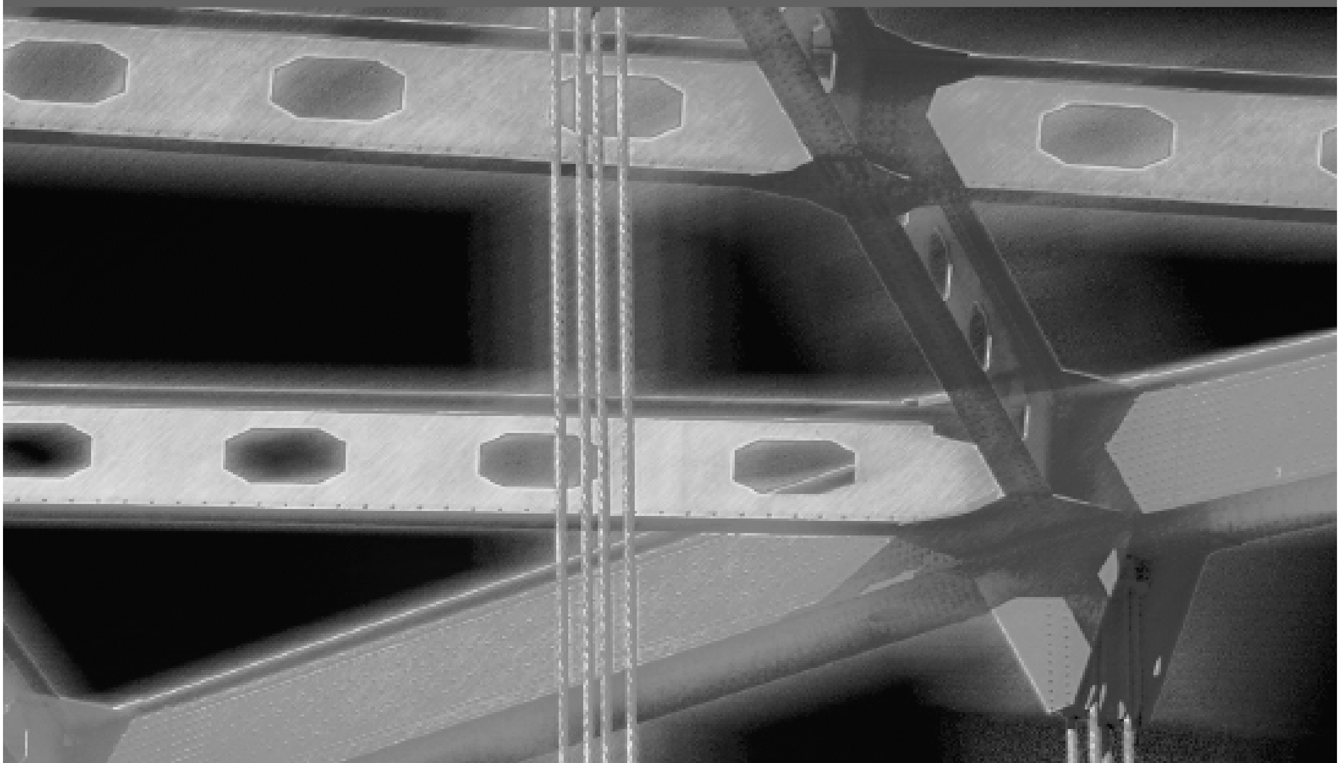
CLIENTS DRIVING CONSTRUCTION INNOVATION

BENEFITING FROM INNOVATION



Edited by Kerry Brown, Keith Hampson, Peter Brandon and Janet Pillay

CRC Australia

CRC Construction Innovation
BUILDING OUR FUTURE

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Foreword

This book has been sponsored by the CRC for *Construction Innovation*.

Construction Innovation is a national research, development and implementation centre focused on the needs of the property, design, construction and facilities management sectors. It develops and promotes best practice project delivery, products, resources and services that can guide project teams towards the best procurement approach for a specific project. Through research and development, the Australian property and construction industry gains a better understanding of these principles and is better informed in tailoring its delivery of projects to greater alignment of value for all the stakeholders.

Objectives of the CRC

- Enhance the contribution of long-term scientific and technological research and innovation to Australia's sustainable economic and social development.
- Enhance the collaboration between researchers, industry and government, and to improve efficiency in the use of intellectual and research resources.
- Create and commercially exploit tools, technologies and management systems to deliver innovative and sustainable constructed assets to further the financial, environmental and social benefit to the construction industry and the community.

Construction Innovation's mission

- Deliver tools, technologies and management systems that will improve the long-term effectiveness, competitiveness and dynamics of a viable construction industry in the Australian and international contexts. This will be achieved through greater innovation in business processes, strengthened human relations and ethical practices, and more effective interactions between industry and its clients.
- Drive healthy and sustainable constructed assets and optimise the environmental impact of built facilities through sound conceptual bases for economic, social and environmental accounting of the built environment, virtual building technology to examine performance prior to documentation, construction and use, and assessing human health and productivity benefits of smart indoor environments.
- Deliver whole-of-life project value for stakeholders, from business need, design and construction, through to ownership, asset management and reuse through improved communication and use of knowledge, increased productivity and value, effective delivery and management of assets.

The strength of *Construction Innovation* lies in bringing together industry, government and research partners committed to leading Australia's property, design, construction and facilities management industry in collaboration and innovation. Across Australia, our CRC has secured the input of almost 400 individuals who are delivering real benefits for our partners, the industry and our community. Together we are facing the challenge of implementing applied research outcomes to improve business.

We trust *Clients Driving Construction Innovation: Benefiting from Innovation* will provide you with powerful evidence-based research outcomes to develop and extend your own ideas for sustaining innovation in the building and construction industry. We commend this book to you.

John McCarthy
Chair
CRC for *Construction Innovation*

Keith Hampson
Chief Executive Officer
CRC for *Construction Innovation*

CIB Task Group 58: Clients and Construction Innovation

The International Council for Research and Innovation in Building and Construction (CIB) provides for international exchange and cooperation in research and innovation in building and construction. The scope of CIB covers the technical, economic, environmental and organisational aspects of the built environment during all stages of its lifecycle (www.cibworld.nl).

Task Group 58 takes as its critical focus and starting point, innovation driven from a client's perspective. This standpoint explores innovation through a range of client-oriented approaches including interrogating construction knowledge, networking and innovation competencies, devising innovation strategies that are highly cognisant of the role and orientation of clients and improving take-up, communication and diffusion of existing client innovations.

The objective is to identify opportunities and barriers to client-driven innovation and to capture ways in which client engagement, interactions and actions affect innovation systems and processes. The learnings from the research and collaboration of members within this group will extend insights into theoretical models of innovation and inform and improve practice outcomes in relation to the construction innovation process.

This Task Group provides opportunities to meet through special sessions at international conferences and through supporting a forum for the ongoing collaborative enterprise of the Task Group. This edited book examining the role of clients in construction innovation is one of a series of deliverables to assist researchers and industry in this important process.

The coordinators of CIB TG58 are Dr Keith Hampson, CRC for *Construction Innovation*, Australia, and Professor Peter Brandon, University of Salford, UK.

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We are also grateful to the chapter contributors whose research forms the basis of this book.

We trust that this book contributes to both theory and practice in understanding and promoting the important role that clients play in construction innovation.

— Kerry Brown, Keith Hampson, Peter Brandon and Janet Pillay

The Use of Lead Indicators in Safety Culture Research: Measuring construction industry safety performance

Don Dingsdag
Herbert Biggs

INTRODUCTION

This paper investigates the potential of the development and applicability of measuring safety performance in the Australian construction industry based on a newly devised 'tool', Safety Effectiveness Indicators (SEIs). Its development emanates from a recently commenced research project funded by the CRC for *Construction Innovation* in partnership with Leighton Contractors, John Holland Group, Thiess Contractors and the Office of the Federal Safety Commissioner (OFSC). Nationally the construction industry has far more injuries and ill-health impacts than the Australian average, and pays one of the highest workers' compensation premium rates in Australia. Similarly, notwithstanding improvement in their rates, fatalities are too high. Yet, other than lost time injuries (LTIs) or similar 'negative' 'lag' performance indicators, reliable, comparable and standardised performance indicators are not available. An evaluation below of Positive Performance Indicators (PPIs) as an OHS performance measuring tool, based on a brief overview of its limited uptake in Australian industry, suggests that it does not reliably measure OHS performance. Similarly, other 'positive' or 'lead' indicators, which owing to word length limitations are not discussed in this paper, have parallel shortcomings. However, based on current workers' compensation claims and incidence of injury and illness there is a clearly demonstrable need to accurately measure safety performance on construction sites in order to improve industry performance. Likewise, in the pre-construction design and scoping phase, in the post-construction facility management stage of completed projects as well as in the repair, maintenance, minor alteration and addition (RMAA) functions, there is a need for reliable safety performance measurement. In part, these issues of safety performance measurability were addressed by Biggs et al. (2006), who while conducting research for *A Construction Safety Competency Framework* (Dingsdag et al. 2006a; 2006b) devised a matrix of safety cultural competencies determined by identified safe behaviours and safety management tasks (SMTs) for the Australian construction industry.

The research objectives for the current research project are to examine how safety cultural competencies and their associated safe behaviours, as well as leadership attributes and effective communication, can be proactively assessed predicated on whether they have a measurable impact on safety performance. It is suggested that, based on their current application in the construction industry, PPIs do not have the capacity to actually measure safety performance although some do recognise safe behaviours, leadership and communication as measurable characteristics of safety culture. Rather, as discussed below, PPIs tend to measure OHS processes, but not safety performance *per se*. In Australia the unsuitability of PPIs gradually became clear to industry, including the construction industry, after 1994 when the then National Occupational Health and Safety Commission (NOHSC) (also known alternatively as WorkSafe Australia) held two initial workshops/symposium to determine the viability of PPIs as an alternative to measuring OHS performance based on lag, or so–called negative indicators, such as LTIs. The difficulty of the measurability of safety performance by most known existing performance indicators is a recurring theme for this paper and the broader research framework of the current and former project. Arguably one of the most practical guiding principles of the measurability of safety performance is given in the Australian/New Zealand Standard, AS/NZS 4804: 2001 *Occupational health and safety management systems: General guidelines on principles, systems and supporting techniques* (AS/NZS 4804) which defines safety performance as:

> *The measurable results of the occupational health and safety management system related to the organisation's control of health and safety risks, based on its OHS policy, objectives and targets. Performance measurement includes measurement of OHS management activities and results.*

Perhaps ultimately, the most informative, yet simple, guidance for the efficacy of any performance indicator emanates from the UK HSE which prefaces one of the key sections of *A Guide to Measuring Safety Performance* by asking 'Why measure performance?' (HSE 2001, p. 6). This simple question is possibly best responded to by Peter Drucker' s often quoted, maxim, 'You can't manage what you can't measure,' which may seem trite, yet its straightforward exhortation seems to offer invaluable advice when attempting to measure safety performance effectively.

PPIS AND THEIR IMPACT ON SAFETY PERFORMANCE

During the currency of the research project that produced *A Construction Safety Competency Framework*, aside from identifying essential leadership attributes, communication and desired safe behaviours as necessary elements of safety culture, Dingsdag, Biggs, Sheahan and Cipolla (2006a) identified the measurement of safety effectiveness as a requirement for measuring the influence of these elements of safety culture on safety performance. However, aside from positing that these have a positive influence on safety performance, there is little validated evidence that the positive safety actions they generate actually influence safety performance positively. Other than anecdotal evidence from industry that safety culture impacts positively on safety performance and a plethora of academic literature that enthusiastically supports the implementation of safety culture, its benefits are largely premised on an article of faith: It is not unusual to hear experienced OHS professionals claim that they know it works, but that their claims are based on intuition, not on measurable criteria. Further, currently, there are no standard national or international PPIs or any other lead indicators measuring safety culture or safety performance that are accepted by the construction industry (nor any other industry) notwithstanding that the application of PPIs was enthusiastically advocated in 1994 by the then WorkSafe/NOHSC at a national symposium attended by all industry sectors' representatives (see, for example, NOHSC 1994b; 15-27).

A series of subsequent workshops and papers commissioned by NOHSC resulted in a consensus that, based on an industry-wide framework, individual organisations should develop PPIs to achieve improved OHS performance. Unfortunately no guidance was established relative to the development, application and valid measurement of PPIs. Significantly for this research, even though safety culture change was identified during the symposium, the use of safe behaviours as performance indicators was considered, but not developed sufficiently. Essentially, the identified positive performance indicators were mainly (but not exclusively) linked to non-behavioural processes and typically measured numbers of OHS-oriented activities and did not provide an indication of these activities' measurability. Examples, as espoused by NOHSC (1994b, 39) included:

- effectiveness of training programs
- effectiveness of OHS structures
- effectiveness of OHS representatives
- return to work rate.

This endorsement of the development of PPIs was a reaction to the perceived inability of traditional 'outcome' safety performance indicators, LTIs, or lag indicators, to measure success. They were condemned as being exclusively quantitative, negative, largely measuring failure; e.g. for lost time injury frequency rates (LTIFRs), the raw number of injuries sustained in an organisation per year and their frequency was obtained by dividing the number of injuries by (a notional) one million hours worked per annum. An inherent flaw resides in the assumption that all organisations work a million hours per year, which is not universally the case in the Australian construction industry for all but the largest contractors: small companies which only operate in the cottage sector, for example, employing only a few workers can perhaps attain only 10 000 hours p.a. and are severely disadvantaged by the LTIFR generated as a result. Obviously, industry comparability is not possible. On the other hand, the capacity of PPIs to show improvement in safety performance, rather than negative outcomes, was explored at length by NOHSC, and their implementation was strongly endorsed largely predicated on the mistaken assumption that their success lay in their attributes, which unlike lag indicators, were qualitative and 'proactive.' The process of what PPIs should measure and how to devise standardised PPIs was also fully discussed eventually to the detriment of their implementation. Andrea Shaw, one of the NOHSC 1994 symposium's facilitators suggested that PPIs may not be sufficiently precise. Further, concerns were raised that PPIs may not be able to be generalised because there was no standardised application of PPIs (see NOHSC 1994a; NOHSCb). Briefly, common limitations of PPIs identified were that PPIs may:

- not directly reflect actual success in preventing injury and/or disease
- not be easily measured
- be difficult to compare for benchmarking or comparative purposes
- be time consuming to collect and collate
- be subject to random variation
- encourage under- or over-reporting depending on how they are measured …

… and that:

- the relationship between PPIs and LTIs was arbitrary
- they only measure the number of events and do not provide any indication or measure of effectiveness of each measured event.

It is the last limitation that has particular relevance for the issues raised in this paper. Another issue that militated against the uptake of PPIs was that for legislative purposes, such as recording and reporting injuries, mainly LTIs and the like are required under the nine disparate Australian OHS jurisdictions. Generally their format is guided by Australian Standard 1885.1-1990, known as the *Measurement of Occupational Health and Safety Performance: Describing and reporting occupational injuries and disease* or alternatively as the former NOHSC's *National Standard for Workplace Injury and Disease Recording*, which are both non-enforceable at law, but nationally and internationally recognised as an authoritative conformance document. Other than a cursory mention of PPIs in AS/NZS 4804: 2001 there is no equivalent standard for PPIs. The application of PPIs is and was strongly denounced in the performance measurement literature, most notably by Dr Edward Emmett, Chief Executive, WorkSafe Australia (NOHSC 1994a) who officiated at the 1994 symposium. On the other hand, the robust denunciation of lag indicators at the same symposium is still current in the construction industry notwithstanding that no reliable, comparable and standardised lead performance indicators have emerged.

In 1999 NOHSC issued an extensive report on the development of PPIs for the construction industry entitled *OHS Performance Measurement in the Construction Industry.* Based on several industry case studies a tripartite working group of industry, government and the union movement examined the possibility of implementing PPIs to measure safety performance in the construction industry. As with its 1994 strategy, NOHSC sought to develop a set of broad (and vague) PPIs that measured performance across the industry. Based on case studies of the various construction industry sectors the following PPIs were found to be commonly used, and support those identified by NOHSC (1999, 44, 45):

- Number of JSAs conducted
- Number of hazard inspections conducted
- Number of toolbox talks conducted
- Number of OHS inductions conducted
- Number of OHS meetings completed
- Number of OHS training exercises held
- Number of OHS audits conducted
- Number of OHS bulletins issued
- Number of OHS non-compliance reports issued
- Whether OHS procedures for critical works have been submitted by subcontractors (rated either yes or no)
- Whether there is evidence that surveillance of subcontractors is carried out (rated either yes or no)
- The frequency of on-site inspections
- The time taken to fix problems in accordance with the allocated timeframe
- General attitude to safety on-site (subjectively assessed by the OHS coordinator)
- Quality of records and documents related to OHS (subjectively assessed by the OHS coordinator)
- Commitment to safety overall (subjectively assessed by the OHS coordinator)
- The consistency of project managers in relation to OHS as a measure of the quality of OHS management in contractors (used informally and subjectively assessed by the OHS coordinator)
- Workers' rating of supervisors or project management's commitment to OHS
- Percentage of injuries incurred for major hazards
- Percentage of substandard conditions identified and corrected as a result of safety audits
- Results of independent (by people in the same company, but from different (sites)) and external audits; measured as number, regularity, quality outcomes and action taken to resolve non-conformances
- Time taken to get hazards under control once they have been identified
- Assessment of the availability and standard of PPE
- Number of hazard reports and feedback from toolbox meetings.

As well as suffering the common limitations of PPIs identified at the 1994 NOHSC workshops/symposium, it is readily observable that those PPIs that merely measure a number of activities without follow-up ('close out') actions, do not directly impact on safety performance. In fact, evidence gathered from industry focus groups held for the current research project strongly endorses what has been known for some time: that, typically other than collecting and collating these indicators, no follow-up action may occur. Hence it's entirely possible that historically there was no impact on safety performance at all, let alone that they may '…only measure the number of events and do not provide any indication or measure of effectiveness of each measured event' (NOHSC 1994a; 1994b).

THE DEVELOPMENT OF SEIS

As a consequence of the vagueness and broadness of PPIs and their measurement, what is undertaken for this research is the investigation of the development of a guidance framework for performance measurement that can be applied by individual organisations based on an industry standardised set of performance indicators suited to their particular organisational objectives and environment. At this stage of the research process we propose to develop a mechanism which may incorporate lead indicators that have demonstrated capacity to measure their impact on safety performance and combine those with measures of safe behaviours and safety cultural competencies. Simply stated, this research project seeks to create a mechanism to standardise and customise the measurement of safety effectiveness with valid and user-friendly industry-supported indicators that measure the effectiveness of specific proactive safety activities each company undertakes.

Even though since the 1994 NOHSC symposium and workshops, lag indicators have been repeatedly denounced in some academic literature and government reports (e.g. NOHSC 1999) as being negative and reactive, and by some academics (e.g. NOHSC 1994b) and practitioners as merely measuring failure; it may well be that LTIs, LTIFRs and a raft of other lag indicators give the most accurate measurement of performance or, in some instances, the lack of performance (refer to Table 23.1). At this stage of the current research project it is envisaged to examine a range of lag indicators as dependent variables with proposed lead indicators (which have not yet been fully definitively identified) as independent variables. The proposed methodology, based on a range of suggested lag indicators and lead indicators, will be industry-trialled and modified according to industry feedback.

Table 23.1 Table of Suggested Lag Indicators

Acronym	Rates
FAIFR	first aid injury frequency rate
FIFR	fatality incidence frequency rate
LTIFR	lost time injury frequency rate
MTIR	medically treated injury rate
NMTIR	non-medically treated injury rate
NDOR	notifiable dangerous occurrence rate
NII	non-injury incident or near miss/near hit
RTWR	return to work rate
WCCR	workers' compensation claim rate
WCPR	workers' compensation premium rate

Data from the two-year national research project (mentioned above) that investigated the motivators of safety culture and safety behaviours in the construction industry has provided a database (Dingsdag et al. 2006b) which identifies measurable safety behaviours informing the future formulation of SEIs. Based on approximately 70 interviews with managing directors, other senior management, construction site managers, union officials and semi-structured focus groups consisting of line and senior management of Australia's 11 largest principal contractors, Dingsdag et al. (2006b) identified the 39 SMTs outlined above that are considered critical to enhancing safety performance by the industry. Two survey instruments consisting of a management and worker questionnaire were administered nationally to the participating construction companies (for worker survey see Dingsdag, Biggs and Sheahan 2008). All of the findings were validated through interviews with senior officials of the ACTU, the principal construction sector union, the CFMEU, and senior managers of each of the OHS regulators in every state and territory. After the qualitative and quantitative data were collated and analysed, the results were taken back to each participating organisation for comment, suggestions for change and/or validation. To create SEIs was outside the scope of the research project, but the standardised measurement of safety actions and associated safety behaviours is seen by industry as a necessary complement to the 39 SMTs. Further, notwithstanding the above opinion that other than anecdotal evidence from industry, safety culture impacts positively on safety performance, the research project's investigation of the motivators of safety culture and safety behaviours in the construction industry data suggested that measurable safety behaviours have the capacity to formulate SEIs (Dingsdag et al. 2006). Other recently conducted research, notably Choudhry, Fang and Mohamed (2007), strongly endorse the measurability of safety culture elements. Further, this important article provided a useful (but incomplete) typology of the major safety culture/safety climate methodologies of which some also incorporate suggested (but largely inconclusive) methods of measuring safety culture actions.

However, the success of measuring safety culture/safety climate is complex, notwithstanding its strong endorsement in the literature. As mentioned above and discussed more fully below, according to Guldenmund (2007), safety culture/safety climate may not be able to be measured accurately at all. Further, other than the reasons examined above and below, at an industry level measurability of safety performance and safety culture is negated by the fragmented nature of the Australian construction industry which in the private sector consists of fewer than 30 very large principal contractor organisations and a similar number of 'second-tier' large principal contractors. Typically these organisations rely on a substantial component of large contractors employing up to 100 or more employees who in turn employ subcontractors, which may consist of two or three to fewer than 20 employees. It is also common to engage subcontractors who are the proprietor/only employee. Conversely, in some construction trades, such as in formwork, there are very large subcontractors employing 100 employees or more. Perhaps the distinction between contractor and subcontractor is notional other than in the contractual basis under which they are engaged. Additionally, construction workers may also be recruited from labour hire companies. In this manner the Australian construction industry employs approximately 900 000 people of which, according to industry informants, in NSW, up to 98 percent of the workforce is employed making principal contractors very small employers indeed relative to the total numbers in the industry.

Further, projects may last from a few months to a few years after which the project team moves on to another project and the safety culture and its safety performance dissipates. In addition, the industry is further fragmented, by the nature of the work undertaken, which includes the erection of commercial and residential highrise buildings, the cottage industry, building refurbishment and maintenance, facility management, road and bridge work, tunnelling, rail infrastructure, energy infrastructure including electricity transmission lines, pipelines of various types as well as the development of open-cut mines. Quite clearly, the industry is not uniform in terms of the work performed and organisational size, and hence organisational resources. In addition, each part of construction work has its own particularised context relative to health and safety hazards, associated risks, safety performance and performance measurement. Notwithstanding this variability, indicators should be based on the particular OHS risk exposure generated by the types of work and projects undertaken, yet they must be uniformly applicable and comparable across industry.

Consequently, in order to improve the industry's safety performance, other than the universally accepted lag indicators, other standardised performance indicators must be developed. In 2002 NOHSC held another workshop whose report also reflects the lack of standardised construction industry PPIs and the difficulty of their measurement (NOHSC 2002). Interestingly, during the currency of the 1994 NOHSC workshops, a common emerging theme was that PPIs should be flexible and particularised to conform to individual projects' requirements. From the data gleaned from the industry focus groups held so far for the current research project, it is gradually emerging that owing to the industry's reliance on commonly used standardised OHS procedures, lead indicators must also be standardised and be able to be applied uniformly to every sector of the construction industry.

Standardisation of OHS procedures in the industry is widely understood, although not necessarily consistently applied. 'Tools' such as hazard identification/risk assessments, even though there are variants, observe the same common principles; for example, (a) to proactively identify hazards, and (b) to identify, assess and evaluate the associated risks (for example as expounded in part in the globally accepted AS/NZS 4360: 2004 Risk Management). Similarly, the implementation of the appropriate control measures based on the universally accepted Hierarchy of Controls should be constantly applied across the entire industry. The premise for this unilateral direction is simple, yet based on irreducible principles of risk assessment, that, no matter how particularised the hazards of each construction industry sector may be, risk exposure must be undeviatingly minimised, or preferably eliminated if possible, by these principles. For example, even though the cottage sector, based on its construction processes, has almost completely divergent hazards from the tunneling sector's particularised hazards, the hazard identification, risk assessment and control processes are identical: hence, lead indicators should be consistently applicable.

Suggestions emerging from the industry consultation conducted for the current research project so far indicate that there are also common processes that were identified in *A Construction Safety Competency Framework* drawing on its 39 safety management tasks (SMTs). In particular, SMT1, Carry Out Project Risk Assessments, has been identified as having universal applicability and standardised measurability across all projects based on its process steps:

- Gather project information required to undertake the risk assessment (scope of work, contract requirements, legislative requirements)
- Select and form a risk assessment team (consisting of representatives from principal contractors, contractors and subcontractors)
- Conduct project risk assessment
- Identify risk controls (resources, people and procedural actions required), and ensure actions are completed (closed out).
- Communicate and review project risk assessment
- Review and control implementation progress.

Currently the project team is considering the scope and nature of the SEI(s) that may be able capture these steps quantitatively, or indeed whether it will be a quantitative measure. The current fluid stage of development is to develop a set of qualitative values for each SEI based on a sliding (quantitative) scale. However, some form of readily accessible and easily applicable enumeration may have to inform the qualitative aspects of the SEIs. This approach is appealing for several reasons: (a) the application of metrics is common practice in the industry so that the construction process itself is accurate and the product is not defective, as is the reliance on scoring/measuring safety performance quantitatively, (b) it is well understood, and (c) the reason for the ease of use is predicated on the industry principle that immediacy of measuring safety effectiveness on-site is imperative and must be usable by all on-site; otherwise the impetus will be lost and its essential linkage to measuring safety performance based on lag indicators will lose its significance as well.

Another way of characterising the on-site measurement of safety effectiveness may be that it represents the microcosm of the macro/global coordinating functions of capturing site data, correlating it with other site data and linking it to the appropriate global organisational lag indicators.

MEASURING SAFETY CULTURE

As indicated in the above abstract, in addition to there being no reliable safety effectiveness indicators that accurately measure safe behaviours, nor the positive safety actions they generate, nor their impact on safety performance, another major obstacle is that there is no known consistent and reliable measure of safety culture. Typically, as outlined briefly above, during the course of the current research project and the previous project alluded to above (Dingsdag, Biggs and Sheahan 2006a) industry respondents claimed they 'knew' that their site safety culture had a positive, but immeasurable, impact on safety performance. When prompted to say what the visible attributes of a vibrant safety culture might be, the most consistent response was 'good housekeeping.' The rationale proffered being that, if housekeeping were attended to regularly, the more essential safe behaviours and related actions, such as conducting regular proactive risk assessments, would also be more likely to be conducted properly. So far, other constant safety culture attributes indicated were:

- **'Good' toolbox talks**, i.e. those that were planned and based on two-way communication rather than a diatribe delivered without meaningful input. What was seen as essential in this regard was that participants' suggestions or concerns were listened to and, more importantly, 'closed out.'
- **Planned alignment of the disparate phases of the construction process**; for example, ensuring that the steel fabrication phase was completed in tradesman-like fashion and on time before the concrete pour began. The rationale is that, when each construction phase is systematically completed, contractors and subcontractors start on time without having to rush their task and, more importantly, without cutting corners, because that is when essential OHS procedures are likely to suffer.
- **Holding pre-construction/design phase meetings** with contractors and subcontractors where site- or task-specific safety management plans and safe work method statements (SWMSs) were prepared, based on meaningful input because of the positive impact these have on safety performance during the construction phase.

A 'lessons learnt' overview of safety culture and the related task and safety performance, undertaken either at the 'close out' stage of the project or about 60 per cent through the project, were also seen as having positive impact on the safety of current and subsequent projects. The latter suggestions were premised on the 'hard' or functional aspects of safety culture; the 'softer' attributes suggested were under the rubrics of visible and engaged leadership and collaboration, for example:

- regular site walk-arounds by senior management and/or board members
- all management regularly seen on-site (wearing the correct PPE)
- work done collaboratively (based on consultation)
- listening to each other
- the need to treat people as people and to have respect for the individual
- commitment from workers and from management built on mutual trust
- explanations given of why actions suggested at toolbox talks/pre-start meetings were undertaken or not.

Relative to the measurability of safety culture investigated in the literature Choudhry et al. (2007, 1000) make the observation that,

> *Traditionally, organizational culture is measured through the application of qualitative methods, such as observations and interviews. Nevertheless, the three main dimensions (psychological, situational and behavioral) can be measured through a combination of qualitative and quantitative methods (Cooper 2000). The situational aspects of safety culture can be seen in the structure of the organization; policies, working procedures, management systems, etc. The behavioral aspects of safety culture can be measured through peer observations, self-reporting and outcome measures. The identified safe behaviors are placed on observational checklists, and trained observers regularly take observations which are then translated into 'percentage of safe scores' to provide feedback to those being observed. The psychological dimension is most commonly examined by safety climate questionnaires devised to measure people's perceptions of safety.*

However, the examples of the models they claim do measure the essential elements of safety culture are all human-resource-intensive and some may also be capital intensive:

> *For example Kennedy and Kirwan (1998) … developed the Safety Culture and Operability (SCHAZOP) approach that focuses on the many aspects of safety management practices. It deals with day-to-day activities, including safety management, real roles and the personnel fulfilling these roles. One drawback of the SCHAZOP approach is that it is very resource intensive.*

(Choudhry et al. 2007, 1001).

Similarly, according to Choudhry et al. 2007, 1001):

> *Cox and Cheyne (2000) incorporated behavioral indicators in their 'Safety Assessment Toolkit' along with climate questionnaire and semi-structured interview schedule. Cox et al. (2004) conclude that behavioral safety is effective in increasing employees' confidence to challenge unsafe practices, as well as highlighting examples of best practice. Behavioral safety process (BSP) supports cultural realignment towards a 'safety first' culture. They indicate that the BSP is an effective motivational tool that assists in both individual behavior and attitude change. Although measurement of safety culture depends on how it is defined (which in turn reflects the adopted perspective), ethnographic approaches are often costly and time consuming. Additionally, they tend to produce discovery data rather than hard data that can be incorporated into a management action plan.*

In other words, BSP is effective, but resource-intensive, and it may well be that, similar to PPIs, they may produce 'discovery data', or what was characterised above as mainly measuring process rather than 'hard data' defined as actions above. Further, the misgivings about the usefulness of the data produced by Choudhry et al. (2007) align with the concerns expressed above about the capacity of PPIs to influence safety performance significantly if at all.

Guldenmund adds another dimension to the accurate measurability of safety culture and/or safety climate. He provides a trenchant critique of 40 per cent of the 27 sources listed and characterised by Choudhry et al. (2007, 997-998). Refreshingly Guldenmund (2007, 727) also criticises his previous work. He writes:

> *In my 2000 paper (Guldenmund 2000) I proposed four principal 'attitude objects' with regard to safety climate – hardware/physical environment, software, people and risk – these partly being taken from Cox and Cox (1991). However, this classification is too coarse and unspecific to be of any use.*

This comment follows from Guldenmund's generic critique of questionnaires which interesting flies in the face of the data obtained from the initial 12 industry focus groups held so far during which questionnaires were identified by several participating construction companies as providing reliable and replicatable data. It is important to remember in this context that Guldenmund's paper is devoted to the generic application of safety culture/safety climate survey instruments, not those specific to the construction industry: yet, the methodological issues raised relate equally well to those that apply to the construction industry.

The opening paragraph of Guldenmund's paper abstract goes to the heart of generic safety culture/safety climate research so far: it also strikes at the heart of the research problematic for the current research, that is,

> *Questionnaires have not been particularly successful in exposing the core of an organizational safety culture. This is clear both from the factors found and the relations between these and safety indicators. The factors primarily seem to denote an overall evaluation of management, which does not say much about cultural basic assumptions. In addition, methodology requires that levels of theory and measurement are properly recognised and distinguished. That is, measurements made at one level cannot be employed at other levels just like that unless certain conditions are met*

(Guldenmund 2007, 723).

First, Guldenmund addresses the unknowable aspects of how and how well safety culture influences safety performance. This methodological hurdle was encountered during the past and current research undertaken by this project team. Those obstacles are briefly addressed above. Second, if Guldenmund's position on safety culture/safety climate holds, then the relationship between what he labels safety indicators, and the current research, Safety Effectiveness Indicators, and the efficacy of safety culture makes the research challenge for the current project even more complex than at first the project team might have predicted. Guldenmund (2007, 727) asks:

> *So, what kind of information do we collect with questionnaires? Although we intend to uncover an underlying trait called culture, the questionnaires invite respondents to espouse rationalisations, aspirations, cognitions or attitudes at best, that is, the very thing called espoused values by Schein (1992). Obviously, one could still argue that behind all these espoused values the 'true' shared values, if any, hide, but it takes a lot of deciphering and a creative analyst to uncover these. Hence, we are stuck with a set of factors and scores on them but we do not know what they really mean or imply. We maybe have an answer to the what question but we certainly do not know why. Basically, we are back where we started from with trying to figure out why this company shows these artefacts and expresses these espoused values. Or, put in another way, survey research does not yield processed climate or culture results but rather provides another source of raw data to extract an organisational culture from.*

Guldenmund poses a highly relevant question for the current research project; that is, what kind of information do we collect; how is it measured and how can the data be correlated with safety performance? Yet, he also provides a solution to this dilemma. To this end Guldenmund proposes a nine-process model that encompasses the entirety of the safety management system of an organisation. It has a more than reasonable fit with the way in which larger construction organisations (principal contractors and the larger contractors/subcontractors) are organised. It is predicated on three levels: organisational, group and individual across the nine processes of risks, hardware design and layout, maintenance, procedures, manpower planning, competence, commitment, communication, and monitoring and change. Each of these has resonance with the SEIs identified so far for the current project although they may have somewhat slightly different designations.

Further, Guldenmund's three levels (2007) of organisational, group and individual have commonalities with the concerns relayed during the currency of the previous, and current research project by industry focus groups; for example, the remoteness of senior management (organisational level) was a recurrent theme. Similarly, the importance of on-site (group level issues) were raised. Guldenmund (2007) addresses common 'barriers encountered/used by the work group to control the risks they face during the execution of their primary tasks.' We used the example above of ensuring that the steel fabrication phase was completed in tradesman-like fashion and on time before the concrete pour began so that contractors and subcontractors start on time without having to rush their task and, more importantly, without cutting corners in safety. Similarly the project research has identified most of Guldenmund's individual elements (2007). Presence of rules, procedures and work instructions for a particular task and their level of detail relates directly to the development of SWMSs and/or JSAs (job safety analyses). After further consultation with industry it may well be that Guldenmund's seminal paper (2007) provides the key to developing SEIs that have the capacity to improve safety culture.

CONCLUSION

The challenge for the current project is to develop reliable, comparable and constant indicators that measure safety performance without the drawbacks commonly attributed to PPIs: in other words, they must be easily measured and be able to be compared for benchmarking purposes within sections of an organisation and across industries without being subject to random variation. For the construction industry specifically, they must be able to be implemented uniformly from project site to project site notwithstanding the disparate sectors of the industry, the variability of the work undertaken and the diverse risk contexts these generate. Further, they must be simple to implement so that they are not capital- and human-resource-intensive: They must not be so complex that they are time consuming to administer and collate and they must measure effectiveness instead of simply measuring a number of events which have no demonstrated effect on safety performance.

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