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# Safety climate in conditions of construction subcontracting: a multi-level analysis

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A multi-level safety climate model was tested in the Australian construction industry. Subcontracted workers' perceptions of the organizational safety response (OSR) and supervisor safety response (SSR) in their own organization and that of the principal contractor were measured using a safety climate survey administered at a large hospital construction project in Melbourne. One hundred and fourteen construction workers completed the survey, representing nine subcontractors engaged at the project. Two requisite conditions for the existence of group-level safety climates, i.e. (1) within-group homogeneity; and (2) between-group variation were satisfied for perceptions of subcontractors' OSR and SSR. This supports the contention that subcontractors working in a single construction project exhibit a unique group-level safety climate. Subcontracted workers also discriminated between group-level safety climates (i.e. the SSR) in their own and in the principal contractor's organizations. The results suggest some cross-level influence. Perceptions of the SSR were positively predicted by perceptions of the OSR in both the principal and subcontractor organizations. Perceptions of the OSR of the principal contractor were also a significant predictor of the perceived OSR and SSR in the subcontractor organizations. Perceptions of the subcontractors' SSR were a significant predictor of the rate of lost-time and medical treatment incidents reported by the subcontractor. Although perceptions of the principal contractor's SSR were not directly related to subcontractors' injury rates, they were a significant predictor of subcontractors' SSR, revealing an indirect link. The results suggest that supervisory personnel (e.g. foremen and leading hands) play an important role in shaping safety performance in subcontracted workgroups.

*Keywords:* Occupational health and safety, organizational safety response, supervisor safety response, lost-time injuries, medical treatment injuries.

## Introduction

### The construction industry's poor OHS performance

The Australian construction industry has a similar profile with regard to its occupational health and safety (OHS) performance to that of other developed countries. Construction is one of Australia's highest risk industries. In 2002–2003 construction workers were more than twice as likely to be killed at work compared to the average worker in all Australian industries. Further, 2006 figures indicate that construction has consistently been Australia's third most dangerous industry, surpassed only by transport and storage and agriculture for the past three years, with a rise of 9% in the number of recorded fatalities in 2006–2007 (ASCC, 2008). Data from the National Online Statistics Interactive (NOSI) system show that in the financial years 2003–2007, there were 184 compensated fatalities in the construction industry (an average of 46 compensated fatalities per year). Preliminary data show that, in the 2006–2007 financial year, the incidence rate for fatal injuries in the Australian construction industry was 7.8 per 100 000 employees. This rate was only surpassed by the transport and storage industry (10.8). In 2006–2007 there were 14 120 serious workers' compensation claims in the construction industry, representing 11% of these claims across all industries. This equates to 39 employees a day sustaining a serious work-related injury or disease requiring one week or more off work (ASCC, 2008). Despite

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technological developments and the implementation of robust occupational health and safety (OHS) management systems, the construction industry's chronic level of fatalities, serious injury and ill-health appears resistant to change. This has led researchers and practitioners to focus on organizational and social factors, including safety climate, to induce positive change to the industry's poor OHS performance.

## Safety climate

There is some debate about the distinction between safety culture and safety climate. Shannon and Norman (2009) suggest culture consists of the underlying values, beliefs and assumptions concerning OHS which shape 'the way we do things around here' (p. 327). Safety climate, on the other hand, refers to perceptions of what is actually done, thus it is the check of whether the behaviour of people in the organization matches the rhetoric. Neal and Griffin (2006, pp. 946–7) define safety climate as 'individual perceptions of the policies, procedures and practices relating to safety in the workplace'. The development of shared perceptions about the priority placed upon safety within the work environment is believed to inform workers' role behaviour through expectations they form about how certain behaviours will be rewarded and supported in an organization (Zohar, 1980; Zohar and Luria, 2005). Cooper and Phillips (2004) comment upon the importance of examining the ability of safety climate to predict OHS outcomes. Griffin and Neal (2000) and Griffin and Neal (2002) report safety climate to be positively related to both self-reported compliance with safety procedures and self-reported voluntary participation in safety-related activities. In the offshore oil industry, Tharaldsen *et al.* (2008) report a significant inverse correlation between safety climate perceptions and accident rates while Mearns *et al.* (2003) likewise show favourable safety climate scores are associated with offshore installations returning a lower proportion of self-reported accidents. Varonen and Mattila (2000) similarly report that perceptions of the prevailing attitude towards OHS within an organization were inversely correlated with the accident rate in wood processing companies. Another Australian study in the health sector reported that safety climate levels measured at one point in time predicted higher levels of OHS motivation and self-reported OHS-related behaviour at a future point in time (Neal and Griffin, 2006). In a recent meta-analysis of safety climate studies, Clarke (2006b) identified a consistent relationship between safety climate and performance in prospective studies (i.e. those in which safety performance is monitored some time after the prevailing safety climate is measured), concluding that this 'effect' is generalizable across occupational settings (Clarke, 2006). Safety climate has also been linked to an organization's ability to appropriately attribute incident causes and learn lessons from safety incidents (Hoffman and Stetzer, 1998).

## Safety climate in construction

Early studies of safety climate in construction combined perceptions of management commitment and workers' involvement in OHS (Dedobbeleer and Béland, 1991). Research has revealed a significant positive association between safety climate and various aspects of OHS performance in the construction industry (Gillen *et al.*, 2002). Siu *et al.* (2004) tested a Safety Attitude Survey, which combined items about workers' perceptions of themselves, their colleagues, management, company safety officers and supervisors. Their analysis revealed that aggregated safety attitude scores were directly related to self-reported occupational injury rates and indirectly related to self-reported accident rates via reported levels of psychological distress. Zhou *et al.* (2008) report that two climate dimensions (management commitment and workmates' influence) exert significantly greater influence on self-reported safety behaviour than workers' personal experiences of training and safety. In a lagged, two-wave study of Swedish construction workers, Pousette *et al.* (2008) report that safety climate scores at one point in time (time 1) significantly predicted self-reported safety behaviours seven months later (after controlling for safety behaviour at time 1).

## Group-level safety climates

The majority of safety climate studies, including those conducted in the construction industry, have focused on the organization as the unit of analysis. However, in large and complex modern organizations, a more fine-grained analysis may be required. Zohar (2000) proposed two levels of safety climate: (1) that arising from the formal organization-wide policies and procedures established by top management; and (2) that arising from the safety practices associated with the implementation of company policies and procedures within workgroups. Zohar tested this proposition in a manufacturing context and confirmed that workgroup members develop a shared set of perceptions of supervisory safety practices, and discriminate between perceptions of the organization's safety climate (OSC) and the workgroup safety climate (GSC). Zohar suggests that the prevailing GSC relates to patterns of supervisory safety practices, or ways in which organization level policies are implemented within each workgroup or sub-unit. A recent analysis by Johnson (2007) validated a measure of group-level safety climate developed by Zohar and Luria (2005), reporting that perceptions of supervisors' actions predicted OHS behaviour and the occurrence of incidents in the manufacturing sector.

Zohar and Tenne-Gazit (2008) describe how, in the measurement of safety climate, individual climate scores are aggregated to the unit of analysis of theoretical interest. This can be the entire organization or organizational sub-units, such as workgroups. Safety climate measures often include items relating to the organization (i.e. top management and company policy) and sub-unit supervision. For example, Lu and Shang (2005) incorporate perceptions of supervisors' safety leadership in a safety climate survey of container terminal operators in Taiwan, but aggregate these scores to the level of the entire organization. Similarly, the safety climate instrument developed by Jorgensen *et al.* (2007) and tested among a sample of English and Spanish speaking construction workers, combines questions about the general work environment (a useful indicator of the organization-level climate) with specific questions about workers' immediate supervisors (a group-level characteristic). Lingard *et al.* (2009) argue that the aggregation of perceptions of group-level safety climate (such as co-workers' or supervisory safety behaviour) to the level of the organization is likely to mask important between-group differences.

### Safety climate in the context of subcontracting

Subcontracting is a key feature of the construction industry, which is known to present significant challenges in the management of OHS (Arditi and Chotibhongs, 2005). Loosemore and Andonakis (2007) identify time pressures, confusion over responsibility for OHS, a dominant culture of risk transfer and implementation costs as impediments to OHS associated with subcontracting in the Australian construction industry. Similarly, Mayhew *et al.* (1997) argue that the 'payment-by-results' system pushes subcontractors to work excessive hours and 'cut corners' with respect to OHS. Intense competition drives down the price of subcontractors' services, further reducing the priority placed upon OHS (Mayhew *et al.*, 1997). Subcontractor involvement is a core aspect of construction organizations' safety culture (Mohamed, 2002; Molenaar *et al.*, 2009) and a feature of effective OHS management in construction (McDonald *et al.*, 2009). Construction subcontractors are often engaged in complex relationships both horizontally (i.e. when multiple subcontractors are engaged by a principal contractor) and vertically (i.e. in the case of pyramid of multi-layered subcontracting). In this context, workers involved in subcontracted companies are only loosely connected with the principal contractor and relatively isolated from their own company, which could affect the development and impact of the safety climate (Melia *et al.*, 2008). Facets of the group safety climate have been linked to subcontractors' safety behaviour. For example, Choudhry and Fang (2008) report that when co-workers and supervisors are perceived to be unsupportive of safe behaviour, subcontracted construction workers are more likely to adopt unsafe work practices. The implication of subcontracting for the development and impact of safety climates within the construction industry is not well understood.

### Aims

The aim of this research was to explore the development and implications of multi-level safety climates under conditions of subcontracting in the Australian construction industry. Specifically, the objectives of the research were: (1) to examine the extent to which distinct group-level safety climates exist within subcontractors engaged by a single principal contractor; (2) to test whether subcontracted workers discriminate between perceptions of the safety climate within their own organization (i.e. the subcontractor) and the principal contractor; and (3) to test the ability of a multi-level safety climate model to predict subcontractors' OHS performance in the Australian construction industry.

## A safety climate model for construction subcontracting

### The multi-level model

A multi-level safety climate model is presented in Figure 1. The model is consistent with previous research showing that workers form distinct safety climate perceptions at the organization and the workgroup level (Zohar, 2000). Assuming terminology adopted by Melia *et al.* (2008), the model specifies the development of safety climate at two levels, the organization and the workgroup. The primary reference point for the organization-level safety climate is workers' perceptions of the organization's safety response (OSR) in the form of instituted OHS policies and procedures, while the reference point for group-level safety climate is observed patterns of supervisory behaviour, or the supervisors' safety response (SSR) (Zohar and Luria, 2005). Thus, it is theoretically possible for group-level safety climates to vary within a single organization as supervisors exercise discretion in the way that they direct workers in the implementation of company OHS policies and procedures. The model also suggests that

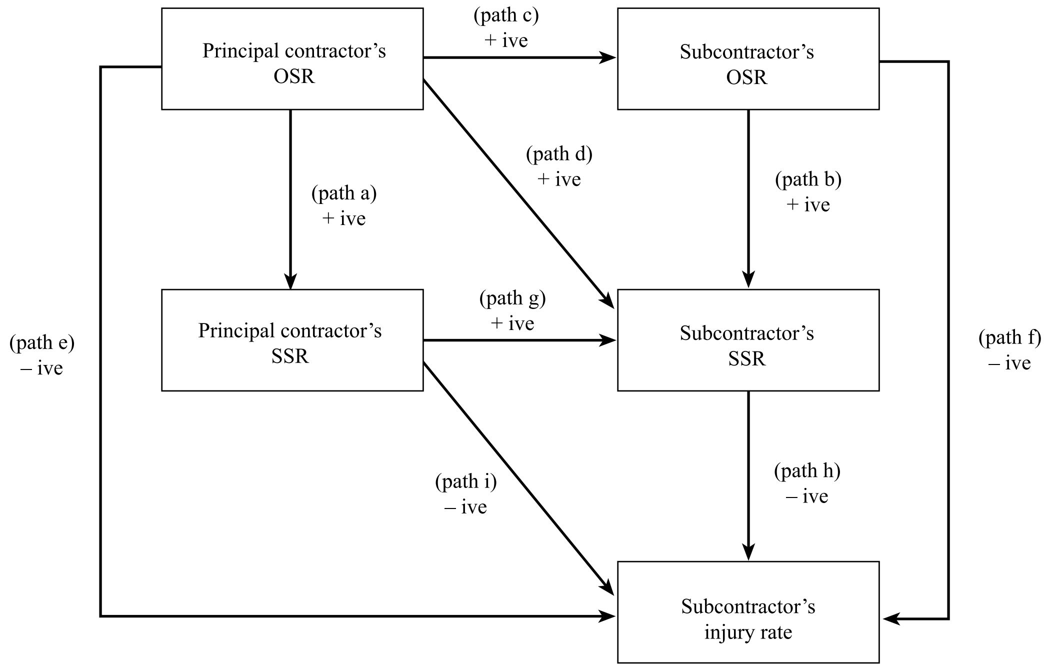


**Figure 1** Multi-level safety climate model for construction subcontracting

shared perceptions of the OSR and SSR develop relating to the actions of both the principal contractor (on the left side of the model) and the subcontractor (on the right side of the model).

The existence of two distinct levels of safety climate has been demonstrated in previous research. However, these two levels of safety climate are not completely unrelated because there are limits to supervisory discretion. Zohar and Luria (2005) argue that supervisors interpret rather than redefine company OHS policies and procedures and therefore group-level safety climates within a single organization are usually aligned with the organizational safety climate. The multi-level safety climate model reflects this, suggesting that perceptions of the SSR will be positively aligned with perceptions of the OSR in both the principal contractor's organization (path a) and within each subcontractor organization (path b). However, in the construction industry context, the subcontractors' safety climate may also be aligned with that of the principal contractor as the principal contractor sets project OHS performance criteria, implements project-level OHS rules and procedures and monitors subcontractors' OHS activities. Thus the model suggests the OSR of the principal contractor will also significantly influence perceptions of subcontractors' OSR engaged in the principal contractor's projects (path c). Perceptions of the principal contractor's OSR are also expected to be positively associated with perceptions of subcontractors' SSR, as subcontractors' supervisory personnel respond to expectations of the principal contractor (path d). Consistent with the substantial body of research linking organizational safety climate to OHS performance, the model suggests that subcontractors' OHS performance (in terms of the rate of incidents resulting in medical treatment or lost-time injuries) in a given construction project will be inversely related to perceptions of the OSR of both the principal contractor (path e) and their own (i.e. subcontractor) organization (path f).

The model also suggests a cross-level mediation effect, by which perceptions of the OSR of the principal contractor and subcontractors are indirectly linked to subcontractors' OHS performance through their effect on SSR. Zohar and Luria (2005) argue that shared expectancies associated with supervisors' practices act as a more powerful and proximal influence on safety behaviour within workgroups than company policy or procedure. This is consistent with the findings of Simard and Marchand (1994, 1995, 1997) who reported that the influence of senior management actions on workgroup OHS performance was mediated by supervisors' OHS behaviour. Thus, the model suggests that the perceptions of the OSR of the principal contractor will be indirectly linked with subcontractors' OHS performance through perceptions of the principal contractors' SSR (paths a and i), through the perceptions of the principal contractors' SSR and the subcontractors' SSR (paths a, g and h), and through perceptions of the subcontractors' SSR (paths d and h). The model also suggests that perceptions of the subcontractors' OSR will be indirectly linked to subcontractors' OHS performance through perceptions of the subcontractors' SSR (paths b and h).

## Research methods

### Data collection

Data were collected from directly employed and subcontracted workers at a large building construction project in Melbourne. Surveys were administered using the 'TurningPoint' automated response system with 'KeyPad' hand-held devices (see http://www.keepad.com/turningsoftware.php). The use of this system helped to overcome issues of literacy as survey questions were projected on to a screen and read out by the researcher. KeyPads are small hand-held devices, measuring 8.5 by 5 centimetres. Each KeyPad has 10 response options which are numbered from one to nine, with a 'zero' option at the base of each KeyPad. The response system can be set so that if a respondent presses an 'out of range' value, the response is not accepted. The researcher can monitor responses to determine completeness of data as they are being collected. The advantages of this system include the completeness of data and minimization of human error in data entry (de Quiros *et al.*, 2008). Participants were invited into the site office during normal work hours to participate in the survey. The principal contractor's Site Safety Coordinator issued this invitation and no inducements were offered to workers to participate. Participation was voluntary and participants were advised that their responses would be anonymous.

A safety climate survey was developed containing 19 items relating to the overall management of safety within the organization. These items were taken from the HSE's Safety Climate Tool (2002) an Offshore Safety Climate Survey developed by Aberdeen University (HSE, 1999). Consistent with Zohar and Luria (2005), the survey measured perceptions of management commitment to OHS as the core meaning of safety climate. While there is limited agreement among researchers concerning first order safety climate factors, e.g. worker involvement, the status of safety personnel or safety training, there is widespread agreement that management commitment constitutes a global higher order safety climate factor. Consequently, the first part of the survey, which measured perceptions of the OSR, included the following items 'I feel that at [company name] management are concerned about my health and safety' and '[Company name's] management only bother to look at health and safety after there has been an accident' (reversed score). Participants were asked to respond to these items in relation to both the principal contractor's OSR and their own organization (i.e. the subcontractors') OSR. All OSR items were rated on a five-point Likert scale ranging from 'strongly disagree' (1) to 'strongly agree' (5), with a mid-point of 'neither agree nor disagree' (3).

The second part of the survey utilized an 10-item group safety climate scale developed by Zohar (2000). The scale measures SSR. Example items are 'Whenever pressure builds up, my supervisor wants us to work faster, rather than by the safe work procedures' (reverse scored), and 'My immediate supervisor often talks to me about health and safety'. Participants were asked to respond to the SSR items in relation to both their own, i.e. the subcontractors' supervisor as well as the principal contractor's supervisor who was responsible for overseeing their day-to-day work. All SSR items were rated on a five-point Likert scale ranging from 'strongly disagree' (1) to 'strongly agree' (5), with a mid-point of 'neither agree nor disagree' (3).

Both scales were selected because of their relevance to the construction sample and the fact that they proved to be internally consistent and valid when tested in a pilot study of Australian blue collar workers, prior to the present data collection. To avoid confusion, during the data collection, the researcher provided clear and explicit instructions to participants about whether each block of questions was to be answered in relation to participants' own organization or the principal contractor, their own company supervisor or the supervisor employed by the principal contractor who oversees their work tasks on a day-to-day basis. Missing data were possible if participants failed to press a valid response option, i.e. a number from one to five, on their KeyPad. However, no data were missing from any items used to measure organizational safety response of either the principal contractor or participants' own companies. Neither were any responses missing from any items used to measure the subcontractors' supervisor safety response. A number of responses to items relating to the principal contractor's supervisor safety response were missing but in no case did this number exceed four (3.5%). All missing data were replaced with the mean score for the item prior to statistical analysis.

Safety performance data were collected for each subcontractor engaged at the construction project for the 12 months preceding the administration of the survey. These data were collected from the records of the principal contractor. As part of the principal contractor's OHS management system, subcontractors are required to report all lost-time and medical treatment injuries that occur at the site. The high degree of trade union oversight of the management of OHS in the Australian building industry helps to ensure the reliability and accuracy of these reported statistics. For each subcontractor, the number of lost-time injuries and medical treatment injuries was collected. Lost-time injuries are occurrences that resulted in a fatality, permanent disability or time lost from work of one day/shift or more. Medical treatment injuries are occurrences which were not lost-time injuries and for which treatment from a medical practitioner was administered. Raw data were converted to an incident rate for these types of injuries. Thus, the number of lost-time and medical treatment injuries incurred by each subcontractor per million hours worked on the project was used as a measure of subcontractors' OHS performance.

### Data analysis

The internal consistency reliability of the safety climate components was assessed using Cronbach's alpha. Consistent with Zohar (2000), between-group differences in safety climate were explored by conducting one-way analyses of variance (ANOVA). Within-group homogeneity of safety climate perceptions was examined by calculating the inter-rater agreement (IRA). The IRA is used to measure the interchangeability or the absolute consensus in scores between group members. It estimates whether responses from one participant are 'similar' to the responses provided by others in the same workgroup, thus reflecting the degree of 'sharedness' in group climate scores (James *et al.*, 1993). According to this test, within-group consensus (i.e. an acceptable level of consistency between the safety climate perceptions of different workers within the same group, in this case the subcontractor) is deemed to exist if $r_{wg(j)} \geq 0.70$ (Ludtke *et al.*, 2006). To adequately reflect team dynamics and protect participants' anonymity, subcontractors with fewer than three workers who responded to the survey at the project were excluded from the analysis. A principal components analysis with varimax rotation was performed to examine the extent to which subcontracted workers discriminate between perceptions of the SSR within their own and the principal contractor's organization. Paired sample t-tests were also conducted to determine whether workers' perceptions of their own companies' OSR and SSR differed significantly from their perceptions of the OSR and SSR of the principal contractor. Modelling procedures, together with multiple regression analyses, were undertaken to determine the extent to which safety climate perceptions predicted subcontractors' OHS performance.

## Results

### The sample

One hundred and fourteen surveys were completed, representing 45% of the 250 workers engaged at the site at the time. Table 1 shows the characteristics of the sample. These respondents were employed by nine different subcontractors working at the construction project. These subcontractors varied in the numbers of workers engaged at the project and thus the numbers of respondents also varied considerably by subcontractor, ranging from 33 respondents employed by subcontractor 6 to four respondents employed by subcontractors 2 and 5.

**Table 1** Characteristics of the sample (N = 114)

| Occupation | N | % | Employer | N | % |
|---|---|---|---|---|---|
| Construction worker | 89 | 78.1 | Subcontractor 1 | 17 | 12.5 |
| Foreman | 7 | 6.1 | Subcontractor 2 | 4 | 2.9 |
| Leading hand | 13 | 11.4 | Subcontractor 3 | 7 | 5.1 |
| Senior manager | 1 | 0.9 | Subcontractor 4 | 7 | 5.1 |
| Site manager | 1 | 0.9 | Subcontractor 5 | 4 | 2.9 |
| Student | 2 | 1.8 | Subcontractor 6 | 33 | 24.3 |
| Missing | 1 | 0.9 | Subcontractor 7 | 20 | 14.7 |
| | | | Subcontractor 8 | 11 | 8.1 |
| | | | Subcontractor 9 | 11 | 8.1 |

### Internal consistency reliability

The Cronbach's alpha coefficient for perceptions of the subcontractors' OSR was 0.89 and for the principal contractor's OSR was also 0.89. The Cronbach's alpha coefficients for perceptions of the subcontractors' and principal contractor's SSR were 0.91 and 0.83 respectively. All of these values are above the threshold of 0.70, indicating acceptably high internal consistency reliability (DeVellis, 1991, p. 85).

### Group-level safety climate

The existence of unique subcontractor safety climates engaged at the construction project was determined on the basis of two criteria established by Zohar (2000). These are:

(1) between-group variability (i.e. whether safety climates differ significantly between subcontractors working at the same construction project); and
(2) within-group homogeneity (i.e. whether workers employed by a single subcontractor share similar perceptions of the safety climate).

Figure 2 shows the mean OSR scores for each of the nine subcontractors engaged at the construction project. Owing to the fact that numbers of respondents from each subcontractor were unbalanced which can violate assumptions of analysis of variance (ANOVA) in circumstances of unequal variance, the Levene's test for

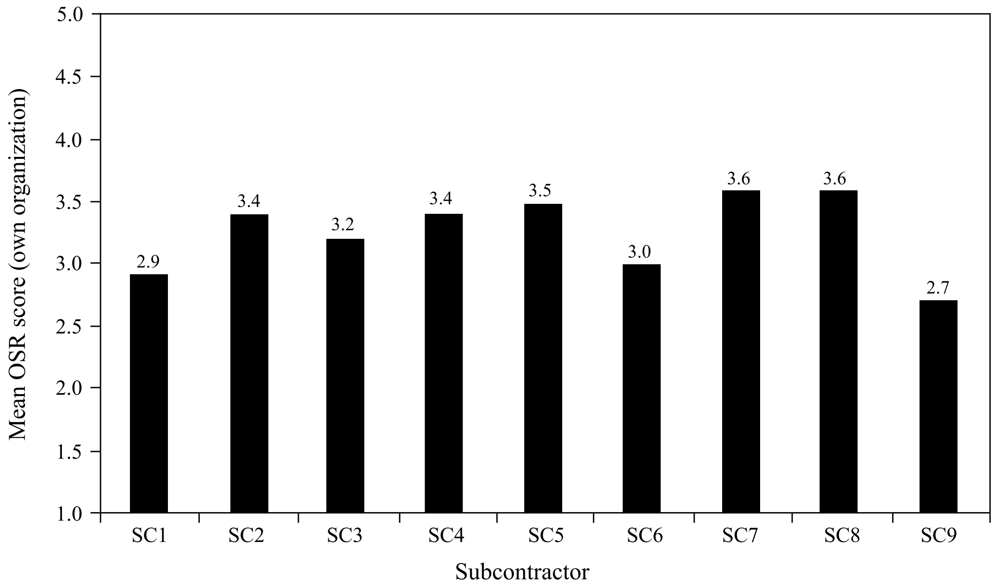


**Figure 2** Mean organizational safety response (OSR) scores by subcontractor in own organization

equality of variance was performed. The result was non-significant ($p$ = 0.420) indicating that equality of variances could be assumed, supporting the validity of the ANOVA model. A one-way ANOVA revealed that the mean OSR scores varied significantly between subcontractors ($F$ = 3.34, $p$ = 0.002, within-group $df$ = 105).

Figure 3 shows the mean SSR scores for each of the nine subcontractors engaged at the construction project. A one-way ANOVA revealed that the SSR scores varied significantly between subcontractors ($F$ = 4.03, $p$ = 0.000, within-group $df$ = 105). The Levene statistic was non-significant ($p$ = 0.117) indicating that equality of variances could be assumed, supporting the validity of the ANOVA model. Thus, the first of Zohar's conditions was satisfied with respect to the existence of between-group variability in the safety climate perceptions of subcontractors at the project.

Next, to test for within-group homogeneity, inter-rater agreement scores were calculated for the OSR and SSR scores. The threshold value for $r_{wg(j)}$ required to establish within-group homogeneity is 0.70. The inter-rater agreement scores for subcontractors' OSR and SSR are shown in Table 2. In eight of the nine subcontractors, there was a high level of within-group

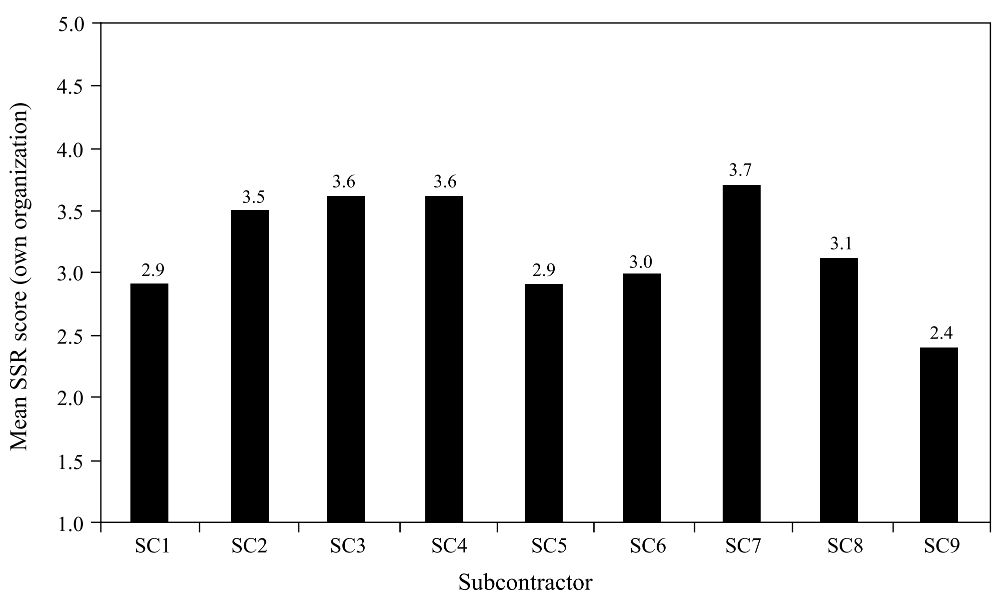


**Figure 3** Mean supervisor safety response (SSR) score by subcontractor in own organization

**Table 2** Inter-rater agreement scores for subcontractors' organizational safety response (OSR) and supervisor safety response (SSR) in own organization

| Subcontractor | SC OSR | SC SSR |
|---|---|---|
| SC 1 | 0.92 | 0.84 |
| SC 2 | 0.90 | 0.77 |
| SC 3 | 0.89 | 0.95 |
| SC 4 | 0.91 | 0.83 |
| SC 5 | 0.00 | 0.00 |
| SC 6 | 0.92 | 0.96 |
| SC 7 | 0.92 | 0.97 |
| SC 8 | 0.95 | 0.93 |
| SC 9 | 0.76 | 0.82 |

agreement concerning both their company's (i.e. the subcontractor's) OSR and SSR. The inter-rater agreement score for workers in subcontractor (SC) 5 did not satisfy the requirement of being 0.70 or greater and thus, no consensus was deemed to exist in this subcontractor. The overall $r_{wg(j)}$ for SSR and OSR was 0.78 and 0.80 respectively, both above the threshold value of 0.70.

## Principal contractor and subcontractor safety climate perceptions

Paired samples t-tests were conducted to test for significant differences between workers' perceptions of the principal contractor's OSR and the OSR of their own organization. The mean OSR score for the principal contractor (mean = 3.33, SD = 0.57) was higher than that for the subcontractors' own organization (3.20, SD = 0.71). The paired sample t-test revealed that the difference was significant ($t$ = 2.07, $p$ = 0.041, $df$ = 113). The mean SSR score for the principal contractor's supervisor was also compared to that of the subcontractors' own supervisor using a paired samples t-test. The mean score for the principal contractor's SSR (mean = 3.06, SD = 0.61) was considerably lower than that of the subcontractor's own supervisor's SSR (mean = 3.46, SD = 0.77). The paired samples t-test revealed that this difference was highly significant ($t$ = 3.80, $p$ = 0.001, $df$ = 39).

Table 3 shows the rotated component matrix generated in a principal components analysis of the SSR items asked about the principal contractor (PC) and

**Table 3** Rotated component matrix for supervisor safety response (SSR) items

| Item | PC SSR | SC SSR |
|---|---|---|
| The PC's supervisor often talks to me about health and safety | 0.947 | –0.013 |
| The PC's supervisor only keeps track of major safety problems and overlooks routine problems (r) | 0.944 | 0.067 |
| The PC's supervisor seriously considers any workers' suggestions for improving safety | 0.925 | 0.050 |
| The PC's supervisor approaches workers during work to discuss safety issues | 0.910 | 0.016 |
| As long as work remains on schedule, the PC's supervisor doesn't care how this has been achieved (r) | 0.897 | 0.069 |
| As long as there is no accident, the PC's supervisor doesn't care how the work is done (r) | 0.897 | 0.163 |
| Whenever pressure builds up, the PC's supervisor wants us to work faster regardless of adhering to safe work procedures (r) | 0.853 | 0.139 |
| The PC's supervisor I work under pays less attention to safety issues than most other supervisors at [project name] (r) | 0.846 | –0.031 |
| The PC supervisor gets annoyed at any worker ignoring safety procedures, even minor safety issues | 0.827 | –0.133 |
| The PC's supervisor compliments me whenever he sees a job done safely | 0.814 | –0.028 |
| The PC's supervisor comments more often when a worker has not followed a safety procedure | 0.705 | –0.173 |
| My (SC) supervisor seriously considers any workers' suggestions for improving safety | 0.064 | 0.865 |
| As long as there is no accident, my (SC) supervisor doesn't care how the work is done (r) | 0.024 | 0.855 |
| Whenever pressure builds up, my (SC) supervisor wants us to work faster regardless of adhering to safe work procedures (r) | 0.008 | 0.829 |
| As long as work remains on schedule, my (SC) supervisor doesn't care how this has been achieved (r) | –0.086 | 0.789 |
| My (SC) supervisor approaches workers during work to discuss safety issues | 0.057 | 0.776 |
| My (SC) supervisor I work under pays less attention to safety issues than most other supervisors in my (SC) company (r) | 0.060 | 0.757 |
| My (SC) supervisor compliments me whenever he sees a job done safely | 0.028 | 0.748 |
| My (SC) supervisor often talks to me about health and safety | 0.004 | 0.748 |
| My (SC) supervisor only keeps track of major safety problems and overlooks routine problems (r) | –0.081 | 0.686 |
| ~~My (SC) supervisor gets annoyed at any worker ignoring safety procedures, even minor safety issues~~ | ~~0.074~~ | ~~0.487~~ |
| ~~My (SC) supervisor comments more often when a worker has not followed a safety procedure~~ | ~~0.043~~ | ~~0.255~~ |

*Note*: (r) denotes reverse scored items.

the workers' own (i.e. the subcontractors') (SCs') supervisor. The analysis revealed two clear factors explaining 65% of total variance. An examination of item loadings shows that all of the SSR items relating to the principal contractor's supervisor clearly loaded on the first component, while all but two of the SSR items asked in relation to the subcontractors' own supervisor clearly loaded on the second component. Two items failed to reach the threshold loading of 0.5 for the subcontractors' SSR component, although one was very close (0.487). The matrix shows that there was no double loading, i.e. when items have high loadings on more than one component, further supporting the suggestion that construction workers discriminate between perceptions of their own organization and the principal contractor's SSR.

## Cross-level safety climate relationships

Table 4 shows the bivariate correlations between perceptions of the OSR and SSR in both the principal and subcontractor organizations and the subcontractors' combined lost-time and medical treatment injury incident rate for the six months preceding the date of the survey. Workers' perceptions of the principal contractor's OSR were significantly and positively correlated with perceptions of the principal contractor's SSR ($r$ = 0.791, $p$ = 0.000), perceptions of the subcontracted workers' own company OSR ($r$ = 0.524, $p$ = 0.000) and perceptions of the subcontractors' SSR ($r$ = 0.330, $p$ = 0.000). Perceptions of the subcontractors' SSR were significantly inversely correlated with the subcontractors' combined lost-time incident and medical treatment injury rate for the 12 months prior to the date of the survey ($r$ = –0.268, $p$ = 0.004). Perceptions of the subcontractors' OSR were also significantly positively correlated with perceptions of the subcontractors' SSR ($r$ = 0.638, $p$ = 0.000).

In order to test the hypothetical safety climate model (or theory) depicted in Figure 1, a technique known as path analysis was used. Path analysis uses regression equations to calculate the relationships between the model variables. The magnitude of the pathways is then examined to determine how variables in the model impact on each other and the outcome variable (in this case subcontractors' OHS performance). Figure 4 shows that subcontractors' perceptions of the principal contractor's OSR were a significant predictor of perceptions of the principal contractor's SSR. Workers' perceptions of their own (subcontractors') OSR were also a strong predictor of perceptions of their own (subcontractors') SSR. Perceptions of the principal contractor's OSR were a strong predictor of perceptions of their own organization (i.e. the subcontractor's) OSR. As expected, perceptions of the subcontractors' SSR were significantly predicted by perceptions of the principal contractor's OSR and the principal contractor's SSR. Perceptions of the principal contractor's OSR also indirectly influenced perceptions of the subcontractors' SSR through the subcontractors' OSR. The magnitude of these pathways can be determined by multiplying coefficients together. Thus, the indirect influence of the principal contractor's OSR on the subcontractors' SSR is $0.524 \times 0.638 = 0.334$. The principal contractor's OSR also indirectly influenced the subcontractors' SSR through perceptions of the principal contractor's SSR. The magnitude of this influence pathway is $0.791 \times 0.567 = 0.448$.

Figure 4 shows that contrary to expectations, neither workers' perceptions of the principal contractor's OSR nor perceptions of the subcontractors' OSR was a significant direct predictor of subcontractors' OHS performance at this particular construction project. However, perceptions of the principal contractor's OSR did influence subcontractors' OHS performance indirectly, through the principal contractor's SSR and subcontractors' SSR ($0.791 \times 0.567 \times -0.268 = -0.128$). Perceptions of the principal contractor's OSR also influenced subcontractors' OHS performance through the subcontractors' OSR and subcontractors' SSR ($0.524 \times 0.638$

**Table 4** Correlation matrix for safety climate and performance variables

| | | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| PC - OSR | Pearson correlation | 1 | | | | |
| | Sig. (2-tailed) | | | | | |
| PC - SSR | Pearson correlation | 0.791** | 1 | | | |
| | Sig. (2-tailed) | 0.000 | | | | |
| SC - OSR | Pearson correlation | 0.524** | 0.713** | 1 | | |
| | Sig. (2-tailed) | 0.000 | 0.000 | | | |
| SC - SSR | Pearson correlation | 0.330** | 0.567** | 0.638** | 1 | |
| | Sig. (2-tailed) | 0.000 | 0.000 | 0.000 | | . |
| LTI/MTI rate | Pearson correlation | –0.078 | –0.133 | 0.140 | –0.268** | 1 |
| | Sig. (2-tailed) | 0.407 | 0.412 | 0.138 | 0.004 | |

*Notes*: ** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

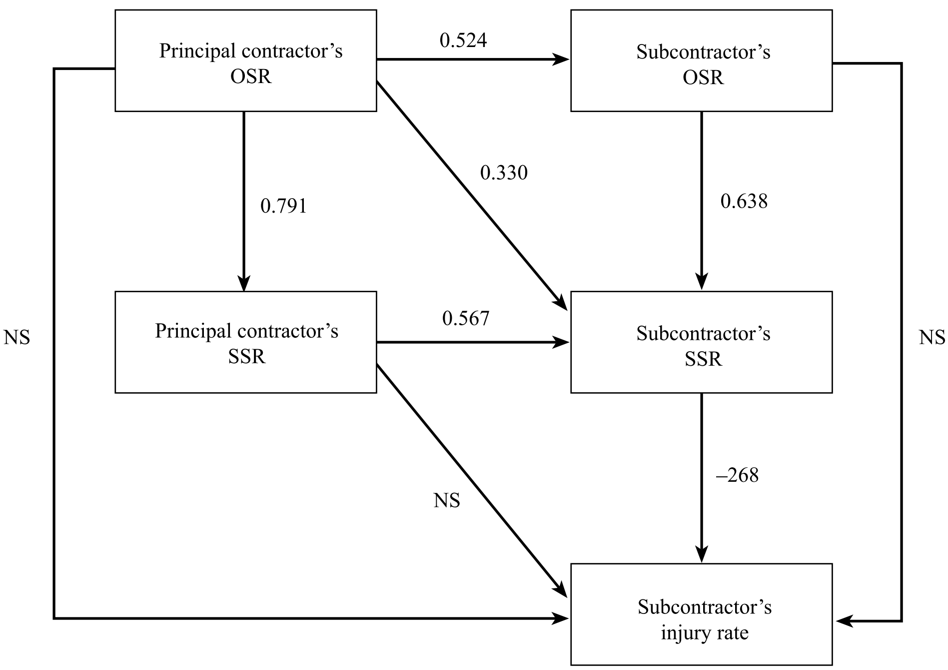


**Figure 4** Path analysis for multi-level safety climate model for construction subcontracting

$\times -0.268 = -0.089$) and through the subcontractors' SSR ($0.330 \times -0.268 = -0.088$).

## Discussion

### Principal contractor–subcontractor interactions

The results suggest that the principal contractor's OSR is influential in shaping the safety climate within the subcontractors they engage. Perceptions of the principal contractor's OSR positively and significantly predicted perceptions of subcontractors' OSR and SSR. This finding has practical implications for OHS management because when top managers in principal contractors are perceived to be highly committed to OHS, perceptions of subcontractors' management and supervisory commitment to OHS are likely to be significantly higher. The important role played by principal contractors in shaping subcontractors' safety climates suggests that the development of OHS leadership capability in project and site level management teams could be helpful. Indeed, interventions focusing on safety leadership activities and behaviour modelling have been effectively used to improve OHS in other industries (O'Toole, 2002). Similar results are reported by Parker *et al.* (2001) who found that supportive management predicted safe working for up to 18 months. The results of the present research highlight the importance of the principal contractor's managers demonstrating their OHS commitment, thereby helping to engender positive safety climates within subcontractors engaged in the projects they manage.

### Group-level safety climates

The results also support the concept of group-level safety climate within the construction industry. There was significant between-group variability and (with the exception of subcontractor 5) within-group homogeneity concerning OSR and SSR in nine subcontractors engaged by the same principal contractor at a single construction project. Further, subcontracted workers at the project discriminated between perceptions of the safety climate of their own organization and that of the principal contractor. Subcontracted workers in this sample perceived that the principal contractor's OSR was more positive than the OSR of their own company. However, they also perceived that their own company SSR was more supportive of safety than that of the principal contractor, perhaps indicating that the behaviour of supervisory personnel of the principal contractor might not be entirely consistent with the company's rhetoric concerning OHS.

The results also indicate a high degree of alignment between group-level safety climate (specifically perceptions of the SSR) and organization-level safety climate within a single organization. Perceived SSR was positively predicted by perceived OSR in both the principal contractor and within each subcontractor. This supports the notion of cascading management influence as the OHS attitudes and behaviours of senior managers shape the OHS attitudes and behaviours of supervisory personnel. This alignment is important because supervisors operate at the interface between management and the workforce. As such, they are a critical conduit through which senior managers' commitment to OHS is communicated. Rowlinson *et al.* (2003) suggest that, in construction, supervisors are often the point at which breakdown occurs in OHS management systems. Supervisory personnel are particularly influential because they 'filter' organizational OHS messages and shape employees' beliefs about how committed managers are to OHS. Put simply, supervisors communicate what 'management really wants'.

The significant inverse relationship between perceptions of the subcontractors' SSR and subcontractors' incident frequency rate supports the important role played by supervisory personnel in shaping OHS outcomes in construction projects. This is consistent with previous studies by Zohar (2002) who reports that perceptions of supervisory safety practices measured at one point in time predicted the incidence of minor (first aid only) incidents experienced by the workgroup for up to six months thereafter: i.e. the stronger the SSR, the lower the incidence of injuries (Zohar, 2002). The results of the present research highlight the importance of developing safety supportive supervision within construction organizations. Zohar and Luria (2003, 2004) demonstrated the effectiveness of cross-level safety interventions whereby OHS performance was improved by modifying the way that supervisors interact with workers on a day-to-day basis.

Various aspects of leadership have been linked to OHS behaviour and performance. For example, Hoffman and Morgeson (1999) reported that the quality of the relationships between group members and their supervisors (leader–member exchange) predicted safety communication, safety commitment and accidents. That is, where relationships between managers and the employees they manage were good, employees were more likely to raise legitimate OHS concerns and internalize the organization's OHS values and less likely to be involved in a work-related accident. Subordinates are also reported to model their supervisors' OHS behaviour (such as wearing protective equipment) and develop similar OHS values to those of their supervisors (Maierhofer *et al.*, 2000). Our results suggest that supervisors are an important conduit through which top management support for safety (in both principal contractor and subcontracted organization) is translated into improved safety performance. Thus, the development of safety leadership capability in first-level supervisors may yield significant improvements in subcontractors' OHS performance. The results also suggest that the principal contractor's safety climate influences subcontractors' OHS performance indirectly to the extent that it shapes workers' perceptions of their own (i.e. the subcontractors') supervisors' safety response. Notwithstanding the indirect nature of this influence, the principal contractor's SSR is an important link in the OHS chain of influence because it is a strong determinant of the subcontractor's SSR, which, in turn, predicts subcontractors' injury rate. Since the survey was conducted, the principal contractor has implemented a safety leadership development training programme at the project in which supervisory personnel, both directly employed and subcontracted, were provided with a full day of safety leadership training paid for by the principal contractor.

## Conclusions

The results of this research have important implications for practice and research. For practice, they suggest that perceptions that subcontracted workers form of principal contractors' safety climates are an important mechanism through which the principal contractor can influence subcontractors' OHS performance. Supervisors act as an important channel of communication and influence between the principal contractor and subcontracted workers and the benefit associated with the development of safety leadership capability in first-level supervisors (foremen and leading hands) should be evaluated. The results also highlight the need to specify the theoretical level of interest in safety climate research in the construction industry and make sure that survey items are appropriate for this level. Construction researchers investigating organization or group level safety climate should also take care to distinguish between safety climate perceptions relating to the principal contractor and the subcontractors' OHS responses.

### Limitations and future research

The research was exploratory in nature and is limited by the fact that data were collected from a relatively small sample of subcontracted workers in a single construction project. No comparable data were available for subcontracted workers who did not complete the survey and this limits the generalizability of the findings, even to the level of the single construction project. Notwithstanding this limitation, the research has highlighted the complexity of multi-level safety climate development in the construction context. However, this research constitutes the first stage in a larger project which combines a longitudinal survey with experimental design. Having confirmed the existence of group-level safety climates in a construction project setting, in the second stage of the project, a safety leadership model and intervention are being developed, implemented and evaluated. Various combinations of safety leadership training and feedback are being delivered to principal contractor and subcontractors' supervisors (leading hands and foremen) at participating construction projects over a 12-month period. Episodic data will be collected from construction workers on a weekly basis to ascertain whether the intervention changes workers' perceptions of the SSR and/or OHS performance within subcontractors' workgroups.

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## References

Arditi, D. and Chotibhongs, R. (2005) Issues in subcontracting practice. *Journal of Construction Engineering and Management,* **131**, 866–76.

ASCC (2008) *Information Sheet, Construction,* Australian Safety and Compensation Council, Canberra.

Choudhry, R.M. and Fang, D. (2008) Why operatives engage in unsafe work behavior: investigating factors on construction sites. *Safety Science,* **46**(4), 566–84.

Clarke, S. (2006a) Safety climate in an automobile manufacturing plant: the effects of work environment, job communication and safety attitudes on accidents and unsafe behaviour. *Personnel Review,* **35**, 413–30.

Clarke, S. (2006b) The relationship between safety climate and safety performance: a meta-analytic review. *Journal of Occupational Health Psychology,* **11**, 315–27.

Cooper, M.D. and Phillips, R.A. (2004) Exploratory analysis of the safety climate and safety behaviour relationship. *Journal of Safety Research,* **35**, 497–512.

De Quiros, A.C.B., Lopez, R., Aranda-Mena, G. and Edwards, P. (2008) Human reliability as a source of error in research, in Dainty, A. (ed.) *Procs 24th Annual ARCOM Conference,* Cardiff, UK, 1–3 September, Association of Researchers in Construction Management, Reading, pp. 687–96.

Dedobbeleer, N. and Béland, F. (1991) A safety climate measure for construction sites. *Journal of Safety Research,* **22**, 97–103.

DeVellis, R.F. (1991) *Scale Development: Theory and Applications,* Sage Publications, Newbury Park, CA.

Gillen, M., Baltz, D., Gassel, M., Kirsch, L. and Vaccaro, D. (2002) Perceived safety climate, job demands and coworker support among union and nonunion injured construction workers. *Journal of Safety Research,* **33**(1), 33–51.

Griffin, M.A. and Neal, A. (2000) Perceptions of safety at work: A framework for linking safety climate to safety performance, knowledge, and motivation. *Journal of Occupational Health Psychology,* **5**, 347–58.

Griffin, M. and Neal, A. (2002) Safety climate and safety behaviour. *Australian Journal of Management,* **27**(Special Issue), 67–75.

Health and Safety Executive (2001) Summary guide to safety climate tools, Offshore Technology Report 1999/063, HMSO, Norwich.

Hoffman, D.A. and Morgeson, F.P. (1999) Safety-related behaviour as a social exchange: the role of perceived organizational support and leader-member exchange. *Journal of Applied Psychology,* **84**, 286–96.

Hoffman, D.A. and Stetzer, A. (1998) The role of safety climate and communication in accident interpretation: implications for learning from negative events. *Academy of Management Journal,* **41**, 644–57.

HSE (2002) *Evaluating the Effectiveness of the Health and Safety Executives Health and Safety Climate Survey Tool,* HMSO, London.

James, L.R., Demaree, R.G. and Wolf, G. (1993) $R_{wg}$: an assessment of within-group interrater agreement. *Journal of Applied Psychology,* **78**, 306–9.

Johnson, S.E. (2007) The predictive validity of safety climate. *Journal of Safety Research,* **38**, 511–21.

Jorgensen, E., Sokas, R.K., Nickels, L., Gao, W. and Gittleman, J.L. (2007) An English/Spanish safety climate scale for construction workers. *American Journal of Industrial Medicine,* **50**, 438–44.

Lingard, H., Cooke, T. and Blismas, N. (2009) Group-level safety climate in the Australian construction industry: within-group homogeneity and between-group differences in road construction and maintenance. *Construction Management and Economics,* **27**, 419–32.

Loosemore, M. and Andonakis, N. (2007) Barriers to implementing OHS reforms: the experiences of small subcontractors in the Australian construction industry. *International Journal of Project Management,* **25**, 579–88.

Lu, C.-S. and Shang, K.-C. (2005) An empirical investigation of safety climate in container terminal operators. *Journal of Safety Research,* **36**, 297–308.

Ludtke, O., Trautwein, U., Kunter, M. and Baumert, J. (2006) Reliability and agreement of student ratings of the classroom environment: a reanalysis of TIMSS data. *Learning Environments Research,* **9**, 215–30.

Maierhofer, N.I., Griffin, M.A. and Sheehan, M. (2000) Linking manager values and behavior with employee values and behavior: a study of values and safety in the hairdressing industry. *Journal of Occupational Health Psychology,* **5**, 417–27.

Mayhew, C., Quinlan, M. and Ferris, R. (1997) The effects of subcontracting/outsourcing on occupational health and safety: survey evidence from four Australian industries. *Safety Science,* **25**, 163–75.

McDonald, M.A., Lipscomb, H.J., Bondy, J. and Glazner, J. (2009) Safety is everyone's job: the key to safety on a large university construction site. *Journal of Safety Research,* **40**, 53–61.

Mearns, K., Whitaker, S.M. and Flin, R. (2003) Safety climate, safety management practice and safety performance in offshore environments. *Safety Science,* **41**, 641–80.

Melia, J.L., Mearns, K., Silva, S.A. and Lima, M.L. (2008) Safety climate responses and the perceived risk of accidents in the construction industry. *Safety Science,* **46**, 949–58.

Mohamed, S. (2002) Safety climate in construction site environments. *Journal of Construction Engineering and Management,* **128**, 375–84.

Molenaar, K.R., Park, J.I. and Washington, S. (2009) Framework for measuring corporate safety culture and its impact on construction safety performance. *Journal of Construction Engineering and Management,* **135**, 488–96.

Neal, A. and Griffin, M.A. (2006) A study of the lagged relationships among safety climate, safety motivation, safety behaviour and accidents at individual and group levels. *Journal of Applied Psychology,* **91**, 946–53.

O'Toole, M. (2002) The relationship between employees' perceptions of safety and organizational culture. *Journal of Safety Research,* **33**, 231–43.

Parker, S.K., Axtell, C.M. and Turner, N. (2001) Designing a safer workplace: importance of job autonomy, communication quality and supportive supervisors. *Journal of Occupational Health Psychology,* **6**, 211–28.

Pousette, A., Larsson, S. and Törner, M. (2008) Safety climate cross-validation, strength and prediction of safety behaviour. *Safety Science,* **46**, 398–404.

Rowlinson, S., Mohammed, S. and Lam, S.W. (2003) Hong Kong construction foremen's safety responsibilities: a case study of management oversight. *Engineering, Construction and Architectural Management,* **10**, 27–35.

Shannon, H.S. and Norman, G.R. (2009) Deriving the factor structure of safety climate scales. *Safety Science,* **47**, 327–9.

Simard, M. and Marchand, A. (1994) The behaviour of first-line supervisors in accident prevention and effectiveness on occupational safety. *Safety Science,* **17**, 169–85.

Simard, M. and Marchand, A. (1995) A multi-level analysis of organizational factors related to the taking of safety initiatives by work groups. *Safety Science,* **21**, 113–29.

Simard, M. and Marchand, A. (1997) Workgroups' propensity to comply with safety rules: the influence of micro-macro organizational factors. *Ergonomics,* **40**, 172–88.

Siu, O., Phillips, D.R. and Leung, T. (2004) Safety climate and safety performance among construction workers in Hong Kong: the role of psychological strains as mediators. *Accident Analysis and Prevention,* **36**, 359–66.

Tharaldsen, J.E., Olsen, E. and Rundmo, T. (2008) A longitudinal study of safety climate on the Norwegian continental shelf. *Safety Science,* **46**, 427–39.

Varonen, U. and Mattila, M. (2000) The safety climate and its relationship to safety practices, safety of the work environment and occupational accidents in eight wood-processing companies. *Accident Analysis and Prevention,* **32**, 761–9.

Zhou, Q., Fang, D.P. and Wang, X. (2008) A method to identify strategies for the improvement of human safety behavior by considering safety climate and personal experience. *Safety Science,* **46**, 1406–19.

Zohar, D. (1980) Safety climate in industrial organizations: theoretical and applied implications. *Journal of Applied Psychology,* **65**, 96–102.

Zohar, D. (2000) A group-level model of safety climate: testing the effect of group climate on micro-accidents in manufacturing jobs. *Journal of Applied Psychology,* **85**, 587–96.

Zohar, D. (2002) The effect of leadership dimensions, safety climate and assigned priorities on minor injuries in work groups. *Journal of Organizational Behavior,* **23**, 75–92.

Zohar, D. and Luria, G. (2003) The use of supervisory practices as leverage to improve safety behaviour: a cross-level intervention model. *Journal of Safety Research,* **34**, 561–71.

Zohar, D. and Luria, G. (2004) Climate as a social-cognitive construction of supervisory safety practices: scripts as proxy of behaviour pattern. *Journal of Applied Psychology,* **89**, 322–33.

Zohar, D. and Luria, G. (2005) A multilevel model of safety climate: cross-level relationships between organization and group-level climates. *Journal of Applied Psychology,* **90**, 616–28.

Zohar, D. and Tenne-Gazit, O. (2008) Transformational leadership and group interaction as climate antecedents: a social network analysis. *Journal of Applied Psychology,* **93**, 744–57.