 fatality investigation reports in the US and observed that risks contributing to 42% of fatalities could have been reduced or eliminated if the practice of safety by design had been adopted. In view of this finding, Behm (2005) suggests that safety by design has the capacity to influence positively the safety of construction workers during the initial construction work and subsequent maintenance, renovation and repair stages. Behm (2005) also observed that the safety by design concept positively contributes to reducing risks across all types of construction projects and that architects have a positive impact on construction safety compared to electrical, mechanical and civil engineers. Although safety by design appears beneficial to accident and risk minimisation, it is not a panacea (Behm 2005). Behm (2005) recommends that a team-oriented approach of designer, owner and constructor is a necessary in order to complement safety by design.

Campion (2000) reviewed the impact of existing design initiatives on OHS in Australia and the UK. He observed that the UK Construction (Design and Management) Regulations 1994 sought to institutionalise the process of designing safe workplaces by establishing the position of a planning supervisor and requiring the progressive development of a safety plan that documents the history of the construction process from concept to completion. This should be distributed to the owner/end user of the facility at the completion of the project. In a similar sense, the WorkCover Authority of New South Wales Year 2000 Best Practice Committee developed an initiative to assist the analysis of OHS implications in the design of a construction project (Campion 2000). This initiative comprises a set of three tools beneficial for architects, engineers, constructors and contractors with respect to analysing the design of a project at different times in its lifecycle in order to identify inherent OHS issues (Campion 2000). Although a trial of CHAIR in New South Wales revealed that this initiative is beneficial as a multi-level tool in process risk identification and pre-construction risk assessment, perceptions that the program is complicated for beginners and requires skilled facilitation for maximum benefit from risk assessments has resulted in a slow uptake by organisations (Campion 2000).

For 10 years, Bovis Lend Lease has analysed OHS considerations in the design stage of its projects through a process known as Risk and Opportunity at Design (ROAD) (Campion 2000). As ROAD seeks to eliminate or modify OHS risks in the design and delivery of structures, key stakeholders such as end users, end-user maintenance authorities, architects and core product or service representatives are informed about key roles within the design process and asked to consider potential issues (Campion 2000).

Campion (2000) observed that the effectiveness of both CHAIR and ROAD is dependent on the skill and knowledge of the facilitator and on participants conducting a pre-evaluation of their key areas of responsibility in order to allow identification of issues for discussion by all participants. In consideration of the many and varied issues that influence effective design of construction projects, Campion (2000) suggests that the following require careful consideration in the design stage of construction:

- Site remediation and methods;
- Provision of amenities/services;
- Site security/access;
- Excavation;
- Adequate ground conditions and type of control medium (e.g. batters, trench boxes, shoring);
- Silica content and machinery types best equipped to mitigate dust; and
- Ensuring a stable structure exists during deconstruction or reconstruction.

According to Campion (2000), the design stage of the construction process must focus on the provision of a safe workplace that prevents persons or objects from falling. Of the 154 fatalities recorded between 1987 and 1998, Trethewy et al. (2000a) found that 45% were attributable to falls from height and injuries caused by falling objects. Both these statements support Trethewy et al.'s claim (2000b, 517) that "proper design and/or engineered solutions/staging are critical to eliminating workplace hazards at source". This concurs with Haslam et al.'s UK-based research

(2003). These authors observed that architects and design engineers could have reduced the risks associated in almost 50% of the construction accidents studied. Despite the central role of design in eliminating risks in the construction, use, maintenance and demolition of buildings and structures, Australian construction companies have neglected to consider dimensions of safety, health and the environment in the design stage of construction (Trethewy and Atkinson 2003).

Trethewy and Atkinson (2003) reviewed the strategies being trialled to enhance safety, health and environmental outcomes in the New South Wales building and construction industry. The research revealed that structured review processes that facilitate the interrogation of design are essential to improving OHS, provided that input is gleaned from multiple stakeholders such as clients, architect, electrical and mechanical engineers and builders (Trethewy and Atkinson 2003). For these reviews to identify risks in an effective fashion, Trethewy and Atkinson (2003) suggest that facilitators with significant OHS experience and familiarity with design concepts and drawings are essential. By leading the group and stimulating discussion, facilitators are though to assist in risk identification and be capable of initiating a process that will lead to the development of solutions (Trethewy and Atkinson 2003). By enhancing the rigour of the planning process, structured review processes are claimed to provide significant benefits in terms of the health and safety of construction and maintenance personnel, improved indoor air quality, improved energy efficiency, enhance public safety and reduced crime (Trethewy and Atkinson 2003).

According to Gambatese et al. (2005), it is both feasible and practical to design for safety. Although their research into the US construction industry revealed that safety by design is a viable practice, implementing these strategies seemed to be a challenge. Gambatese et al.'s study (2005) revealed that the feasibility of designing for safety relies on the designer's knowledge and acceptance of the concept and general safety expertise. Designers were also hesitant for safety to be integrated into their work owing to fear of interfering with the constructor's means and methods, increasing their liability, the minimal construction experience of designers, time constraints and the lack of influence retained by designers in the selection of constructors (Gambatese et al. 2005). Since OHS is considered of least priority across all construction tasks, designers were also observed to lack the motivation to design for safety (Gambatese et al. 2005). Gambatese et al.'s study revealed that designing for safety was considered to increase project costs, extend project timelines and limit design creativity and impact overall work quality in a negative sense. For safety by design to become an effective OHS strategy, designers must develop a high regard for safety, be motivated to design for safety, increase their knowledge of the concept, incorporate construction safety knowledge into the designing process and consider design for safety modifications (Gambatese et al. 2005). In a similar fashion, Smallwood's research (1996) identified a role for safety education in tertiary courses for architects and design engineers. Design for safety tools and guidelines must also be readily available and liability exposure for designers should be mitigated (Gambatese et al. 2005).

Fadier and De la Garza (2006) examined the core considerations essential for a proactive approach to safety by design. According to these authors, proactive safety in design must accommodate the different design levels and phases from clients, engineers, needs analyses and specifications to industrial equipment and installation. The different management levels in the production company (such as general management, decision centres, local supervision and the operational level) must also be considered, in addition to the different risk levels involved, such as operator health or safety risk, cognitive reliability risk, socio-technical system reliability, performance-related risk and environmental risk (Fadier and De la Garza 2006).

Toole (2005) explored the role of designers in OHS, particularly the barriers and opportunities available for enhancing construction OHS practice. He contrasted US construction industry practice with that of the UK. Toole (2005) observed that design engineers have the potential to enhance construction worker safety by reconsidering the manner in which five tasks are performed, these being a) the use of performance reviews of the designs, b) the creation of design documents that consider worker safety across the design process, c) assisting owners to procure for safety, d) reviewing contractor safety plans or submittals and e) including safety as a priority in regular site operations conducted. Toole's recommendations (2005) for enhancing safety by design in the US converge with UK practices with respect to regulation. For example, UK regulations require the safety of construction workers and future maintenance and repair workers to be reflected in designs (HSE 2002). Furthermore, designers should identify significant health and safety hazards likely to be associated with design and either re-design in order to avoid the identified risks or minimise the magnitude of the risks (HSE 2002). In the UK, designers are also required to inform clients of their health and safety obligations, specifically ensuring that safety-competent contractors are engaged (Toole 2005; HSE 2002). Toole's suggestions (2005) to improve OHS in the US surpass UK practices by specifying two tasks not included in UK regulations, viz. the review of submittals and site inspections by designers (Toole 2005).

In the US construction industry, Toole (2005) also observed that various barriers exist to prevent designers from increasing their role in ensuring safety. With regard to safety practices and processes, designers were found to be lacking in safety expertise, understanding of construction processes and typical contract terms (Toole 2005). Increased liability and professional fees incurred by including designers in safety initiatives constituted another barrier (Toole 2005). For designers, Toole's research also identified a need for the development of formal safety training programs that include state and federal regulations, and the revision of undergraduate degree programs in order to accommodate the identified barriers. Furthermore, Toole (2005, 206) notes that enhancing the designer's role in construction safety requires a "long-term, intentional and focused effort" by all constituents in the construction supply chain, viz. government, universities, professional design associations and state licensing boards.

Incorporating interviews and focus groups, Hecker et al. (2005) explored the development, implementation and feasibility of safety by design in the US. Although the research revealed that safety by design is a feasible option for the US, various barriers exist to impede implementation of the safety by design concept. Hecker et al. (2005) observed that the separation between design and construction phases can be overcome through preconstruction services agreements that permit significant constructor inputs into design discussions and decisions during programming and detailed design. Financial and organisational barriers were also minimised through strong owner commitment to safety and the demonstration of the benefits gleaned from this process. Hecker et al. (2005) also identified liability issues as a barrier to the implementation of safety by design. However, these authors failed to develop effective strategies that could minimise this challenge.

Hegazy et al. (2001) investigated possibilities for improving design coordination for building projects. These authors advocate a collaborative design system that uses information technology and computer applications in order to facilitate collaboration, improve coordination and increase productivity in the design stage of construction projects. They postulate that such systems have the capacity to store building information, record design rationale and effectively manage multidisciplinary design changes in a collaborative environments. At the same time, these collaborative design systems should assist design firms with respect to the production of designs with more desirable time, cost and rework outcomes. The study also suggests that traditional design practices should be modified with a view to including a dedicated design coordination official known as the design administrator. This position is charged with generating and administrating a building components library in order to ensure necessary building components are included (Hegazy et al. 2001). Full access rights to this building components library should be given only to the administrator (Hegazy et al. 2001). The authors suggest that all other designers only be given access to the library when additional information needs to be added. The design administrator also presets the required communication paths for each library component and provides input for traditional design rationales of the library's components such as dependency relationships among components (Hegazy et al. 2001). Coordination among designers and architects, as well as among designers, is also facilitated (Hegazy et al. 2001). The design administrator program also allows for contingencies in the value of components and tracks and follows up on communication among all the involved parties (Hegazy et al. 2001). It also administers pending changes and tracking change proposals (Hegazy et al. 2001). The design administrator is also responsible for conducting regular meetings in order to discuss the designers' comments on any proposed changes, review pending changes and monitor work progress (Hegazy et al. 2001).

In order to increase designer involvement in construction safety, Gambatese et al. (1997) developed a computer-based safety tool entitled the Design for Construction Safety Toolbox. This design tool includes a variety of approaches for reviewing projects and provides for a) safety hazard identification, b) suggesting the best means to eliminate or reduce the likelihood of hazard occurrence, c) effective documentation and generation of report results and d) the ability for other design suggestions to be included, saved and used in the future. The authors claim that this software package is practical and efficiently and effectively addresses specific project hazards. They claim that the design tool is useful with respect to improving safety in the construction, start up, maintenance and decommissioning phases of a project (Gambatese et al. 1997).

Weinstein et al. (2005) used interviews, construction documentation and consultation with expert panels in order to analyse safety in design initiatives. These authors examined a safety review process that considered safety in all phases of a project's lifecycle from programming, detailed design, construction, operations and maintenance, retrofit and decommissioning. The safety review process also sought to address OHS for multiple stakeholders including construction workers, tool or equipment installers, maintenance workers and operators of fabrication facilities (Weinstein et al. 2005). Weinstein et al. (2005) observed that comprehensive safety review processes, which include the owner of the project, design firm, general contractor and the numerous trade contractors involved in the construction and operation of a particular project, effectively eliminate or mitigate OHS risks during construction. However, these authors also acknowledge that such a comprehensive safety review may not be practical in general commercial construction projects and therefore advocate the development of a meaningful, practical and less comprehensive safety review process (Weinstein et al. 2005). Weinstein et al. (2005) also suggest that increased safety awareness, development and continual refinement of safety be incorporated into design checklists.

### 5.5 Construction and Commissioning

Hislop (1999, 2) claims that the underlying cause of most "safety-related losses" is the "absence of a systemic process to identify and mitigate workplace hazards and unsafe work practices. He argues that construction supervisors and management fail to communicate the importance of safety with respect to the continued economic viability of construction organisations. This especially pertains to ensuring workforce health in order to ensure that qualified individuals are available for work when needed.

#### 5.5.1 Causes of Construction Accidents, Injuries, Illnesses and Fatalities

Abdelhamid and Everett (2000) identified and evaluated the underlying causes of construction accidents in the US. In a similar vein to Hislop (1999), these authors suggest that unsafe working conditions are attributable to four causes, viz. management action/inaction, unsafe practices of workers, non-human related acts and unsafe conditions that exist as natural elements of the initial construction site conditions. Holt (2001, 4) concurs with this view and suggests that unsafe acts and conditions are "symptoms" of "basic underlying indirect or secondary causes". Although Holt (2001) claims that the primary cause of construction accidents is the inability of safety legislation to specify the safety requirements of materials and contracting parties, he also identifies the following unsafe acts and conditions as causes of construction accidents:

**Table 2**
**Causes of Construction Accidents: Unsafe Acts and Conditions**

| Unsafe Acts | Unsafe Conditions |
|---|---|
| ▪ Working without authority;<br>▪ Failure to warn others of danger;<br>▪ Leaving equipment in a dangerous condition;<br>▪ Using equipment at the wrong speed;<br>▪ Disconnecting safety devices such as guards;<br>▪ Using defective equipment;<br>▪ Using equipment in the wrong way or for the wrong tasks;<br>▪ Failure to use or war personal protective equipment;<br>▪ Unsafe loading of vehicles;<br>▪ Failure to lift loads correctly;<br>▪ Being in an unauthorised place;<br>▪ Unauthorised servicing and maintaining of moving equipment;<br>▪ Horseplay;<br>▪ Smoking in prohibited areas; and<br>▪ Alcohol or drug consumption. | ▪ Inadequate or missing guards to moving machine parts;<br>▪ Missing platform guardrails;<br>▪ Defective tools and equipment;<br>▪ Inadequate fire warning systems;<br>▪ Fire hazards;<br>▪ Ineffective housekeeping;<br>▪ Hazardous atmospheric conditions;<br>▪ Excessive noise; and<br>▪ Inadequate lighting. |

(Source: Adapted from Holt 2001, 4)

Incomplete structural connections, temporary facilities, tight work areas, varying work surface conditions, continuously changing work-sites, multiple operations and crews working in close proximity have been identified as common causes of construction-related deaths and injuries (Hislop 1999). The UK HSE (2003, 1) notes that the biggest single cause of reported injuries in the UK construction industry was from “handing, lifting or carrying.” The most common cause of fatal injuries reported by the HSE (2003, 1) was “fall from heights.” Lack of preplanning, inadequate selection of contractors and laissez faire attitudes comprise other causes that are often easily overlooked (Hislop 1999). Other general causes of construction workplace accidents consisted of inappropriate protection, harmful substances and environment, workers being hurt by falling objects, removal of protection measures, insufficient physical and mental capacities, distraction from carrying other tasks, unauthorized access to hazardous areas and mechanical failures (Chi et al. 2005).

In addition to these causes, Holt (2001) argues that secondary causes of accidents centre on management system pressures such as financial restrictions, lack of commitment, policy, standards, knowledge and information, restricted training and task selection and poor quality control systems that result from these restrictions and deficiencies. He also suggests that construction accidents are indirectly caused by social pressures, particularly group attitudes, trade customs, industry tradition, society attitudes to risk-taking, workplace behaviour norms and commercial or financial pressures between contractors.

Toole (2002) also purports that onsite construction accidents are caused by deficient safety management through a lack of proper training, deficient safety enforcement and provision of safety equipment, unsafe methods or sequencing and unsafe site conditions. He also suggests that unsafe acts of injured parties or their co-workers also contribute to accidents by failing to utilise safety equipment provided, poor safety attitudes and isolated, sudden deviations from prescribed behaviour.

Suraji et al. (2001) studied the causes of construction accidents. These authors note that onsite construction accidents are complex and multi-causal in nature. Suraji et al. (2001) classify the causes of accidents into proximal and distal factors, which may be provoked by actions of clients, designers and operatives. Distal factors were observed to include constraints of the project conception, project design, project management, construction management, subcontractor and operative that precipitate potentially unsafe responses by clients, designers, the client's project team, contractors, subcontractors and operatives (Suraji et al. 2001). These distal factors include the influence of management and organisational factors, environmental factors (such as economic, legislative, political and social) and individual factors of the participants (Suraji et al. 2001). Proximal factors causing construction accidents were identified as inappropriate processes (such as construction planning, construction control and construction operation), site conditions and operative actions (Suraji et al. 2001).

Accident causation in trenching operations formed the focus of a study conducted by Arboleda and Abraham (2004). These authors analysed 296 fatality reports related to trenching operations from the Occupational Safety and Health Administration between 1997 and 2001 and documented the causes of trenching accidents as they relate to physical processes and human behaviour. Arboleda and Abraham (2004) identified the three core causes of trenching accidents, viz. being caught in cave-ins, caught in or compressed by equipment or objects and being struck by objects. Lack of safety equipment, unsafe methods or sequencing and lack of proper training were identified as behavioural-related causes of trenching accidents (Arboleda and Abraham 2004). The study also revealed that construction safety can be enhanced through the provision of adequate and appropriate safety equipment at the right time, the reinforcement of specific training in equipment use and safe construction procedures, the institution of more effective planning processes before the onset of trenching operations in order to identify job site hazards and incorporating clearly-defined accident prevention strategies.

Halperin and McCann (2004) evaluated the scaffold safety practices of 113 scaffolds in nine areas of the eastern US. Their research found that 31.9% of scaffolds examined were either in danger of collapse or were missing planking, guardrails or adequate access. The authors suggest that scaffolds should be inspected regularly in order to ensure appropriate plankings and railings are in place and that they are both accessible and securely tied to buildings. These authors also suggest that scaffolding safety is enhanced when a) outside scaffold erectors are employed, trained and competent scaffold individuals are onsite, b) appropriate frame scaffolds are utilised and c) inspections examine plankings, railings, access and secure tying to buildings.

In addition to the numerous causes of accidents already discussed, falls have been identified as a leading cause of fatalities in construction operations (Mitchell et al. 2003; Sorock et al.

1993). In an analysis of data from 621 case reports of work-related fatal falls that occurred during 1994-1997 in the Taiwan construction industry, Chi et al. (2005) examined the factors contributing to fatal falls. These authors observed that the factors contributing to fatal falls include individual victim characteristics such as age, gender, experience and use of personal protective equipment, the fall site itself, the size of the organisation and the specific cause of the fall. Chi et al. (2005) found that contributing factors to fatal falls varied depending on the nature of the fall.

Chi et al. (2005) also observed that inexperienced workers and employees of small construction companies were at greatest risk with respect to fatal falls. Likewise, Larsson and Field's study (2002) into occupational injury risks in the Victorian construction industry revealed that falls from height represented the most severe injury problem. These authors observed that falls were also associated with the different equipment and tasks of the varying construction parties. According to Larsson and Field (2002), architectural, engineering and design solutions are required to manage the risk of falls in construction.

### 5.5.2 Accident, Illness, Injury and Fatality Prevention

Fall Protection Guidelines developed by the Manitoba Labor and Immigration Division (MLID) of Canada (2003) suggest that fall protection measures exist in primary and secondary forms. Those initiatives that physically prevent the occurrence of lower-level falls are considered primary in nature, while secondary fall protection measures are thought to inhibit or minimise injuries after the initial lower-level fall has taken place (Bobick et al. 1994). Of the six categories of fall protection measures developed by MLID (2003), primary measures include surface protections (non-slip flooring), fixed barriers (handrails and guardrails) and surface opening protections (removable covers and guardrails). Within the same Guidelines, travel restraint systems (safety line and belt), fall arrest systems (safety line and harness) and fall containment systems (safety nets) are considered secondary measures (MLID 2003).

Since the implementation of fixed barriers in hazardous areas is a very difficult process, fall arrest and containment systems have been identified as fundamental to fall prevention from building girders and other steel structures (Chi et al. 2005). In addition, given that improper use of personal protective equipment was identified as a major contributing factor to fatal falls (Chi et al. 2005), it has been suggested that safety training focus should focus on a) improved hazard and danger recognition, b) enforcement of the use of fall protection systems and regular inspections and tests of protection systems, c) tools and the environment of the facility and d) other administrative interventions (Janicak 1998).

According to Holt (2001), accident prevention in construction extends beyond mere rules and safety inspections. He suggests that a system for managing health and safety that satisfies business and legislative requirements is needed. In view of this, Holt (2001, 5) developed seven generic principles that can be used to guide the development, control and management of OHS strategies in construction:

- If possible, avoid a risk altogether by eliminating the hazard;
- Tackle risks at source;
- Adapt work to the individual when designing work areas and selecting methods of work;
- Use technology to improve conditions;
- Give priority to protection for the whole workplace rather than to individuals;

- Ensure that everyone understands what they have to do to be safe and healthy at work; and
- Ensure that health and safety management is accepted by everyone and that it applies to all aspects of the organisation's activities.

Although various fall prevention and accident reduction strategies have been developed, Chi et al. (2005) claim that the effectiveness of these prevention measures is dependent upon the degree to which they are implemented by the organisation and applied by workers. They also identify commercial and cultural barriers as significant impediments to the widespread acceptance and adoption of prevention strategies by construction employers and workers (Chi et al. 2005). In order to further minimise accidents and injuries, hazard identification and control should be viewed as another proactive preventative area (Carter and Smith 2006).

### 5.5.3 Hazard Identification

Although the formal identification of workplace hazards is fundamental to successful safety management and an essential component of OHS legislation in Australia, it is a problematic process for contractors (Trethewy et al. 2000b). Most contractors lack the willingness to identify hazards in a formal documented way either through a) job safety analyses or b) safe work method statements that identify medium to high-risk hazards in the workplace and appropriate controls to eliminate or minimise hazards (Trethewy et al. 2000b). Trethewy et al. (2000b) suggest that both contractors and those who review submitted procedures require a reasonable understanding of OHS legislation and safety training. These authors argue that safety training should involve basic theory that aims to provide personnel with the appropriate knowledge to identify and address workplace hazards and advocate the use of "Tool Box Talks" (Trethewy et al. 2000b, 510). These talks directly involve those individuals who conduct the work and allow contractors to develop an intricate knowledge of the work task in order to assist them in identifying hazards and developing safe work practices for implementation (Trethewy et al. 2000b). Trethewy et al. (2000b) claim that the interpersonal interaction that these types of training forums foster is particularly useful where contractors are from a non-English speaking background.

Mitropoulous et al. (2005b) considered the factors affecting the likelihood of accidents during a construction task. Incorporating a systems view of accidents, this study focused on the way in which the characteristics of the construction production system generate hazardous situations and shape work behaviours. The research identified that the nature and number of hazardous work situations during a construction task depends on the characteristics of the activity and context, safety efforts to control the conditions, and task unpredictability. A critical role for task unpredictability in generating unexpected hazardous situations was identified and the inevitability of exposures and errors in construction tasks was acknowledged (Mitropoulous et al. 2005b). In view of the research findings, Mitropoulous et al. (2005b) identify two accident prevention strategies, viz. reliable production planning in order to reduce task unpredictability and error management in order to increase worker ability to avoid, trap and mitigate errors.

By itself, hazard identification and control is not enough to prevent accidents. Mitropoulous et al. (2005a) put forward three strategies for accident prevention, these being a) a reduction in task unpredictability with regard to reducing the frequency of hazards, c) an improvement in work conditions in order to facilitate more productive behaviours without increasing safety risk and c) the development of error management strategies that prevent, trap and mitigate the consequences of errors. The next section further explores these dimensions of work conditions and employee behaviour.

#### 5.5.4 Site Work Conditions, Safety Attitudes and Worker Behaviour

Worker attitudes and site work conditions heavily impact the implementation of OHS at the job site (Kartam et al. 2000). Teo et al. (2005) investigated the safe work behaviour of onsite construction workers in Singapore. These authors identified two reasons for unsafe behaviour, viz. lack of awareness and poor attitude towards safety.

In examining the impact of worker safety attitudes on construction safety outcomes, McCabe et al. (2005) surveyed construction workers and supervisors. The research revealed that employee demographics influence safety attitudes. Siu et al. (2003) observed similar results in their study into the impact of age differences in safety attitudes and performance amongst Hong Kong construction workers. It was found that older workers exhibit more positive attitudes to safety than younger workers and that an impetus exists for safety programs to reflect this trend. Conversely, Gun and Ryan (1994) observed that risk of injury was unrelated to operator age or experience. Keeping within this theme of worker demographics and accident causes, Chau et al. (2004) examined the relationship between individual characteristics and OHS injuries in the French construction sector. Their case-control study involved surveying 880 male workers who had experienced one or more workplace injuries within a two year period. Chau et al. (2004) observed that, although young age, sleep disorders, smoking, disabilities, sporting activities and experience influenced the likelihood of occupational injuries, the risks for individual workers were dependent on the specific position retained within the construction supply chain. In addition, Ringen et al. (1995) notes that, where a large proportion of the construction labour force is comprised of immigrants with limited language capabilities, the inability of workers to understand English also has the capacity to increase the risks of injury.

In response to the lack of OHS awareness contributing to construction accidents, Teo et al. (2005) observed that technical and safety training has the capacity to minimise the lack of safety awareness inherit in the construction workforce. These authors also note that poor safety attitudes can be overcome through the systematic application of operant conditioning techniques that incorporate behaviour modification. Teo et al. (2005) explain that operant theory defines the changes in behaviour as the result of individual responses to events that occur in the environment. Since operant conditioning consists of both responses and consequences, favourable or positively reinforcing consequences indicate that the likelihood of similar responses is higher if consequences are punishing in nature (Teo et al. 2005). Under operant conditioning theory, positive reinforcements motivate workers to perform tasks in a safe fashion. As a result, contractors should offer monetary rewards, bonuses and job promotions as incentives (Teo et al. 2005). Conversely, in order to motivate workers to maintain safe work practices, negative reinforcements such as criticism or threats by management may be necessary (Teo et al. 2005). While extinction involves limiting dysfunctional behaviours by eliminating their reinforcements, punishment refers to undesired or negative consequences being administered in the event of dysfunctional behaviours, with punishment taking the form of pay cuts, temporary suspensions, demotions and firings (Teo et al. 2005). The research revealed that positive reinforcements, both monetary and non-monetary, were most effective. The findings also indicate that close and strict supervision, appropriate OHS training and fines for misconduct were the most effective means of enhancing worker safe behaviour.

In both raising OHS awareness and developing positive safety attitudes, Hislop (1999) and the ILO (1992) suggest that a clear role exists for construction managers and employers. Hislop (1999, 56) outlines a “typical” organisational structure whereby the Construction Manager

> *"…provides leadership for the project, provides technical guidance, and monitors conformance with defined specifications. The construction manager is responsible for integrating the skills and performance of the participants into a cohesive project. Information related to the control of hazards can now be developed, warning flags added to the project schedule, and a determination made of the safety information that needs to be included to the contract general conditions.*"

In explaining the integral role of employers in the implementation of health and safety precautions, the ILO (1992) define employers as "any physical or legal person who employs one or more workers on a construction site" and, depending on the context ,comprise "the principal contractors, the contractor or the sub-contractor" (ILO 1992, 2). This responsibility ranges from maintaining workplaces and equipment and actively improving any working situations to guarding against physically stressful positions that could prove dangerous (ILO 1992, 6-7). The ILO (1992) also noted that the employer should provide protective clothing and work-gear in order to protect employees against dangerous conditions and poisonous agents.

The ILO stated, in section 2.2.5 of *Section 2: General Provisions*, that the employer should be responsible for arranging "regular site safety inspections by competent persons". Overall, the ILO required employers to ensure that health and safety practices are implemented, including the provision of safety tools such as first-aid facilities, protective gear and safety training (ILO 1992). The employers are also expected to monitor the actions of their employees with a view to ensuring that they are working safely (ILO 1992). In addition, it is the responsibility of the employer to ensure that delegated tasks do not exceed the physical capabilities of a staff member (ILO 1992). The ILO holds that employers are also responsible for ensuring that the equipment provided is both safe and operational (ILO 1992).

In compliance with the ILO (1992), the guidelines written by the New Zealand Federal Government have specified that employers in New Zealand are responsible for providing first aid facilities. The guidelines also recommend that workers be trained to use first aid equipment (New Zealand Department of Labour 1995, 13). The New Zealand Department of Labour assigned responsibility for facilities management, including maintenance, to employers (New Zealand Department of Labour 1995, 12-16). This includes ensuring that facilities are clean and accessible (New Zealand Department of Labour 1995, 13).

In Hong Kong, the employer is ultimately responsibility for implementing safety guidelines and for ensuring compliance with company-developed policies and plans. It is the employer's responsibility to develop a safety policy, with guidelines, and then effectively enforce the organisation's own rules. Mirroring the responsibilities of the employer as presented by the ILO and the New Zealand Government, Hong Kong charges employers with the responsibility of training staff in the area of safe work conduct. In comparison to the New Zealand way, the Hong Kong guidelines go further and recommend that the employer undertake a "Risk Assessment Program" that identifies specific individual dangers that each worker may encounter. The employer must also ensure the provision of proper protective safety equipment for all workers.

In line with the OHS responsibilities of employers and construction managers, the New Zealand guidelines for 1995 outline, in specific terms, the various facilities that should be provided on worksites (New Zealand Department of Labour 1995, 12-16). This includes the provision of washing facilities and cleaning solutions, especially for those worksites where potentially hazardous substances are present (New Zealand Department of Labour 1995, 12-13). There is an expectation that worksites provide toilet facilities for both male and female employees and that a suitable number of these facilities are provided in order to cater for the number of staff members who have access to the job site (New Zealand Department of Labour 1995, 12-13). It is also required that a sufficient supply of clean drinking water be provided, as well as shelter space for breaks and rests (New Zealand Department of Labour 1995, 12-14).

The European Union *Construction Site Directive* also outlines minimum safety standards and requirements for temporary or mobile construction sites (European Commission 1992).

# 6.0 CONTEMPORARY ISSUES IN CONSTRUCTION OHS

Marais et al. (2006) suggest that organisational safety performance is related to dynamic organisational behaviours. They provide seven reasons in order to explain why safety-related decisions do not always result in desired behaviour and claim that independent decisions in different parts of an organisation, taken together, can negatively impact safety. According to Marais et al. (2006), poor organisational safety performance is caused by stagnant safety practices in the face of technological advances, decreasing safety consciousness, eroding safety goals and disappointing safety programs, safety complacency, unintended side effects of safety fixes and unsuccessful problem resolution, fixing symptoms rather than root causes, inappropriately designed reporting schemes and other regulatory requirements, and a vicious circle of bureaucracy. In addition to these factors, a range of other issues heavily impact OHS performance in the construction sector. These contemporary issues in construction OHS include organisation size and resource capacity, an ageing population, shortage of skilled labour, worker turnover and the young labour force.

## 6.1 Organisation Size and Resource Capacity

Lin and Mills (2001) examined 44 construction companies in Victoria, Australia and identified various factors that influence safety performance such as a) company size and b) employee and management commitment to OHS. These authors found that OHS is likely to improve if contractors were committed to ensuring that workers utilise the safety equipment provided. Minimal OHS inspections and testing were also observed and few regulatory guidelines or mandatory requirements for inspections justified this practice. Company size was also observed to influence OHS standards. Indeed, most of the smaller contractors did not have safety committee experience and lacked the financial resources and management commitment needed to improve OHS performance. Lin and Mills (2001) also found that the application of effective occupational health and safety management systems facilitate better OHS performance.

Similarly, Mayhew et al.'s analysis (1997) of US census data revealed that self-employed workers were two times more likely to suffer from work-related deaths and that subcontracting regimes experience a higher incidence of serious injuries and fatalities. Since subcontractors are usually smaller in size and have access to fewer resources than main contractors, they are generally less organised and are unable to implement OHS systems. Their smaller onsite involvement also results in a lesser OHS commitment (Holmes et al. 1999). In another study across four industries in Australia, Mayhew and Quinlan (1999) considered the effects of sub-contracting on OHS outcomes. Four key features were identified in order to explain poor sub-contractor OHS performance, these being outsourcing the poorly perceived economics of OHS, disorganisation and poor scheduling of work, inadequate regulatory controls and the ability of workers to protect themselves in an independent way (Mayhew and Quinlan 1999). In addition, Hasle and Limborg (2006) maintain that the operating context of SMEs is such that limited economic and human resources are available, trust and dialogue are crucial and, where owners or managers retain a central focus, OHS efforts should be relevant, low cost and applicable.

## 6.2 Ageing Population, Shortage of Skilled Labour and Worker Turnover

The construction workforce predominately consists of 'casualised' employees or contractors and sub-contractors, although a major construction project can sometimes involve a large number of these workers (Hislop 1999). In consideration of the fact that the population is ageing and that the availability of experienced, qualified construction workers is at a record low, it has been estimated that recruitment and training for 250,000 specialist workers will be required to replace those that leave the industry (Hislop 1999). Thus contractors will be forced to either pay bonuses or higher wages in order to attract qualified workers or else hire less experienced workers (Hislop 1999). The presence of new and unskilled construction workers increases the potential for accidents and injuries to occur (Hislop 1999). The likelihood of these accidents and injuries is further exacerbated by work intensification and individual emotional responses, stress and fatigue (Trethewy et al. 2001).

The high labour turnover in the construction industry has also been associated with poor OHS performance (Kartam et al. 2000). Compared to other industries, the high mobility required of workers, coupled with the fact that workers are usually contracted to multiple sites that are geographically dispersed, results in an industry with a high ratio of staff turnover (Kartam et al. 2000). This corroborates the finding of Yu (1990) that in excess of 50% of construction accidents are explained by worker turnover and ignorance of safety regulations. In addition to these factors, Kartam et al. (2000) attributes the lack of training and orientation programs for new staff and ineffective hazard identification to poor OHS practice.

Deacon et al. (2005) proposes that specific OHS initiatives need to be developed for older construction workers. Their research into the health and well-being of this demographic revealed that older construction workers are at high risk from work-related conditions and chronic diseases linked to ageing. The research suggests that construction work has the capacity to affect the health and well-being of workers in the long and short term and thereby cause significant losses for construction companies, both financial and non-financial. Deacon et al. (2005) suggest that it is in the interests of construction companies to examine the cost benefits of optimum worker health and conduct regular medical surveillance and management of worker health.

Kartam et al. (2000) examined the safety issues inherent in the Kuwait construction industry. Incorporating a focus on contractors, these authors surveyed technical managers, safety directors and chief engineers and designers and interviewed safety engineers, heads of safety departments in government and company superintendents. Kartam et al. (2000) found that the competitive nature of the construction industry, in which contractors bid for contracts, culminated in safety costs not being considered unless specifically recognised by the contract documents. These authors also observed that the absence of a unified set of safety regulations has an adverse effect on onsite safety enforcement. In Kuwait, Kartam et al. (2000) observed that minimal training, experience and inappropriate workplace conditions (particularly the lack of work-life balance) comprised core contributors to poor OHS performance.

### 6.3 OHS and the Young Labour Force

Griffith University in Queensland has undertaken research that has revealed that young workers are at higher risk of injury at work than any other age group. In an article published on the Griffith University website, Barr (2006) wrote that nearly “40 percent of Australia’s 15-19 year olds are active in the workforce, with close to 70 percent employed as casual or part-time workers with extremely limited bargaining power” (Barr 2006, 1). This limited amount of bargaining power is thought to result from the nature of the employment conditions experienced by young people. The “irregular hours spread across late evening and early morning shifts” have been linked to “a very long working day if study and work hours are combined” (Barr 2006, 1). Griffith University’s Bradley Bowden said these conditions inevitably result in lethargy and, more seriously, “fatigue and/or exhaustion”, which increases the risk of “slips, trips and falls”, especially for those young people working in hospitality and retail (Barr 2006, 1).

Furthermore, Bowden attributed the higher rate of exposure to risk to the inability of inexperienced workers to manage risks in an effective fashion, which is the result of their lack of "skills, experience and size" (Barr 2006, 2).

# 7.0 INTERNATIONAL BEST PRACTICE

## 7.1 OHS Agencies

### 7.1.1 International Labour Office

In order to ensure that worker health and safety is maintained, a division of the International Labour Organization, viz. the International Labour Office (ILO), promotes the implementation of preventative measures with a view to protecting workers from hazards (ILO 1992). Operating as an enforcement agency, the ILO ensures that its members fulfil previously agreed upon obligations and actively work towards improving OHS standards and hazard reduction (ILO 2006). The ILO is of the opinion that “competent authorities” are responsible for continual application of OHS national regulations (ILO 1992, 5-8). With a view to ensuring that legal obligations are fulfilled, the ILO has ascertained that these “authorities”, namely state and federal governments, are charged with the responsibility of organising site inspections and ensuring that appropriate “resources” are provided for inspections to be conducted effectively and in compliance with national and state legislation (ILO 1992, 5-8). In a similar fashion, the Hong Kong Department of Labour has charged government with the responsibility of developing and enforcing OHS legislation, in addition to establishing compliance measures (Hong Kong Labour Department 2004).

The government authorities listed above can be regarded as moderators since they must undertake measures to facilitate cooperative relationships consistent with obligatory cooperation between employers and workers, as is stipulated in legislation (ILO 1992). Furthermore, for the purpose of representing different groups and individuals, the ILO recommends the appointment of safety delegates, inspectors and health and safety committees (ILO 1992). This includes a sufficiently trained safety delegate to represent workers and a committee of members to represent employers (ILO 1992). In addition, the ILO (1992, 5) advocates that national laws should require a “client or relevant authority” in order to provide notification of the logistical characteristics of a project.

In 1992, the Geneva-based arm of the ILO released a set of international OHS guidelines for construction entitled “Safety and Health in Construction” (ILO 1992). The guidelines served to provide “practical guidance” for OHS issues on construction projects and works, viz. accident, injury and illness prevention, “appropriate design and implementation”, and looking at a project from a safety “point of view” in order to approach work in the safest way possible by means of “planning, control and enforcement measures” (ILO 1992, 1). The ILO guidelines therefore provide consistent international guidelines that constitute basic requirements for worker OHS. The code targets those with influence or decision-making in order to bring about the inclusion of OHS provisions and change workplace practices (ILO 1992).

The guidelines regard “competent authorities, employers, self-employed, workers, designers and clients” as key OHS stakeholders and specify “general duties” for each of these groups (ILO 1992, 5-9). In order to compartmentalise the responsibilities of each party, these general duties are presented separately in the document. The guidelines briefly discuss “cooperation and coordination”. However, the different roles of the stakeholders involved in construction are not divided into individual responsibilities. This constitutes an attempt to discourage collective decision-making across the stakeholder groups.

As a diplomatic forum for all member states, the ILO holds an annual International Labour Conference in Geneva every June (ILO 2006). The conference provides a diplomatic forum for member states, which include Australia, New Zealand, the UK and most European nations, Canada and China (which represents Hong Kong). The 2006 conference addressed the further development and maintenance of a system for OHS regulation across different countries and effectively established a generic set of principle-based recommendations for developing a flexible and progressive OHS policy (ILO 2006). At the conference, the member states developed a global OHS strategy and confirmed the ILO as a "central pillar" for health and safety promotion (ILO 2006, 3). Other foci of the 2006 conference included integrated action that better connects ILO standards with advocacy, awareness raising, knowledge development, management, information dissemination and technical cooperation initiatives (ILO 2006). In addition to the ILO's centralised, global position as OHS champion, a number of country-specific OHS bodies are responsible for OHS.

## 7.2 Country-Specific OHS Initiatives

The next sections explore the OHS initiatives of the United Kingdom, New Zealand and Hong Kong.

### 7.2.1 United Kingdom

With an estimated two million workers, the construction sector forms the largest UK industry (HSE 1998). Compared to Australia, other European nations and the United States, the UK has undertaken considerable volumes of research and has invested more extensively in campaigns to improve safety. Despite this safety focus, the UK HSE reported that, in the UK, "at least one person is killed and over 600 injured at work each day" (HSE 1998, 3). As a result of work-induced injury, an estimated "three quarters of a million people" are absent from work each year (HSE 1998, 3).

Safety in the UK construction industry has traditionally resembled Australian practices of poor working conditions, a culture of working to deadlines and inflexible budgets (Paton 2003, 3). In order to protect staff from the financial consequences of work-related injuries and illnesses, UK employers have been forced to invest in "liability insurance" (HSE 1998, 3). However, this insurance "only covers a small portion of the [total] costs of accidents" (HSE 1998, 3).

In 2003, Nic Paton released an article that evaluated the UK's progress on improving OHS standards. The article, 'Measure of Success', expressed dissatisfaction with overall health and safety standards. This was especially so since the number of injuries remained high. Despite this trend, Paton (2003) acknowledged that the UK had been actively working to improve OHS by implementing safety initiatives and enforcement measures. The UK government's '10-year Revitalising Health and Safety Strategy' encompasses a number of programs and campaigns. For instance, the HSE targeted specific hazards. For example, it promoted awareness of ladder safety through 'Ladders Week' (Paton 2003, 4). Furthermore, the 'Constructing Better Health' campaign was initiated with a view to providing "free safety advice and support to construction projects" (Paton 2003, 4). As an integral part of a successful safety campaign, Paton (2003) argued that enforcement is a crucial element. He also noted that HSE inspectors had carried out a "targeted 'blitz' on construction sites" (Paton 2003, 4).

The HSE released a document outlining accident prevention procedures. The document, entitled 'Managing Health and Safety – *Five Steps to Success*', emphasised that safety could be improved by a combination of learning from past experiences and monitoring current worksites (HSE 1998). The first five steps recommend the development of a clear safety policy. With a view to clarifying responsibilities, the HSE (1998) prescribes that safety standards must be expressed in writing. As an important measure that assigns responsibility to staff in assisting with safety at work through “training, recruitment and advisory support”, in addition to allocating responsibilities and working cooperatively and communicating effectively through “instruction and supervision”, Step 2 outlines staff responsibilities with respect to assisting in the creation of a “positive health and safety culture” (HSE 1998, 5-7). This is summarised in the recommendations with four key words, viz. “competence, control, cooperation and communication” (HSE 1998, 5). Step 3 examines setting standards and possible considerations such as “identifying hazards, assessing risks, implementing standards of performance and developing a positive culture” (HSE 1998, 7-8). The HSE (1998, 7) recommends that safety standards should be “measurable, achievable and realistic”. With respect to monitoring prevention measures, step 4 suggests implementing an anticipatory response mechanism by means of addressing a problem before it occurs (HSE 1998). Step 5 advises organisations to “learn from experience” through a system of audits and reviews by “staff and outsiders” (HSE 1998, 10). This final step resonates with aspects of the Australian Cole Inquiry, which aimed to review the current system of OHS policy and further improve areas of weakness.

Step 2 of the health and safety outline, which calls for staff to be involved actively in safety management, has also been recognised by the international construction and support service provider John Mowlem Constructing Excellence. This construction body devised a Safe Gang Initiative (SaGa) for its UK branch “to improve safety standards on construction worksites” (Constructing Excellence in the Built Environment (CEIBE) 2006). CEIBE (2006) maintains that this can be achieved by encouraging team work or ‘gangs’ to take effective control of safety standards. This campaign has been promoted in order to involve workers in the communication and implementation of safety in a more active fashion (CEIBE 2006).

The UK construction company Taylor Woodrow, has implemented a communication network in order to improve safety and reduce worker absenteeism (Paton 2003). The company has undertaken preventative measures in order to assess and monitor employee health and safety, in addition to establishing a “communication network” that aims to coordinate information about health and safety issues. As a result of developing these communication networks, Paton (2003, 43) identified that absences due to illness decreased from an average of “3.2 days in 2002/03 to 2.8 in 2003/04”.

There are evident similarities between the Australian Cole Inquiry recommendations and guidelines already implemented in the UK. For instance, recommendation 18 of the Cole Inquiry calls for regular conferences to be convened by the National Occupational Health and Safety Commission (NOHSC) and that these should be “linked to the National Occupational Health and Safety Strategy 2002-2012 (Cole 2003). In a similar fashion, the UK Federal Government already holds a “construction summit” each year (Paton 2003, 4). The summit aims to provide a forum for the discussion of progress made in construction OHS and for the promotion of further improvements to the industry (Paton 2003, 4). The UK HSE (2005) notes that ‘challenging targets' were set at the first Construction Summit held in February 2001. The outlined purpose of the 2005 conference was to evaluate the progress of OHS development programs by reporting on the positive outcomes of OHS initiatives and, in addition, reviewing the areas requiring improvement. The Summit exemplifies the importance of a review and reporting process that reflects on the effectiveness of safety program initiatives.

### 7.2.2 New Zealand

In 1995, the New Zealand Federal Government released safety guidelines for the construction industry based on its national Health and Safety Employment Act 1992. The1995 guidelines are presented as a list, accompanied by relevant regulations. The New Zealand Government recommended that the guidelines should change as legislation does, which is an important issue to note since they are now 10 years old. These guidelines are intended primarily to be a resource for employees and, although they could be useful for other parties involved in construction, the New Zealand government has recommended that health and safety inspectors refer to the specific OHS Handbook. The Minister of Labour at the time, Doug Kidd, wrote that these guidelines are a useful vehicle for providing essential information for those working in the construction sector, especially with regard to changing negative perceptions of health and safety (New Zealand Department of Labour 1995, 5).

In 1999, the New Zealand independent organisation, Site Safe, released a set of guidelines that focused exclusively on improving health and safety standards on construction site. These guidelines were entitled 'Construction Safety Management Guide: Best Practice Guidelines in the Management of Health and Safety in Construction' (Site Safe 1999). In developing this best practice guide, Site Safe was supported by the Accident Rehabilitation and Compensation Insurance Corporation (ARCIC), the Building and Construction Industry Training Organisation (BCITO) and a number of construction and development companies, in addition to "many other organisations and individuals from various industry sectors" (Site Safe, 1999, 5). Developed by a non-government agency in order to supplement the Health and Safety in Employment Act 1992, the guide aims to "provide all players in the construction industry with a better understanding of their roles and responsibilities [under the Act]" (Site Safe 1999, 6). According to Site Safe (1999, 6), guidelines of this scope, which supplement existing legislation, are beneficial since they "reinforce the understanding of the various roles people involved with construction may have and how they can assess their performance in these roles".

### 7.2.3 United States

The United States National Institute for Occupational Safety and Health (NIOSH) is an agency of the US Department of Health and Human Services. NIOSH was developed as a result of the Occupational Health and Safety Act of 1970. NIOSH describes itself as being able to provide OHS "research, information, education, and training" (NIOSH 2006). NIOSH is empowered to develop OHS standards by providing safety recommendations, holding worker training and education sessions, distributing research grants and undertaking safety and health research (NIOSH 2006).

The US Occupational Safety and Health Administration (OSHA) was also derived from the Occupational Health and Safety Act 1970. OSHA is responsible for enforcing labour regulations and delegating "enforcement powers … to 21 states, Puerto Rico, and the Virgin Islands" (CPWR 2002, 1). Specific to the construction industry, the OSHA has "concentrated on fall protection in an effort to reduce the leading cause of work-related deaths in the industry" (CPWR 2002, 1). As part of its enforcement strategy, the OSHA employs inspectors to conduct site visits and check whether construction sites are complying with OHS regulations.

The OSHA has been working towards coupling its enforcement measures with encouraging contractors to undertake "voluntary protection" procedures. The OSHA has provided a number of programs and services in order to educate construction workers and its "training grants" and to provide further resources for high-risk or remotely located construction workers" (CPWR 2002, 1).

The US employee advocacy group denominated the Center to Protect Workers (CPWR) has developed a Construction Chart Book as one of many resources that it provides to workers. The Chart Book asserts that, on account of resource limitations, the number of site inspections conducted by the OHSA has declined over time. The CPWR concluded from US Census Bureau data that there is one safety inspector for "more than 3,000 sites, in all industries" (CPWR 2002, 1). In 1999, there were 7 million total worksites and 700,000 construction worksites (CPWR 2002, 1). However, in contrast to the declining number of site inspections, the number of employer inspections carried out by the OHSA has been increasing over the years. Owing to resource limitations, the CPWR has concluded that the OSHA is 10% more likely to inspect "union-contractors' sites, than non-union contractors [sites]" (CPWR 2002, 1). It was further observed by the CPWR that a considerable amount of the OSHA's "enforcement resources" (CPWR 2002, 1) were allocated to "worksites of very large companies, even though compliance inspections of mid-size and smaller companies produced a higher proportion of citations" (CPWR 2002, 1). As site inspections have declined, the penalties for breaches have increased significantly. This may have been offset by an increase in the size of fines that the OSHA is able to issue, coupled with the increased time allowed for inspectors to look over sites (CPWR 2002, 1).

In addition to the Construction Chart Book, the CPWR also provides reference material on its website regarding occupational hazards on construction sites. Developed and maintained by the CPWR, this database is entitled eLCOSH and consists of a comprehensive electronic catalogue of OHS regulations and legislations. eLCOSH has been established "to provide accurate, user-friendly information about safety and health for construction workers from a wide range of sources worldwide" (eLCOSH 2006). This initiative has received financial support from the US Federal Government's National Institute for Occupational Safety and Health.

The eLCOSH database is an innovative resource, with the capability of being updated regularly and easily accessed. The eLOSCH database provides information to workers across disparate national locations and works towards improving the discontinuity that is inherent in fragmented OHS regulations. As a consequence, the database concept embodies a practical storage device that provides a systematic record of the issues emerging from OHS in the construction industry. This type of system could potentially prevent overlapping of information available to the public. It thus provides a comprehensive collation of online information.

### 7.2.4 Canada

The Canadian Federal Government established the Canadian Centre for Occupational Health and Safety (CCOHS), an initiative focused on reducing the frequency of work-related injuries and deaths. The CCOHS sees itself as an advisory service that provides relevant information about safety regulations, standards and OHS rights for all members in the construction industry. The Centre also asserts that it has an international reputation for providing OHS resources that are "innovative [and] authoritative" (CCOHS 2004). Focusing on preventative action in order to prevent work-related illness, injury and death, CCOHS provides free "OHS Answers" as an online information source for the various risks and hazards associated with different workplaces, and the way in which these risks and hazards might be respectively mitigated and prevented (CCOHS 2004). In addition, CCOHS provides information about relevant legislation for different industries, health and safety initiatives and programs and useful safety-related information resources. In order to complement the online information service, CCOHS also provides an "inquiry service" administered by consultants and delivered via the telephone, email or in person (CCOHS 2004).

CCOHS also distributes monthly email newsletter reports to its members. These include updates on health and safety (CCOHS 2004). For example, issue 4, the monthly report for April 2006, highlighted the dangers of minor safety hazards, which, without identification and management, could result in major accidents (CCOHS 2006). The May 2006 newsletter suggested that people participating in a construction project should be more active with respect to identifying minor risks that have the potential to turn into major hazards. The CCOHS email newsletter also provides updates on changes to regulations and legislation (CCOHS 2006). For instance, in the May 2006 newsletter, the CCOHS updated its members on recent changes to legislation that require employers to submit a report "at least every three years, on how risk management is progressing" (CCOHS 2006). This reporting involves record-keeping and outlining the measures undertaken in order to mitigate any risks in the workplace (CCOHS 2006).

The concept of an email newsletter service distributed by a Federal Government department is unique to Canada. Despite the fact that communication has been identified as fundamental to OHS awareness and improvement, Australia, New Zealand, Hong Kong, UK, the US and the member states of the EU have not adopted similar practices.

### 7.2.5 Hong Kong

In a publicly available report, the Accident Analysis and Information Division of the Hong Kong Government's Labour Department tabled the number of national accidents in the construction industry for 2000-2005. Although the Department of Labour reported that the construction industry is the most dangerous sector in the country, the same department claimed that the number of injuries and deaths had decreased over time, from 4367 in 2003, to 3833 in 2004. The Department also claimed that, in comparison to the 2000 figures, the number of accidents had decreased by 67%. The study also found that the frequently cited cause of death on construction sites was falls from heights and that this accounted for over 50% of all fatalities (Hong Kong Labour Department 2004, 5). The second most frequent cause of death was identified as electric shock or "contact with electricity" (Hong Kong Labour Department 2004, 5).

The same Labour Department has facilitated a "partnership program" that encourages companies involved in construction to develop a safety charter based on regulations and "best practices" (Hong Kong Labour Department 2004). The Department recommends that employers and employees work together in order to develop an OHS agreement. Although these agreements are not compulsory, the Government believes that a safety charter can help a company to comply more satisfactorily with legal standards by contextualising the relevant industry legislation and integrating legal requirements into company practices. The Department thus promotes communication across all levels of an organisation and, furthermore, encourages self-evaluation of the effectiveness of safety regimes.

According to the Hong Kong Labour Department (2004), a 'Safety Management System' contains a mixture of precautionary and planning stages that aim to prevent accidents, with procedures for addressing surfacing problems also recommended. The design stage is seen as a fundamental aspect of safety, especially with regard to alleviating hazards at a preliminary stage, along with defining OHS responsibilities for different parties to the construction process. The Hong Kong Labour Department (2004) proposes that effective overall safety management should include investigating accidents if something does go wrong since this practice prevents the same mistake from being repeated (Hong Kong Labour Department 2004, 5). Furthermore, if breaches of law are found, an investigation into company conduct should be pursued (Hong Kong Labour Department 2004, 5). The Hong Kong Labour Department (2004) also maintains that communication between employers and employers and input from all levels of an organisation is fundamental with respect to maintaining a safe workplace. The Labour

Department envisages integration of OHS across all levels of the construction process, including the implementation of safeguards and preventative measures such as training and campaigning in order to raise safety awareness.

# 8.0 AUSTRALIAN BEST PRACTICE

## 8.1 Agencies

In Australia, the National Occupational Health and Safety Commission, Building Industry Taskforce and Australian Safety and Compensation Council are the agencies focusing on enhancing OHS.

### 8.1.1 National Occupational Health and Safety Commission

Recommendation 19 of the Cole Inquiry encouraged the Commonwealth to refer to the National Occupational Health and Safety Commission (NOHSC). Established as an overseeing agency to coordinate state, territory and federal programs in an attempt to work towards the prevention of occupational injuries and deaths, NOHSC is representative of state and federal governments, employees and employers. The federal Workplace Relations Ministers' Council released a National Occupational Health and Safety Strategy 2002-2012 on 24 May 2002. This document outlined five specific goals that would help reduce the overall number of injuries and deaths by reducing hazards and engaging managers and workers to consider and incorporate OHS, encourage proactive hazard reduction, and integrate the design phase into other areas. NOHSC stated that the 10-year strategy was supported by "all Australian state and territory governments, the Australian Chamber of Commerce and Industry and the Australian Council of Trade Unions" (NOHSC 2005, i).

In 2005, NOHSC released an outline of National Standards for Construction Work in order to "prescribe preventative action to avert occupational deaths, injuries and disease" (NOHSC 2005, i). These standards were envisaged with a view to engendering a consistent approach to OHS across the states, territories and the nation as a whole, all the while working towards more uniform national OHS regulations. NOHSC outlined the "Objective and Principles" of the national standards as assisting with hazard identification, risk assessment and minimisation and elimination (NOHSC 2005, 4). The NOSHC national standards form a prescriptive document that specifies the responsibilities of different stakeholders, which are presented under the headings of "responsibilities of clients" and "responsibilities of designers" (NOHSC 2005, 1). These "must do" responsibilities are assigned to "individuals to identify hazards and either eliminate them or, where this is not reasonably practical, minimise the risks they pose" (NOHSC 2005, 1). The document consistently assigns duties to "a person with control" who is liable for providing "general health and safety provisions" such as "lighting", "access" and "traffic control" (NOHSC 2005, 22-25). The overlapping of individual responsibilities for OHS is merely addressed in the document. One section discusses "joint responsibilities" and states, in a general sense, that, if there is "more than one person" working on a project, they each must take responsibility for their work. Furthermore, although the document refers to consultation, this concept is briefly mentioned as a process that should be arranged. Further explanations are not provided. In a general sense, the document is a successful guide to prescriptive stakeholder responsibilities, but is limited by its prescriptive format, which is general but at the same time limited in scope.

### 8.1.2 Building Industry Taskforce

In 2002 the Australian Building Industry Taskforce was established and charged with the responsibility of enforcing legal regulations affecting the building industry. This was achieved by investigating potential breaches of the Workplace Relations Act 1996 (WPA) and educating those involved in the building and construction industry about their workplace rights (Building Industry Taskforce 2005). The Taskforce merged with the Office of the Australian Building and Construction Commissioner (ABCC) in 2005 (Building Industry Taskforce 2005). Ebsworth and

Ebsworth (2003) noted that the taskforce actively monitored and inspected sites and referred cases to relevant authority agencies such as the police or the Australian Competition and Consumer Commission if dangerous or illegal practices were suspected. The Building Industry Taskforce focused on union activity and action, as evidenced by the types of complaints received by the Taskforce. Over a 3 year period, between 1 October 2002 and 30 September 2005, the taskforce had undertaken “540 reactive investigations” (Building Industry Taskforce 2005). The most common investigations resulted from claims of “coercion, threats, intimidation [and] violence”, which constituted 27% of all investigations (Building Industry Taskforce 2005). Equally, “miscellaneous” matters, which included “contractual matters, loss of work, secondary boycotts, misuse of OHS” complaints also accounted for 27% of total investigations (Building Industry Taskforce 2005). Other recorded complaints included “freedom of association, hindering/obstructing the right of entry, unprotected action, strike pay and inappropriate payments” (Building Industry Taskforce 2005). The Taskforce also ran a 1800 hotline for complaints, which recorded “3,523 calls received between this same three year period between 1 October 2002 and 30 September 2005” (Building Industry Taskforce 2005).

### 8.1.3 Office of the Building and Construction Commissioner

As previously discussed, the now-disused Building Industry Taskforce was replaced on 1 October 2005 by the Office of the Building and Construction Commissioner. The ABCC has similar capabilities to the Building Industry Taskforce since it retains the power to “enforce workplace laws, to address the problems that the building and construction industry encounters” (ABCC 2005). The ABCC covers a number of different aspects of OHS enforcement, for instance compliance with the 1997 National Procurement Council’s Code of Practice (ABCC 2005). Together, the ABCC and the “Code Monitoring Group (CMG)” remain responsible for ensuring that compliance with this Code of Practice is maintained for government-funded construction projects. The ABCC also released implementation guidelines in 2006 for the Code of Practice. These guidelines specify the importance of safety to the “Federal and State/Territory Governments” (Department of Employment and Workplace Relations 2006, 27). It is also specified in the implementation guidelines that the “principal contractor” is responsible for establishing a “site-specific OHS&R [Occupational Health and Safety and Rehabilitation] management plan before work commences” (Department of Employment and Workplace Relations 2006, 27).

This management plan covers a broad spectrum of OHS areas such as explicit management commitment, employee involvement, rigorous work practices analysis, proactive worksite analysis that anticipates and assigns roles and responsibilities and defines efficient procedures while onsite, hazard identification, prevention and control, induction and task training, appropriate case management and rehabilitation, and efficient maintenance of records. The implementation guidelines specify that safety should be part of the “organisational culture” (Department of Employment and Workplace Relations 2006, 27). According to this document, in order to ensure successful integration of safety into the culture of the organisation, it is necessary to document fully and clearly communicate the safety process, define the roles and responsibilities of different individuals and groups involved in the project and engage in prevention rather than reaction (Department of Employment and Workplace Relations 2006, 27).

### 8.1.4 Federal Safety Commissioner and Australian Safety and Compensation Council

The Federal Safety Commissioner (FSC) along with the Office of the Australian Safety and Compensation Council (ASCC) were established by the federal government with the intention of developing and supporting construction OHS (FSC 2005). The FSC was established in response to recommendation 26 of the Cole Inquiry, viz. that the Federal Government should have “a substantial influence on the industry in its roles as a client and provider of capital” (Cole 2003, 46). The role of the FSC, as mandated by the Building and Construction Industry Improvement Act 2005, involves monitoring and promoting OHS compliance as well as disseminating information about safety from the relevant aspects of the Australian Building Code. The FSC has the pivotal role in the “development and administration of the Australian Government Building and Construction OHS Accreditation Scheme” (FSC 2005). Within this scheme, the government represents a “model client” by selecting head contractors who readily apply safety principles into work practices and perform work “on budget and on time” (FSC 2005). Under this scheme, in a practice viewed by the federal government as best OHS practice, accredited contractors are the only ones able to “contract for Australian Government construction projects” (FSC 2005).

### 8.2 National Code of Practice

To provide a set of guidelines for federally commissioned construction projects, a National Code of Practice for the construction industry in Australia was established by the state, territory and Commonwealth governments for the Australian Procurement and Construction Council (APCC 1997). The APCC (1997, 2) set out “principles and standards of behaviour” between “clients, their representatives and members of the Construction Industry”. It was recommended that private sector companies adopt the code voluntarily (APCC 1997, 2). Although useful with respect to providing background information about conduct in the construction sector, this code is not specific to OHS and only includes one paragraph on safety. The age of this code, coupled with the issues faced by the construction sector in terms of worker turnover, ageing population and the increasing potential for technological advancements being applied to construction practice implies that the existing code is both irrelevant and obsolete.

## 9.0 CONCLUSION: BEST PRACTICE FRAMEWORKS FOR CONSTRUCTION OHS

According to Holt (2001, 40), the following framework constitutes world's best practice in construction OHS:

- All work follows a managed design that accommodates safety, health and environmental issues affecting end user, structure construction and maintenance parties and population of surrounding area;
- Work has been assessed and steps taken to identify and control significant hazards and risks;
- Work is managed by staff who retain appropriate knowledge of safety, health and environmental issues involved;
- Work conducted by health and safety competent contractors and workers who retain job-specific skills and have been given job-specific induction;
- Work completed by contractors who have made appropriate allowance in tenders for necessary health and safety measures required by demands of contract
- Workers have been given necessary information and training about hazards and risks and control measures used to remove or minimise them;
- System for ensuring work is coordinated between groups of workers and different contractors and work safety issues are discussed and solutions agreed before work begins;
- Work conducted in compliance with national or local standards and in accordance with international good practice when national/local standards are non-existent;
- Safety plan specific to work – includes details of control methods applied to hazards and risks and comprehensive fire, emergency and environmental plan, in place before commencement of work;
- System of reward for safe behaviour and compliance with safety management system and unsafe behaviour penalised and discouraged.

Holt (2001, 40)

The literature concludes that best practice in construction OHS encompasses dimensions of government involvement, contractual specification of safety, use of safety plans and programs, worker participation in OHS management, OHS education and training, provision and use of safety equipment, hazard assessment and control strategies and measurement and evaluation of the effectiveness of OHS initatives.

### 9.1 Government

With a view to enhancing construction OHS, Kartam et al. (2000) suggest that there is a need to conduct safety inspections, maintain clear and concise contractual specifications and introduce a role for government in OHS. According to these authors, existing government safety inspection programs are ineffective since they lack the numbers of trained and experienced staff required. They suggest, furthermore, that a "competent person with appropriate credentials and certification … [should] make an independent review of a construction project and its safety plan and … sign off on it before work commences" (Kartam et al. 2000, 176).

The government role for OHS that Kartam et al. (2000) identify involves the development of policies requiring construction safety planning for design and construction, the development of a safety information bank of construction accidents and prevention methods, a shift from preliminary and routine construction safety audits or inspections to competent safety engineers, introducing fines for non-compliance with safety initiatives, and funding a "safety information highway" from OHS fine-generated revenue (Kartam et al. 2000, 177).

In Australia, there has been a shift from "prescriptive laws", which merely outline the means of achieving satisfactory outcomes to a more effective "performance-based" legislative format, which instead provides targets or outcomes (Durham et al. 2005, 8). An "extensive" analysis undertaken by the Industry Commission into OHS regulation found that a move to "performance-based regulation" can only succeed if coupled with "a range of other measures" (Durham et al. 2005, 17). The authors explain further that these performance-based regulations will only be successful if they are coupled with enforcement measures, including legal penalties if breaches are found (Durham et al, 2005). In addition, the ACCI (2003, 6) maintain that governments and policy makers must "make change practical, meaningful, clear and consistent", whilst ensuring that industry adopts a medium- to long-term focus with respect to implementing OHS change.

### 9.2 Contractual Specification of Safety

According to Kartam et al. (2000), effective safety enforcement and control is difficult when sub-contractors are involved onsite. In these circumstances, Kartam et al. (2000) maintain that the general contractor should be responsible for insisting that all necessary safety measures be written into the subcontractor's contract. The importance of this clear contractual specification is summarised in the following statement: "Unless proper provision is allowed for subcontractors to consider safety in their bid, it is doubtful whether they will take safety seriously" (Kartam et al. 2000, 174). These authors suggest that contractual specifications must establish specific guidelines in order to control anticipated hazards by naming the person responsible for overseeing the contractor's performance, requiring contractors to prepare and submit an acceptable project hazard prevention plan that defines supervisory and employee safety training, identifies specific published safety standards and hazard prevention requirements, and lists qualifying requirements for eligible contractors with a view to ensuring that bidders are restricted to those whose past performances demonstrate care, competence and safety. A similar view is provided by Hislop (1999), who maintains that the contract must clearly outline that the contractor and subcontractors have a contractual responsibility to a) perform all onsite inspections as per the pre-approved site specific environmental health and safety plan and b) ensure competent individuals implement the program (Hislop 1999).

### 9.3 Safety Plans and Programs

In consideration of evidence showing that employees tend to have a greater awareness of workplace hazards compared to employers, Lin and Mils (2001) suggest that employees should be involved in safety programs. Worker participation in programs is thought to allow workers to easily understand and accept OHS changes (Lin and Mills 2001). Hinze and Raboud (1988) found that regular onsite meetings assist the identification of OHS problems and solutions and serves to improve accident prevention.

In Australia, the state of Queensland adopts a self-regulatory approach to OHS (Johnstone 1999). In 1997, the Workplace Health and Safety Regulation required principal contractors, demolishers, employers, contractors and sub-contractors to prepare OHS work plans before the commencement of onsite work if the value of the work exceeded $40 000 or involved significant OHS risk (Johnstone 1999). In particular, OHS work plans are required when work involved excavation exceeding 1.5 metres in depth, when falls from heights of 2.4 metres or more were possible, or when work involved removing, sealing or inspecting for asbestos (Johnstone 1999). The OHS Work Plan is a document that requires principal contractors,

contractors and sub-contractors to document their hazard identification and management initiatives, particularly those related to risk assessment and control (Johnstone 1999). These parties are required to review each other's Work Plan and discuss OHS issues (Johnstone 1999). Under these plans, each party has equal access to the Work Plans of other core construction parties. The Work Plans thus operate as a risk assessment tool and mechanism that facilitates coordination of OHS management initiatives among principal contractors, contractors and sub-contractors (Johnstone 1999). Although these Work Plans require the different construction parties to document their intended OHS practices in a formal manner, the varied quality of risk identification and assessment, in addition to the manner in which these plans are implemented, creates subjectivity and difficulties with respect to determining their effectiveness (Johnstone 1999).

In view of the difficulties involved in effectively implementing OHS Work Plans, Johnstone (1999) conducted a study into the area. His research incorporated interviews with construction inspectors and obligation holders such as demolishers and principal contractors and sub-contractors in large scale commercial and smaller commercial construction and domestic building and focused, furthermore, on examining the implementation issues of OHS Work Plans in a Queensland construction inspectorate. Johnstone (1999) found that effective implementation of OHS Work Plans requires self-regulation principles to be promoted along with codes of practice and advisory standards, guidance material and sample Work Plans. According to Johnstone (1999), inspectorates require a clear vision in order to facilitate self-regulation, strategic alignment and enforcement.

According to Peyton and Rubio (1991), the US Occupational Safety and Health Administration has outlined twelve basic elements of an effective safety program. These are as follows:

- The safety program should reflect the size of the business;
- Management should be committed fully to safety above all else;
- Safety responsibilities should be clearly defined;
- Adequate funds should be budgeted for safety programs;
- Management should lead by example in implementing safety programs;
- Open communication should exist between management and employees;
- Hazard identification and assessment through inspections must take place;
- Active employee participation is required;
- Safety should be planned from the bid process until workers leave the job site;
- Written employee disciplinary programs must be in place;
- Safety training and orientation needs to be incorporated; and
- Periodic safety performance reviews must be undertaken (including accident statistics, reports of injuries and results of safety inspections)

Hopkins (2006) evaluated the effectiveness of safe behaviour programs in Australia. He concluded that safe behaviour programs are ineffective when workers mistrust management and perceive these programs as another means to increase worker accountability. In such instances, Hopkins (2006) advocates that employers should first acquire employee trust, address some of the safety issues at the employee operational level (such as production pressures or fatigue) and introduce safe behaviour programs by means of upward appraisals of management behaviour. The research also revealed that, although safe behaviour programs are a required component of comprehensive safety management systems, the plans should not be given a central focus over other areas such as safety by design. While safe behaviour programs have the capacity to enhance construction safety, Hopkins (2006) observed that these plans omit to document critically important unsafe behaviour such as worker attempts to restart work processes that have been temporarily interrupted.

In order to identify the critical success factors for behaviour-based safety, DePasquale and Geller (1999) conducted interviews and focus groups across 20 organisations that had implemented behaviour-based safety programs in the US. The authors identified five employee-related factors that were seen to influence the success of behaviour-based safety programs, these being a) adequacy of behaviour-based safety training, b) trust in management abilities, c) evidence of safety program accountability through performance appraisals, d) the presence of a safety program designed to educate workers, and e) the duration of employee tenure within the organisation.

The study also investigated whether voluntary or mandatory safety programs were most effective. The results suggested that both types of program were equally effective. However, the mandatory processes were observed to include higher levels of employee involvement, trust in management and co-workers and positive feedback than the voluntary safety program. DePasquale and Geller (1999) note that, since employees became more involved in the observation and feedback process, they realised that the program was designed to benefit them. Upon realising this, their trust increased. The research also revealed that mandatory processes have the capacity to facilitate employee perceptions of personal control and increase the number of relationship-based variables necessary for the success of behaviour-based safety programs, provided that proper development and implementation occurs. In view of this, the authors suggest that management should first establish the expectation that everyone must participate in the observation and feedback process. At the same time, the authors advise that management should be flexible with regard to the process specifics and offer ongoing support for procedures customised by line workers. The research emphasises a need for a safety steering committee responsible for overseeing observation and feedback processes. In order to manage negative perceptions of its members, DePasquale and Geller (1999) highlight the need for safety steering committees to select appropriate representatives and regularly rotate these members.

Tam et al. (2001) investigated the impact of attitudes on safety management systems in Hong Kong before and after the implementation of a site safety Supervision Plan. The Supervision Plan allocated responsibility for safety to authorised persons, such as registered structural engineers and main contractors, and required five grades of technically competent people to make regular site visits in order to check on working practices and document the faults and corrective actions in a safety logbook. Tam et al. (2001) observed that, following the implementation of the safety plan, respondents increased in their appreciation of safety and the plan itself.

Dedobbeleer and Béland's survey (1991) of 384 workers across nine non-residential construction sites in Baltimore provided various strategies to improve safety policies and programs. The research revealed that safety programs and policies should reflect the safety concerns of both management and workers and that management safety concerns and actions should be publicised among workers. Since safety meetings were identified as an adequate forum in which to involve workers in safety matters, Dedobbeleer and Béland (1991) suggest that workers participate in safety program development, the conduct of safety audits and the identification of solutions. The research also suggests that management commitment to safety and worker involvement in safety is critical for effective safety management.

In addition to safety plans, Lin and Mills (2001) suggest that safety committees are beneficial with respect to enhancing OHS outcomes. Comprised of representatives of the employer, worker and subcontractor, a safety committee encourages interaction between parties and helps to improve trust and communication, while at the same time allowing the relative expertise of each party to be drawn upon (Lin and Mills 2001). It has been suggested that safety committees assists in terms of promoting accident prevention and safe working habits (Lin and Mills 2001). In addition to safety plans and committees, worker involvement in OHS management is claimed to induce increased worker involvement and regard for OHS.

### 9.4 Worker Participation in OHS Management

In the future, Hislop (1999) argues that success in construction OHS will rests on the ability of organisations to recognise that the construction industry and its workforce are changing. He suggests that organisations that involve contractors and their workforce in the safety process will be more successful than those that do not exercise management commitment at all levels. Furthermore, management commitment to safety must be communicated clearly, along with a vision for the project team. According to Hislop (1999, 2), safety must be integrated into the “conduct of routine work”.

The HSE (2005) advocates that staff and employees must be encouraged to contribute to the improvement of health and safety and to provide input with regard to the most effective ways to achieve higher safety standards). The HSE (2005) believes that this is an effective way to boost employee morale and make employees feel that their contributions are valued. It is also believed that this will encourage loyalty amongst employees. The HSE (2005) understand that unions play an integral role in improving safety standards. In addition, the HSE (2005) believe that, if people involved with a construction project consistently communicate and hold regular briefings tin order to communicate effectively, workers will be able to understand the risks associated with their work and the way in which these risks might be mitigated (HSE 2005).

Ayers and Culvenor (2002), who hold that worker participation in OHS is an important principle contained in Australian OHS legislation, investigated the benefits of problem-solving and the creativity of two OHS committees from two large construction companies in New South Wales. These authors observed that enhanced knowledge of risk-control concepts is important and that OHS committees require a greater focus on this area during the provision of training. Worker participation in OHS has become a routine practice in Hong Kong. In this country, employees are responsible for proactively working towards safety improvements (Hong Kong Labour Department 2004, 2). The Hong Kong guidelines focus on the responsibilities of the employee and the way in which they can actively work towards improving safety standards (Hong Kong Labour Department 2004, 2).

Dedobbeleer and German (1987) conducted a study of the individual and situational factors associated with construction workers safety practices and their individual and combined impact. These authors, who incorporated data from nine non-residential construction sites located in metropolitan Baltimore, USA, observed that age, attitude towards safety performance, perceived control over personal safety, absence of a serious injury record and training exposure affected worker compliance with regard to safety regulations. It was found that factors such as management’s attitude, the enforcement of safety practices, foremen’s safety enforcement and the attitudes of unions, co-workers and families towards safety practices clearly influence worker safety performance (Dedobbeleer and German 1987). These factors were observed to impact indirectly on OHS performance through attitudinal shifts and perceived control over personal safety (Dedobbeleer and German 1987). The age of workers was also found to be related to the level of OHS pursued (Dedobbeleer and German 1987).

In addition, Dedobbeleer and German (1987) outline several implications for safety interventions in the construction industry. Limited knowledge of safety practices and unfavourable attitudes toward safety performance among the youngest construction workers indicated that this group requires more concentrated OHS efforts, especially with regard to those who are not union members. The authors advocate mandatory training programs before employment. What is more, worker attitudes to safety performance were identified as the most powerful predictor of construction worker's safety performance. However, attitude was weakly related to safety training exposure and not related to attendance at safety meetings. The findings of Dedobbeleer and German (1987) revealed a lack of relationship between knowledge of safety practices and onsite safety interventions. This suggests that, although OHS practices exist, they are not being applied or enforced particularly effectively. As a consequence, an impetus exists for more effective safety interventions to be developed and reinforced. Furthermore, the same authors observed that safety instructions given at initial employment proceedings and safety meetings were conducive with regard to enhancing worker safety performance yet admitted that the specific impact of this undertaking remains unknown.

Andriessen (1975) observed that construction workers' behaviour with regard to safety was related to expectations of management reaction, work pace and injury reduction. In other industries, factors associated with injury comprise age and job experience, beliefs about the costs and benefits of using protective devices, concerns about potential accidents, the absence of serious workplace injuries, availability of adequate personal protective devices, safety pressures from supervisors or co-workers, and feedback (Dedobbeleer and German 1987). Before workers can become actively involved in OHS management, they must first be well-educated and trained in this area.

### 9.5 OHS Education and Training

According to Hakkinen (1995), there is a growing need for education and training strategies that do not emphasise external control, enforcement and technical inspections and instead focus on top management internal control, human factors, safety management and safety culture. In demonstration of this need, Kartam et al.'s research (2000) observed that workers and engineers were found to receive almost no safety training and were mostly uninformed about the company's safety programs and policies. Kartam et al. (2000) contend that formal training programs assist personnel to complete various preventative activities effectively and also establish positive attitudes towards safety. The safety training should also be specific to the problem areas and safety situations most frequently arising within the organisation (Kartam et al. 2000). Training material should also discuss the costs of accidents, the importance of sound safety performance, the safety objectives of the organisation, the legal obligations and the contractual relationships with clients related to safety (Kartam et al. 2000). Kartam et al. (2000) maintains that, in order to minimising vulnerability on job sites caused by unfamiliarity with potential hazards and new construction processes, it is imperative that new workers be inducted properly to their job environment. In support of this line of reasoning, Gun (1993) examined the safety performance of contractors across 98 different construction sites over a two-year period. He concluded that injuries associated with the violation of regulations are best prevented by means of management training and good management practice.

Lin and Mills (2001) argue that workers and managers must be able to anticipate possible workplace hazards. However, Wilson and Koehn (2000) has observed that organisations with poor safety performance often leave safety training to site experience and consequently adopt inadequate approaches to the prevention of OHS incidents. Nishgaki et al. (1994) and Garza (1988) recommend that workers should be educated about all aspects of work safety and should be provided with the necessary skills to act upon this knowledge. In a similar fashion, Davis and Tomasin (1999) suggest that effective training in the construction industry encompasses one approach by means of which safety can be improved. Active company management is also considered necessary with respect to reducing the number of injuries and fatalities (Davis and Tomasin 1999). Company policy statements form another means of ensuring that safety standards are maintained. These policy statements indicate the company's position on OHS by outlining management's OHS responsibilities and the manager's commitment to providing safety information, training and advice to employees (Lin and Mills 2001).

Jensen (2005) developed a safety training flowchart that reflects the relationships among the component processes for all health and safety training. According to Jensen's safety training flowchart, once a need for training has been identified and specific training needs have been listed, learning objectives, activities, materials and specifications should be developed. If pre-training evaluation data is to be collected, pre-training evaluation data should be obtained and, thereafter, training should be conducted (Jensen 2005). The next steps in the safety training flowchart require the training program to be evaluated (Jensen 2005). The final stages in Jensen's (2005) safety training flowchart require possible improvements to the training program to be identified and acted upon.

Trethewy and Gardner (2000) advocate the development of performance indicators in the OHS training provided to contractors. These authors suggest that contractors require appropriate training before work commencement and that refresher training should be provided at regular intervals (Trethewy and Gardner 2000). Trethewy and Gardner (2000) also maintain that effective OHS training involves analysing workplace tasks for specific training needs and ensuring personnel charged with OHS responsibilities retain the necessary training.

Hawk (2005) provides various strategies in order to make OHS training interesting and appealing for participants. According to Hawk (2005), training should involve audience participation, personal stories, questions and comments from the audience, use of props and objects, pictures and examples and experimentation on the part of the training facilitator. He also suggests that training programs a) include competitions that mostly revolve around the topic, b) should be challenging and c) establish their purpose up-front. In addition, Hawk (2005) also maintains that OHS training programs need to include a practical element whereby participants actively design an item of practical significance.

Laukkanen (1999) reviewed the health and safety issues in construction with a view to identifying the specific training regimes required in order to enhance OHS. The research revealed that a basic need for training exists in the hazard recognition stage of the construction process. The author suggests that flexible construction work arrangements, a reduction in time spent working alone and multi-skilled work teams are essential if better safety outcomes are to ensue (Laukkanen 1999). Furthermore, the research revealed that safety training in construction necessitates safety instructions, the teaching of first aid skills and accident prevention. Skill training and ergonomic instruction, in addition to job training, were also identified as fundamental training requirements for enhanced construction safety (Laukkanen 1999). In a similar manner, Gun and Ryan (1994) observed that the provision of written operating procedures slightly decreased the risk of injuries.

## 9.6 Safety Equipment

Lin and Mills (2001) contend that the wearing of protective clothing and the use of safety equipment is critical with respect to reducing onsite accident effects. In a similar fashion, Harper (1998) and Holmes et al. (1999) suggest that, although safety equipment is generally provided, employees are often reluctant to use it. As a consequence, the provision of safety equipment alone does not warrant effective OHS practice. In view of this, management commitment is required with respect to enforcing the wearing of safety equipment in addition to a corporate culture that encourages such practices.

In order to avoid the illusion that protective equipment safeguards workers from injuries, Ringen et al. (1995) suggests that it is important to understand the limitations of equipment before use. For instance, gloves can only protect workers hands for two hours against the methylene chloride present in paint strippers (Ringen et al. 1995). Indeed, hazardous chemicals may seep through gloves onto workers hands during a single work shift (Ringen et al. 1995). LIkewise, the lack of eating and sanitary facilities provided for construction workers also exposes them to hazards (Ringen et al. 1995). The limited facilities available for workers to wash their hands, coupled with their dining area constituting the work zone, often results in workers swallowing toxic substances transferred from their hands to food or cigarettes (Ringen et al. 1995). A lack of change-room facilities is also argued to culminate in contaminants being transferred from the construction site to a worker's house (Ringen et al. 1995).

Irizarry et al.'s research (2005) also notes that the perception on many construction sites is that the use of safety equipment increases task duration, which thereby causes many workers to fail to use safety equipment. The authors suggest that, in order to encourage the use of personal protective equipment on construction sites, project managers should evaluate the manner in which they coordinate work so as to achieve efficient use of safety equipment. Irizarry et al. (2005) also provide three strategies that serve to offset increases in task duration arising from the use of safety equipment, these being a) improved equipment quality, b) reduction in the occurrence of accidents that generate cost savings from reduced insurance premiums and c) increased industry competitiveness resulting from a lower experience modifier rate. Although Irizarry et al.'s research findings suggest that the appropriate use of personal protective equipment is one factor that may increase the duration of steel erection tasks, the authors note that the use of personal protective equipment not only improves existing equipment and work procedures but also benefits workers by providing lighter tools, improved installation procedures and personal protective equipment that does not hinder worker movement, especially when working at heights.

Irizarry et al. (2005) evaluated the way in which factors related to the use of personal protective equipment and environmental conditions in steel erection sites affects worker task duration. By directly observing steel erection activities and conducting a statistical analysis of task duration data, these authors observed that the use of safety equipment alone does not increase worker task duration. The research revealed that the specific nature of the task and the work environment heavily influenced the task duration. For instance, the authors observed that task duration was higher when the floor below the workers included decking. Although the decking appears to create a sense of safety, more intense activity may be occurring on the decked surface at closer proximity to workers installing steel members. According to Irizarry et al. (2005), this activity creates a perception of risk among workers and results in increased task duration.

## 9.7 The Role of IT and Web-based Tools

Carter and Smith (2006) also present a new IT-based system of safety risk management entitled Total Safety. This system operates on the premise that safety tools should be available on every construction project within an organisation and that these tools should be "platform independent" and operate without the need for high specification hardware and software (Carter and Smith 2006, 201). They may therefore be used within web browsers (Carter and Smith 2006, 201). Carter and Smith (2006) conclude that IT-based hazard identification modules, primarily those that include a centrally-based safety database, assist engineers to produce method statements with high levels of hazard identification.

## 9.8 Hazard Assessment and Control

OHS legislation indicates that the assessment of the level of risk associated with a particular hazard is essential for the effective management workplace hazards (Trethewy et al. 2000b). Trethewy et al. (2000b) claim that this approach allows resources that are in limited supply to be regarded as medium- and high-risk hazards, as deemed appropriate (Trethewy et al. 2000b). Conversely, as repetitive low-risk hazards are generally disregarded, they have the potential to become medium- to high-risk hazards (Trethewy et al. 2000b).

Trethewy et al. (2000b), who acknowledging that knowledge and communication of OHS is critical to safety performance, are of the opinion that the risk assessment process is fundamental with respect to determining which hazards require management in the construction environment. Despite this importance of hazard management, the authors note that, although hazards are identified, appropriate controls to eliminate and minimise them do not exist. They point out that this process is very subjective and, in response to this, put forward the following categories for rating OHS risks.

**Table 3**
**OHS Risk Assessment Categories**

| Risk Category | Considerations |
|---|---|
| Class 1 High Risk | Does the hazard have the potential to kill or permanently disable individuals or cause long term serious environmental damage? |
| Class 2 Medium Risk | Does the hazard have the potential to cause a serious injury or illness that will temporarily disable an individual or cause temporary environmental damage? |
| Class 3 Low Risk | Does the hazard have the potential to cause a minor injury that would not disable an individual or cause minor environmental damage? |

(Source: Adapted from Trethewy et al. 2000b, 514)

Trethewy et al. (2000b) suggest that risk assessment is concerned with reinforcing the potential effects of a workplace hazard rather than numerically calculating whether a hazard is high or low risk. Thus these authors claim that a simple scale, such as the one above, comprises adequate risk assessment practice. In addition to Trethewy et al.'s hazard management approach (2000b), Kirchsteiger (2005) proposes that the following five principles should be embedded into risk management initiatives:

- Transparency – extensive and open consultation, clear and comprehensive regulations;
- Rationality – legislative decisions mostly based on objective decisions, explicit assumptions and value judgements;
- Accountability – clearly defined responsibilities for action;
- Targeting – precisely stated specific objectives, outcomes and groups affected;
- Consistency – new legislation consistent with existing legislation; and
- Proportionality – legislation implementation costs proportionate to benefits gained from risk reduction.

According to Nishgaki et al. (1994), regular inspections of construction sites by safety patrols are beneficial and thus may be viewed as a central component of hazard management. In a similar fashion, Hinze and Raboud (1988) observed that frequent site visits by upper management results in improved site safety.

To ensure contractor compliance with established safety standards, the UK HSE conducts rigourous inspections of construction sites (HSE 2001). Australia is yet to successfully integrate a measure of this type into its OHS management practices. Durham et al. (2002) note that although existing compliance measures are administered at the state level in Australia, the Cole Inquiry did not comprehensively cover this area. The same authors also view compliance initiatives as a step towards encouraging construction industry stakeholders to adhere to and enforce OHS regulations.

In conducting safety inspections, Holt (2001) suggests that these safety assessments should be conducted in order to identify hazards and initiate remedies, improve conditions and reduce risks and measure safety performance. In particular, Holt (2001, 18) suggests that different types of inspections should be conducted (refer to Table 4).

**Table 4**
**Types of Inspections**

| Inspection Type | Description |
|---|---|
| Statutory | For compliance with health and safety legislation |
| External | By enforcement officials, insurers and consultants |
| Executive | For internal control purposes, primarily undertaken through senior management tours |
| Scheduled | Planned at appropriate intervals by supervisors |
| Introductory | To check on new or reconditioned equipment |
| Continuous | By employees, supervisors in either a formal and pre-planned manner or informal |

### 9.9 Measuring and Evaluating OHS Effectiveness

Trethewy and Gardner (2000) note that improved safety performance in the Australian construction industry has been hindered by a failure to focus on and measure contractor OHS performance. It has been suggested that a single reliable measure of OHS is both non-existent and insufficient to evaluate safety in a comprehensive fashion (Gallagher et al. 2001; Health and Safety Executive 2001). In specific terms, Gallagher et al. (2001) claim that the complexity of OHS means that simple quantified measures such as incident or claim data are essentially meaningless and unreliable. This is argued to be attributable to the dynamic nature of OHS, wherein the combination of human interaction and complex technology constantly results in safety problems and accidents (Perrow 1984), to the extent that hazards can never be entirely eliminated and risks can only be managed (Mearns and Håvold 2003). Likewise, the UK Health and Safety Executive (2001) claims that, compared to other areas, OHS measurement is problematic since success results in the absence of an outcome rather than the presence of one. What is more, low records of injuries or illnesses do not necessarily guarantee risk-free environments in the present or future. Mearns and Håvold (2003) assert that accidents and incidents incur both direct and indirect costs that have the potential to influence organisational growth and profitability. For instance, the UK privatised rail network provider Railtrack failed to manage potential safety problems, such as badly positioned signals and wear and tear of railway tracks, in an adequate fashion, to the extent that two rail disasters ensued (Mearns and Håvold 2003). Mearns and Håvold (2003) suggest that the following indirect costs of poor OHS have heavy impact on organisations:

- Interruption in production immediately following the accident:
- Morale effects on co-workers;
- Personnel allocated to investigating and documenting the accident;
- Recruitment and training costs of replacement workers;
- Reduced quality of recruitment pool;
- Equipment and material damage;
- Product quality reductions following accidents;
- Reduced productivity of injured workers on light duty;
- Overhead costs of spare capacity maintained in order to absorb accident costs;
- Market share reduction/customer retention;
- Reduced goodwill;
- Higher insurance premiums/difficulties in obtaining insurance; and
- Financial problems/stock exchange prices.

The difficulties of measuring OHS are further exacerbated by the varied measurement tools employed by the various parties involved (Mearns et al. 1997; 1998). Commonly used indicators of OHS performance vary depending on the stakeholder being considered and range from worker perceptions of the workplace safety state, communication, workforce involvement, perceived management and supervisor competence, safety performance satisfaction, and willingness to report accidents/incidents (Mearns et al. 1997; 1998). In order to maintain consistency in OHS performance indicators, the UK Health and Safety Executive (1997) developed a benchmarking framework comprised of six core areas:

- The development and effective implementation of health and safety policies that are timely and satisfy both legislative requirements and best practice guidelines;
- The management and organisation of health and safety, particularly control, communication, cooperation and competence;
- Management commitment to health and safety;
- Workforce involvement in health and safety activities including risk assessment and control;
- Health and safety auditing; and
- Health surveillance and promotion.

Trethewy and Gardner (2000) examined OHS measurement initiatives in Australian construction companies where a large proportion of workers may be characterised as contract employees. These authors observed that existing outcome performance indicators are inadequate as sole measures of safety and that regular maintenance and inspection of construction tools and safety devices are essential components of safety initiatives (Trethewy and Gardner 2000). Traditional safety indicators are not considered “true measures of safety performance” since they do not include those incidents or near misses that have the potential to cause injury but do not actually result in lost time (Trethewy and Gardner 2000, 529). Traditional measures are also regarded as ineffective with respect to recording employee exposure to long-term harmful environmental conditions such as noise and asbestos (Trethewy and Gardner 2000). Thus reactive approaches to OHS management often ensue, which means that hazard identification and prevention becomes neglected in the long term (Trethewy and Gardner 2000). Furthermore, traditional outcome measures have been observed to highlight failures of management systems, although they fail to provide an accurate measurement of actual workplace safety performance (Trethewy and Gardner 2000). Despite the inherent limitations of conventional safety measures, Trethewy and Gardner (2000) note that these indicators are necessary in order to translate OHS outcomes into monetary terms and provide solid economic arguments for enhancing OHS practices.

Trethewy and Gardner (2000) note that an impetus exists to develop enhanced safety performance indicators that a) accurately capture the important elements of workplace safety performance, b) indicate the effectiveness of safety management procedures and systems implemented by principals and minor contractors and c) include broad conceptions of safety performance that extend beyond accident and incident frequency rates. These authors also suggest that multiple OHS measures are required and that, instead of focusing solely on outcomes, OHS performance indicators must be related to safety management processes and should be simple to understand and put into action (Trethewy and Gardner 2000).

Trethewy and Gardner (2000) suggest that micro-performance indicators in the areas of management responsibility, contracting works, training and compliance verification are required in order to manage OHS in construction. These authors propose that senior management should clearly define and allocate OHS roles and responsibilities to qualified personnel and provide an OHS budget (Trethewy and Garner 2000). Trethewy and Gardner (2000) also argue that contractors should be provided with standard OHS information in the tendering process and that OHS commitment should comprise a consideration in the review and selection of contractors. In addition, these authors also suggest that contractors must provide safe work statements that address the medium to high risks likely to be encountered on the worksite (Trethewy and Gardner 2000). These statements should be reviewed before the commencement of work onsite (Trethewy and Gardner 2000). In the view of Trethewy and Gardner (2000), risk assessments should be undertaken when new work tasks arise and when planned work tasks change. Appropriate safe work methods should also be developed for medium- to high-risk work (Trethewy and Gardner 2000).

In terms of compliance verification, Trethewy and Gardner (2000) assert that it is necessary to conduct periodic internal reviews and external audits of OHS management systems and efficiently address identified issues. These authors also advocate that monthly safety statistics including lost time injury be reported and that trends in this area should be monitored (Trethewy and Gardner 2000). Compliance with documented work tasks and safety controls should be regularly examined and repeated medium- to high-risk hazards should be detected, recorded and addressed during regular workplace inspections (Trethewy and Gardner 2000).

According to Jaselskis et al. (1996) effective OHS measurement tools should include both quantitative and qualitative devices. Quantitative measures include lost time and severity rates and experience modification ratings, while qualitative measures refer to outstanding, average and below-average project performances as determined by OHS assessors (Jalselskis et al. 1996).

Trethewy et al. (2001) explored the key factors of successful OHS programs and performance measurement techniques in the New South Wales construction sector. These authors claim that formal feedback methods and positive encouragement with respect to reporting hazards are often overlooked in construction. When one considers that operational day-to-day management of OHS issues are critical to superior OHS performance, such practice is argued to strengthen the perception of management commitment to OHS (Trethewy et al. 2001). Furthermore, these authors suggest that attitudinal surveys, management commitment and OHS behaviour observation and reporting exist as effective tools for measuring OHS performance. Trethewy et al. (2001) found that the positive feedback and practical results produced from OHS observation and reporting not only heighten awareness of safe behaviour and workplace safety but also initiates a change process that serves to renew organisational values and safety culture. For instance, these authors observed that workers did not always wear safety glasses and gloves at work yet, within two to four months of initiating behavioural observations, goal setting and regular feedback, a 100% success rate with respect to using this safety equipment was eventually reported (Trethewy et al. 2001). When the company extended the focus of its safety promotional campaign to include tasks conducted outside work hours, employees transferred this safety focus to their homes with instances reported where workers wore safety glasses to mow the lawn (Trethewy et al. 2001). The effectiveness of this change was attributed to five implementation principles:

- Focusing on a small number of behaviours at any one time identified through industry statistics published by regulatory OHS authorities;
- Ensuring joint ownership through partnering with the construction workforce;
- Integrating behaviour observation into everyday operations;
- Emphasising positive reinforcement and recognition; and
- Integration and application into all business areas.

(Trethewy et al. 2001)

Trethewy et al. (2001) developed a Site Safety Meter Measurement Technique for assessing OHS. They suggest that, once construction-related OHS risks are mutually agreed upon by key contracting parties, they must be defined and measured against the following prescribed criteria that appraise both behavioural- and systems-based aspects of a construction worksite (refer to Table 5).

**Table 5**
**Site Safety Metre Measurement Criteria**

| Category | Observation Element | Criteria for "Correct" Score |
|---|---|---|
| Work Practices (use of protective gear, risk factor) | ▪ Each worker | ▪ Workers are using the required PPE or safety equipment correctly and are not taking any obvious risk (e.g. harness is attached, ear and eye protection when using circular saw) |
| Housekeeping (use of waste bins, work area tidiness, access ways) | ▪ Each bin<br>▪ Housekeeping<br>▪ Each access way | ▪ Clear access ways<br>▪ Waste bins are not overflowing<br>▪ General work area is clear of trip hazards and any rubbish or offcuts do not affect the workflow<br>▪ Clear working platform (e.g. deck on scaffold or formwork frames) |
| Electrical and Lighting (temporary electrical boards, leads and tools, lighting to work area) | ▪ Each lead or other piece of equipment<br>▪ An earth leakage switch<br>▪ Lighting | ▪ Leads are off the ground, no exposed wires or cuts<br>▪ Tagged and current equipment, including switchboards<br>▪ Earth leakage switch is fitted to mains supply or portable generator<br>▪ Adequate lighting to conduct work activities |
| Scaffolding and Ladders (correctly erected and secured) | ▪ Each section of the scaffold<br>▪ Each ladder | ▪ Scaffold is adequately braced and tied at regular intervals<br>▪ Tied off and correctly angled ladders<br>▪ Correct assembly of mobile (e.g. adequate ladder, bracing and toeboards where necessary)<br>▪ No large gaps between perimeter edge and scaffold |
| Protection Against Falls and Falling Objects (perimeter handrail, penetrations, overhead protection) | ▪ Each section of the handrail<br>▪ Each penetration<br>▪ Each section of overhead protection | ▪ Adequate edge protection is in place<br>▪ Penetration is covered and cover is secure<br>▪ Adequate overhead protection |
| Plant and Equipment (hoist or crane, concrete pump, jackhammer, other) | ▪ Each piece of plan and equipment | ▪ Flashing light and reversing buzzer are operating on all mobile plant including those operating onsite (e.g. loader, bobcat and backhoe when positioned on a public road)<br>▪ Appropriate plant/machine guards in place<br>▪ Correct storage of oxy and acetylene bottles<br>▪ Up to date logbook or service tags |

(Trethewy et al. 2001, 257)

Although this criteria-based approach measures OHS practice by means of a simple "correct" or "incorrect", Trethewy et al. (2001, 256) are of the opinion that a numerical scoring system should provides powerful feedback on a more frequent basis, and that this should allow management to develop preventative measures. They also suggest that scores should be actively communicated to workers through the display of posters in prominent locations. This practice is claimed to a) promote worker awareness of safety, b) keep the workers informed of OHS progress in performance and c) demonstrate management commitment to safety (Trethewy et al. 2001). As a consequence, it is envisaged that active worker support for improved OHS practice should result (Trethewy et al. 2001).

In view of the issues inherit in measuring and evaluating OHS, there has been an increasing trend towards benchmarking and the use of balanced scorecards. Mearns et al. (2003) conducted a literature review into benchmarking in health and safety within the offshore industry. In their study, these authors noted the importance of benchmarking measurement tools in order to provide managers with an efficient and comprehensive view of the organisation that includes both internal and external operations.

Fuller (1999) considered the effectiveness of OHS benchmarking through company safety competitions in a water utility in the UK. He examined the implementation of an audit programme that involved managers, supervisors and operators and was comprised of three components, viz. an employee understanding of OHS, site inspections, and accident frequency rates. Employee understanding of OHS included areas of law and company policy, safe working procedures, audit and review, and accident prevention and reporting (Fuller 1999). Site inspections addressed OHS issues at each of the three work environments of offices, workshops and operational sites while reported accidents, numbers of lost days on account of accidents or illnesses and numbers of road traffic accidents comprised the means of assessing accident frequency rates (Fuller 1999). Fuller (1999) concluded that, through safety competition, the audit programme provided an initiative for enhancing and maintaining employee awareness of OHS. What is more, benchmarking provided senior management with an initiative to improve OHS management (Fuller 1999).

As a method of benchmarking, Petersen (2005) examined the effectiveness of perception surveys in enhancing construction OHS. He suggests that perception surveys are an adequate evaluative measure of safety systems. Petersen's study (2005) found that these surveys establish baseline safety outlooks and provide diagnoses for areas requiring improvement.

In view of the issues inherent in consistently measuring OHS performance, Mearns and Håvold (2003) argue that a balanced scorecard (BSC) is the world's best-known organisational performance measurement system since it contains a diverse set of performance measures, viz. financial performance, customer relations, internal business processes and learning and growth. These authors claim that the BSC provides a useful alternative to benchmarking.

### 9.9.1 The Balanced Scorecard Approach to OHS Measurement

The UK Health and Safety Executive (2001), together with Mearns and Håvold (2003) and Gallagher et al. (2001), propose that a balanced scorecard that provides information on a range of health and safety activities is best equipped to assess safety performance. Gallagher et al. (2001) are of the view that the BSC provides a tailored and effective means of combining multiple measures of OHS performance. They also contend that it reflects the interests of different stakeholder groups. It has been argued that a balanced approach that incorporates multiple forms of measurement is best equipped to assess safety performance (Health and Safety Executive 2001). The table below outlines this measurement process.

**Table 6**
**Balanced Scorecard OHS Measurement Matrix**

| Measurement Type | Purpose | Scope |
|---|---|---|
| Input | To measure the hazard burden in terms of the nature and distribution of hazards created by the organisation's activities | ▪ Monitor activities to provide information about the significance of the hazards and variations of hazards over time and across the organisation<br>▪ Determine whether the organisation is successful in reducing or eliminating hazards<br>▪ Determine the impact of organisational changes on the nature and significance of hazards |
| Process | To measure the health and safety management system and activities to promote a positive health and safety culture (leading indicators) | ▪ Assess organisational factors such as policy, organising, planning and implementation, performance, operation, systems maintenance and improvements and the development of a health and safety culture<br>▪ Assessed through audits, reviews and surveys |
| Outcome | To measure failures (lagging indicators) | ▪ Reactive measurements such as injuries and work related ill health and other losses similar to property damage, incidents, hazard and faults or weaknesses or omissions in performance standards or systems. |

(Source: Adapted from Health and Safety Executive 2001)

Mearns et al. (2003) propose that OHS performance should be measured against the following BSC criteria:

**Table 7**
**Balanced Scorecard OHS Measurement Criteria**

| Category | Criteria |
|---|---|
| Financial | ▪ Accident costs<br>▪ Investments in safety |
| Customer | ▪ Frequency of communication about health and safety issues<br>▪ Workforce involvement and commitment to health and safety |

| | |
|---|---|
| | issues |
| Internal Business | ▪ Health and safety policies<br>▪ Safety organisation and management in terms of control, communication, cooperation and competence<br>▪ Management commitment demonstrated and workforce involvement in OHS<br>▪ Health and safety auditing<br>▪ Health surveillance and promotion |
| Learning and Growth (Best Practice) | ▪ Employee tests of knowledge about the health and safety policy<br>▪ Interaction between workforce members and managing director, business unit and manager/director responsible for OHS policy implementation<br>▪ Monthly safety committee meetings with high staff attendance<br>▪ Implemented OHS plan accompanied by health promotion activities in decentralised locations<br>▪ High percentage of corrective actions formally closed out in accordance with planned timeline |

(Source: Adapted from Mearns et al. 2003)

Mearns and Håvold (2003) examined the measurement issues inherent in assessing OHS performance in light of the BSC. These authors, who incorporate data from the UK offshore oil and gas industry, focus on applying health and safety performance indicators and benchmarking practices to an existing health and safety BSC model. Mearns and Håvold's study (2003) revealed that managers require a clear and cohesive OHS performance measurement framework that is understood by all levels of the organisation and supports objectives and the collection of results. The BSC was used to determine potential relationships between leading and lagging OHS performance indicators, while leadership was identified as critical to the design and deployment of effective performance measurement and management (Mearns and Håvold 2003). The study also noted an important role for senior executives and managers to establish and implement OHS policies and practices in a proactive fashion, particularly in terms of articulating a mission, vision and goals to all levels of the organisation. In addition, effective communication with employees, process owners, customers and stakeholders was deemed vital to the successful development and deployment of an OHS BSC. Although Mearns and Håvold (2003) feel that the BSC is a vital tool with respect to improving OHS in both the short and long term by means of providing continuous implementation and monitoring occurs, they acknowledge that mere monitoring and measurement does not guarantee effectiveness. In specific terms, these authors state that

> *Just because the system is being monitored and measured, this does not mean that unanticipated hazards or interactions of hazards can still arise. The BSC has to be reviewed periodically and questions have to be asked: are we measuring the*

*right things, are we making better decisions and how can we improve our measures to get the information we need?*

(Mearns and Håvold 2003, 421)

Mearns and Håvold (2003) also observed various factors that contribute to enhanced OHS practice. Employee perceptions of safety in the working environment, communication and workforce involvement seemed to have the most impact on accident and incident reduction. Perceptions of management commitment were also influential with regard to improving OHS, with high levels of perceived commitment being associated with lower accident rates. Finally, Mearns and Håvold (2003) noted that health and safety auditing impacted the levels of dangerous occurrences, while good health surveillance and health promotion activities were associated with lower lost time injury rates.

## 9.10 Summary

This report has reviewed academic literature, industry publications, existing codes of conduct and best practice guidelines on OHS across the globe and considered the key issues faced by both government and industry in improving OHS. Causes of construction accidents, injuries and fatalities have been identified as falls from heights, unsafe site conditions, continuously changing worksites, multiple operations and crews working in dangerously close proximity. Secondary causes such as management system pressures, social pressures, time and budgetary pressures and the fragmented operational nature in which the construction industry operates have also been examined. This report has also considered contemporary issues in construction such as the ageing population, the shortage of skilled labour, high worker turnover, organisational size, resource capacity constraints and the impact of an increasingly younger labour force on OHS outcomes. From this information, a need for closer supply chain integration, coordination, communication and collaboration has been identified for all parties involved in a construction project. Best practice frameworks for construction OHS have also been presented. The review concludes that best practice in construction OHS centres around dimensions of government involvement, demonstration of management commitment to safety, contractor selection criteria that extends beyond cost, clear contractual specification of safety roles and the enforcement of these obligations, the inclusion of safety by design principles, safety plans and programs, safety education and training, the provision and use of safety tools and equipment, the use of computer-based safety applications and continual measurement, evaluation and revision of safety initiatives.

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