SAFETY PLUS - IMPROVING CONSTRUCTION WORKER SAFETY

Construction Industry Institute, Australia Inc.

Dr Ron Sharpe, Adjunct Professor, QUT, Brisbane

Published by
Construction Industry Institute, Australia Inc.
Queensland University of Technology
2 George Street
BRISBANE QLD 4000

Phone: 07-3864 2811
Facsimile: 07-3864 1170
BACKGROUND

Despite concerted efforts to improve safety, the construction industry still has twice the average industrial accident rate per worker with over 50 fatalities, 12,000 compensation cases and 120,000 person-weeks absence per year in Australia. The Industry Commission (1995) estimated total costs of all workplace accidents as $15bn pa, split into $5bn direct costs and $10bn in indirect costs. Total costs were spread 15 per cent by employers, 40 per cent by employees, and 45 per cent by the community. A crude estimate of the construction industries share based on having 7% of the workforce and twice the average accident rate would give a 14% share of $15bn, i.e., about $2bn pa.

The majority of the 750,000 workers in construction work in small firms with little or no understanding of safe work practices. For them, the economic loss, trauma and human misery destroys lives and families. Controlling construction safety is made difficult by the diverse unstructured nature and changing tasks and environments in construction. It often involves transient individuals and work teams making it difficult to build and maintain routine safety practices that cover all potential events at all sites.

Previous attempts to improve safety have tended to focus on mechanistic procedures, compliance, and management practices, and still we experience “macho” attitudes that defy rationalisation. New research ideas explore the psycho-social behavioural characteristics of the worker and attempt to induce attitudinal change. A pilot study by Leighton Contractors on a major project showed that workers with low levels of safety awareness and training were five times more likely to be involved in safety incidents resulting in five times as many days lost compared to those with higher awareness levels. A group of major contractors (Thiess, Baulderstone, Leighton, Transfield) and the Victorian Building Commission will collaborate to develop a tool which will identify workers who might be at higher risk of being involved in an accident and provide them with a training intervention regime to reduce risk. We propose to develop an industry wide program tailored specifically for the Australian engineering, mining and construction to find better ways to motivate workers to improve the safety culture of the industry.

Even when safety procedures are well established, the culture of a project site and worker attitudes often result in procedures not being followed to achieve the best safety outcome. Although there is a strong desire by management to find ways to motivate workers towards a zero-risk safety attitude, employees are often under great pressure to get a job done. Such attitudinal change can be achieved through an increased awareness and understanding of risks, better peer support for safety procedures, better training and motivational reinforcement.

Attitudes are difficult to define, measure and change but researchers believe behaviour is far easier to define, measure and change, and once behaviour is changed, attitudinal change often follows, (Cooper, 1999; Geller, 2002; Lingard & Rowlinson, 1998; Rowlinson & Lingard, 1995). A classic example is the wearing of seatbelts or drink driving, where many people changed their behaviour to avoid penalty initially but have since developed a positive attitude towards both wearing seat belts and not drink driving. Existing literature on improving safety behaviour, safety climate and culture focuses on changing organisational behaviour through
employee involvement and work group interventions in order to reinforce the use of safe work procedures, as opposed to targeting individuals.

Mohamed (1999) in a questionnaire survey of 36 construction companies operating in Queensland found that they provided a reasonable-to-high level of safety management activities. However it was not reflected in their view of their safety performance with respect to the industry’s norm and in how they implement these activities as a safety management package. The inclusion of subcontractors in safety discussions and the rewarding of safety performance was seen to be below average for a significant percentage. Mohamed like many others concluded that what was needed was a change in safety culture.

**SIGNIFICANCE AND INNOVATION**

The engineering and construction industry accounts for 14.4% of Australia’s GDP, employing some 750,000 workers, if we can reduce accidents by a factor of five as indicated by preliminary research then the savings in Lost Time Injuries and concomitant productivity gains will bring substantial economic and social benefits estimated above to be of the order of $2bn pa.

**The research has five objectives:**

1. To develop an "assessment tool or model" to identify risk factors for employees that will identify personnel whose understanding of safe work practices is such that it places them, and those with whom they work, at a higher risk of being involved in an accident.

2. To develop further tools to bridge the gap in safety including motivational, personal skills and other support systems to improve their safety awareness.

3. To provide the appropriate personnel with the safety tools and thereby minimise the likelihood of them being involved in an accident.

4. To track the effectiveness of the program against key performance indicators.

5. To automate as much information handling as possible via computer based systems to assist in the delivery of the assessment and training program and also help the industry overcome access and resource problems, reaching sub-contractors and aiding cost effectiveness.

The Australian National Occupational Health and Safety Commission in a study of the construction industry (NOHSC, 1999) recommended a positive performance measurement approach be adopted to provide stronger accident prevention environments. They argued that while traditional outcome indicators such as lost time injury frequency ratio (LTIFR) are relatively easy to collect and easily understood nevertheless they have limitations regarding OHS performance. For instance injuries and fatalities have a low probability of occurrence, and so the absence of unlikely events alone is not a useful indicator of OHS management. The use of outcome indicators largely measure negative performance and may involve under- or over-reporting of work-related injuries or disease and might in fact act as incentives for and reward under-reporting.
As most unsafe acts do not result in immediate injuries it is also important to focus on positive performance measures to measure relevant OHS systems, processes, management and compliance with OHS practices in the workplace. NOHSC go on to expand these under 5 main headings:

1. Planning and design (integrating OHS into design and planning phases of construction);
2. Management processes (demonstrating genuine commitment and providing appropriate leadership);
3. Risk management (risks/hazards are eliminated or controlled);
4. Psycho-social working environment (workforce capabilities and opportunities to contribute to OHS management, problem solving and receive education and training that is practical and fit for purpose); and
5. Monitoring (OHS self assessment or independent auditing of systems and practices).

Hecker (2000) discusses the transient nature of construction sites and the challenges to implementing and maintaining worker participation in improving safety. Toolbox meetings, safety committees, and suggestion systems are traditional means of worker involvement but usually do not achieve the level of worker involvement or ownership of safety sought by contractors pursuing "injury free" workplace cultures. Best Practices Sampling (BPS) was developed as a crew-driven performance management approach to safety on construction sites that builds worker involvement into the daily work of the site. In a facilitated process the crew or work team develops a list of best practices required for safe performance of their work tasks. BPS was implemented on an industrial construction site on a pilot basis with six subcontractors working under a single general contractor. Effectiveness of implementation varied among crews and contractors. Important factors included:

- Quantity and quality of worker training
- Management understanding of and commitment to the process
- Specific management support to crews
- Workers' trust or lack thereof in how the sampling data would be used
- Ability to bring new workers into the process
- Ability to handle data collection and analysis

Komaki et al (1980) have shown that incorporating frequent feedback is important to gaining benefits from safety training.

Behaviour-based safety management (BSM) in construction is advocated by several researchers and industry groups following successes in manufacturing (Emerging Construction Technologies, 2002). It is a proactive approach and it is claimed by some proponents that to get the best benefit full employee participation is required in a team building manner. It is important that safety is seen by employees to be part of their professional competency and that it is rewarded with positive feedback and encouragement by peers and management (Geller, 2002). The international Behavioural-safety group (1999) claim accident reductions of 40-75% within six to 12 months of implementing procedures. Fleming and Lardner (1999) studied four behavioural safety programmes in the oil and gas industry and concluded:

- All the interviewees were convinced that the behavioural intervention they were using was having a significant positive impact on safety.
Only one of the four case studies (Care Plus) could demonstrate a significant reduction in accident rates following the introduction of the programme. The success of all four programmes was dependent upon management support and commitment. The success of programmes aimed at frontline employees requires a pre-existing level of trust between management and workers. Early employee involvement in the choosing and implementing of a behaviour modification programme increases the likelihood of success. Setting quotas for the number of observation cards to be submitted is likely to be counterproductive and may lead to fictitious cards being submitted. It is important to moderate people’s expectations for early reductions in accident statistics. Setting quotas for the number of observation cards to be submitted is likely to be counterproductive and may lead to fictitious cards being submitted.

The interpersonal skills (e.g. non-threatening questioning techniques) of installation staff (and supervisors) need to be developed in order for the behaviour modification programme to be effective. It is important to note that although some proprietary programmes do not include interpersonal skills training, employees still require these skills to ensure programme effectiveness.

The last point is most important. Helen Murphy, consultant to the project states that “too often line managers and supervisors are assumed to have the interpersonal skills to problem solve non-compliant behaviour and encourage positive behaviour, and too often they simply do not. There are workplace cultural influences on this as well where even providing positive feedback, for example, can be seen as insincere in some environments. Communicating and problem solving in groups is another area where skills are needed”. Traditionally BSM is an intervention assessed performance technique presented to workers, and then improvements are negotiated. The approach proposed in this research is novel in that it assesses attitudes and culture at the earliest stage during recruitment, and develops remediation and training opportunities with metrics to monitor and provide the feedback loop.

**APPROACH AND TRAINING**

This proposal brings together a research team which will meld the lessons from previous seminal work in Hong Kong by Professor Rowlinson, with the practical and theoretical experience of Professor Sidwell, the psychology and social domain expertise of Professor Mary Sheehan, and the applied advice from Helen Murphy who monitored the pilot study by Leightons. The research fellow, Dr Ron Sharpe, will provide expertise in research design, data collection and analysis. Industry partners will provide access to sites and employees in order to undertake case studies to develop and test the methodology and gather data.

Safety cultural issues can be structured on four levels:
- individual worker,
- project or site teams,
- company or organisation, and
- industry wide.

While the research will focus primarily at the individual level the other levels will also be addressed to provide a system wide approach.
The following factors can be considered fundamental to a person being able to work safely:
1. Knowledge, skills and ability to perform safe work procedures (they need to know what to do and be able to do it)
2. Risk awareness (ability to identify a situation or behaviour as risky, and solve emergent risk problems in at least a basic way e.g. reporting a hazard)
3. An avoiding risk response-style (tendency to behave cautiously as opposed to taking risks).
4. Motivation (intrinsic such as "I don't want to get hurt" but extrinsic environmental factors can be much more influential such as incentives and recognition for performing safe work procedures and hazard reporting, management commitment, positive safety climate, etc).

The methodology will use a multiple-baseline design involving multiple training and feedback phases with a relevant set of positive performance and outcome indicators based on the NOHSC framework. Typical positive performance indicators include:
- Risk management (eg. risks and hazards that are identified, eliminated and controlled through safety walks, inspections by management and workers; percentage of reported incidents that do not result in injury compared to those that do; average time to rectify hazards)
- Psycho-Social working environment (eg. percentage of employees assessed as motivated and competent in OHS following inductions and training programs; rating effectiveness of OHS communication; rating effectiveness of employee participation in OHS management)
- Monitoring (eg. OHS is self assessed and or independently audited and indicators measure change in scores and number of corrective actions required over time).

Typical outcome indicators will include:
- lost time injury frequency rate;
- medical treatment injury rate;
- compensable injury rate;
- minor injury (first aid) injury rate;
- average lost time rate;
- all incident case rate;
- cost of claims per project;
- rehabilitation case rate;
- near-miss frequency rate; and
- compensation insurance premium rates.

A further investigation will be undertaken into the construction safety network system in terms of its complexity. Recent developments in complex network systems behaviour are helping to identify important universal properties of such systems and how they can be manipulated so that critical information can be dispersed to achieve wide impact. It is being shown that many man-made systems (eg., internet, economies) as well as natural systems (eg., food webs, ecological, biological) are complex systems that share universal properties and generate networks that conform to a single well-defined ‘scale-free, power law’ mathematical formula (Cohen, 2000). Important properties include the identification and roles of critical hub nodes in networks for controlling and aiding the rapid spread of information across
the rest of the network (Barabasi, 2002). Such networks are robust if the hub nodes are well supported and maintained but vulnerable otherwise irrespective of the condition of other non-hub nodes. On the other hand random networks are less robust and harder to influence. Some networks that initially appear to be scale-free may have constraints such as limitations on hub node capacities, as in the case of airline networks. Others are quite dynamic and will have competition between nodes leading to evolutionary properties.

Since one of the goals of the project is to produce a wide spread culture change including individual, project, site, organization and industry wide levels, it is important to understand the nature of the construction industry network through which OHS ideas and culture are spread. If it can be shown to have a ‘scale-free’ linkage structure it is critical to identify and change the culture of ‘hub’ elements first otherwise any intervention is ineffective. The contractor network already has indications of being of a ‘scale-free’ type with a relatively few major contractors, such as the partners in this project, and a hierarchical network of sub-contractors. The major contractors typically lead in the introduction of innovation and reforms for the rest of the construction industry. It is important to confirm that the structure of network linkages of players in construction helps in disseminating safety innovation and also to map and quantify the linkages so that dissemination paths can be optimised.

The research will investigate ways of adapting and improving behaviour-based safety procedures that, according to Geller (2002), are currently not optimal in their general industry use. This will include tailoring to the Australian construction environment.

Developing and rigorously proving the effectiveness of new OHS procedures is challenging in a typical changing construction environment because of the large number of variables involved. Traditional control group design is generally not applicable and alternative evaluation strategies such as reversal and multiple-baseline designs (Komaki, 1977; Komaki et al, 1980) are preferable. In the research these approaches will be reviewed and extended.

Cooper and Phillips (1994) highlighted the potential for the use of computer-based training (CBT) in programs designed to improve safety attitudes with benefits being cost-effectiveness, consistency, responsiveness and flexibility. Studies cited in their review of the literature indicate improvements in safety attitudes and behaviours in manufacturing, mining and health industries where CBT was used as a training methodology have been found, although there were few published studies at that time. In terms of cost-effectiveness, an estimate of a 30% reduction in training time is described as conservative. In the construction environment, the innovative use of computer technology in the assessment and development of safety awareness and behaviours has the potential for much greater cost reductions being realised with the ability to deliver easily updateable training at site-office level providing flexible and rapid access for personnel coming on-site.

Compliance costs for safety are usually very high on construction projects and a significant part of this cost is in documentation, reporting and monitoring. Paper-based safety documentation is usually inconvenient to handle at the workplace.
While previous IT development has helped the office documentation productivity, it has not helped greatly at the workface where there is minimal, if any, computer access. However, integration of internet and mobile technologies is now providing greater opportunities to communicate timely information to and from the workface. An example is the BSITE system (http://www.bsite.net/) which uses SMS (short message technology) to enable mobile phones two-way communication to extensive databases, documentation, management and reporting systems. The research will explore extension of BSITE to effectively collect, share and distribute critical OHS information between the office and site based teams.

Tucker et al (2000) provides a comprehensive review of Return-On-Investment (ROI) procedures for general education and training for advancing the construction industry into a prominent leadership position in using training and results-based evaluation to improve the development and utilization of a skilled workforce. It concludes that any rigorous analysis of the return on investment to training must consider a broad range of variables that can impact training. These include increased outputs, cost savings, time savings, improvements in safety, health, or wellness, reduced injury and sickness rates, reductions in insurance costs, reduced grievances, reduced downtime in equipment, reduced employee turnover, reduced training time and reduced absenteeism.

The Research Associate and APAI research student will be the main research resources for the project. The Research Associate will focus on overall management of the project including organising, conducting and facilitating meetings, making observations and keeping notes, undertaking literature reviews, analysing results (with some statistical analysis of quantitative data), developing new design and evaluation procedures and business rules for the industrial partner, and writing the final report of the research project.

A major research component will be undertaken by the APAI involving the mapping the safety behaviours, understanding and motivation of the workers and management. This research will also examine the role of feedback on maintaining and improving safety performance including the effectiveness of using the IT support technologies.

Both will have to travel to the workshop meetings to meet and facilitate discussions between stakeholders from a wide range of backgrounds.

The international collaboration with Professor Rowlinson, who has conducted early studies in Hong Kong will allow the comparisons and normalisation of circumstances and results in the Hong Kong construction industry with Australian conditions. Professor Rowlinson will travel to Australia in order to be involved in local case studies.

The research plan and the expected timing will be as follows:

1. Appointment of APAI Research Student 1 Jan 2003
2. RA orientation and familiarisation Jan 2003
3. Model development and establishment of CIIA website Feb-May 2003
4. First workshop – begin implementation study Jun 2003
6. Modification to model  Jul-Sep 2003
7. Workshop 2  Sep 2003
8. Modification to model  Sep-Nov 2003
9. Workshop 3  Dec 2003
10. Synthesis of outcomes from workshop 2 and 3  Jan- Mar 2004
11. Interim report & Workshop 4  Apr 2004
12. Modification to model  May-Jun 2004
13. Workshop 5  Jul 2004
14. Final Workshop and presentation of results  Dec 2004
15. Completion of thesis by APAI  Mar 2005

INDUSTRY PARTNER COMMITMENT AND COLLABORATION

The Construction Industry Institute of Australia (http://www.cmp.bee.qut.edu.au/cii/) supports applied leading edge research projects that result in major breakthroughs that add significant value to members and Australian construction industry. Research proposals are generated by industry needs and the CIIA is part of an international network of similar institutes based at universities in the United States, Europe and Australia and more recently, in South East Asia. This project was identified as being of high priority for CIIA members including several major construction contractors and State government departments responsible for public works, housing and road construction. The project will help these organizations to substantially improve OHS as well as improving construction productivity and reducing insurance and other costs. Five member organisations will collaborate to undertake this research, providing access for data collection and testing of outcomes and dissemination throughout the industry.

Leighton Contractors (http://www.leightoncontractors.com.au/) is a leading construction contractor with over $1.2 billion worth of work in progress in Australia currently. Leighton’s are leaders in improving OHS conditions on construction projects and the proposed research provides an ideal independent assessment of the benefits of training as well as the introduction of new IT technology to improve the delivery and effectiveness of OHS programs.

Thiess (http://www.thiess.com.au/) is Australia’s leading integrated engineering and services provider, with a turnover approaching $2 billion in the 2000-2001 financial year. Thiess is committed to maintaining a safe and healthy workplace for all of its 7000 employees. It recognises a responsibility to ensure the safety and well-being of all those who work with the company, whether as a direct employee, subcontractor or consultant. It also recognises that the safety of clients and their clients is of paramount importance. Within the construction and mining industry, Thiess’ LTI (Lost Time Injury) frequency rate is one of the best. Safety audits and ongoing training ensure that a process of continuous improvement is in place.

Baulderstone Hornibrook is one of Australia’s largest and most capable construction groups, delivering innovative and cost-effective solutions to clients in building, transport infrastructure and heavy industry. It aims to be an industry leader in Occupational Health and Safety and has established a lost time injury target of zero, signalling there will be no tolerance of unsafe acts on its projects. (http://www.bh.com.au/partner_safety.htm).
Transfield Construction (http://www.transfield.com.au/) is a leading civil engineering contractor with more than 45 years experience in Australia, New Zealand and in several countries of South East Asia. Transfield's approach to Health and Safety is an integral part of an overall process of organisational growth and development toward achieving its mission of providing the highest quality services and applying the most advanced international technology to continually meet client expectations.

BSITE (http://www.bsite.net/) is a workforce management and project collaboration software system to link office computer systems via mobile phones to the construction site to improve the delivery of important project workflow information to the on-site workforce. The proposed research includes collaborative design of OHS software extensions and assessment of the delivery and effectiveness of these extensions in live construction projects. BSITE will support the project with in-kind resources and facilitate the development of software extensions to the BSITE system.

**NATIONAL BENEFIT**

The potential national benefit to Australia is large. Firstly, significant social benefits will result from improved safety through death and injury reduction on construction sites, not only for employees, but also their families and communities. Reduction in economic costs is also expected to be substantial, not only for the direct costs in injury costs, hospitalisation, rehabilitation etc, but also the in-direct costs arising from delays and multiplier effects to other sectors.

The identification and promotion of a clear cultural and technology migration path for OHS enhancing strategies, processes and tools will benefit all sectors of the construction industry including the normally hard-to-reach SME’s, which have little understanding or application of safe work practices and yet form a majority in the construction supply chain.

The research will further enhance the reputation and competitiveness of Australian contractors in overseas markets, particularly SE Asia where construction safety is a major concern. It will also add to Australia’s reputation for innovation in construction.

Major outcomes of the research will be:

- An increase in our fundamental knowledge of the cultural and attitudinal factors that influence worker awareness of safety
- The development of data and metrics to evaluate and benchmark improvements in performance
- The development and validation of models and methodologies to evaluate and change worker attitudes to risk and safe work practices.
- The methodologies will be tailored to suit the Australian industry and the involvement of the CIIA and major industry organisations will encourage industry wide acceptance and take up.
COMMUNICATION OF RESULTS

The results of the research will be disseminated by means of refereed journal papers and annual CIIA conference papers together with a series of seminars to construction organisations and industry associations around Australia to ensure the results are fed back into the education and training system. Outcomes of the project will be disseminated via the CIIA website to a wider audience, particularly SME’s, and encourage others to exchange ideas and data.

DESCRIPTION OF PERSONNEL

QUT’s Professor Tony Sidwell’s role in the research project is to provide overall management and supervision of the research associate and research student. He has both practical on site experience in construction activities which are essential to understanding of practical issues, as well as academic and professional experience in accident investigation and analysis.

QUT’s Professor Steve Rowlinson’s role will be as an expert advisor based on his previous construction safety research in Hong Kong. Although regular communication will be via email and teleconference he will take part in case study visits to identify cultural and technical differences between the two countries so that we can effectively judge and interpret the Hong Kong methodologies and results against Australian data.

Both the CI and PI will also ensure the research is well placed internationally by publication in leading journals and conference presentations.

Helen Murphy is an industrial psychologist and was involved in the pilot study with Leightons. She will provide practical advice and assistance relative to the pilot study and data.

Dr Ron Sharpe is an experienced researcher and will provide intellectual and analytical skills in development of the research instruments and data analysis.

Professor Mary Sheehan is professor of psychology at QUT and will provide academic advice and joint supervision of the research student.

REFERENCES


