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Group-level safety climate in the Australian construction industry: within-group homogeneity and between-group differences in road construction and maintenance

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Abstract

In modern organizations it is overly simplistic to assume that a uniform, organization-wide climate for safety develops. Workgroup-level safety climates are more likely to arise in decentralized organizations and their influence on occupational health and safety (OHS) behaviour is likely to be stronger when work is non-routine, as in construction. The existence of workgroup-level safety climates was examined in the Australian construction industry. A group-level safety climate survey was conducted in a road maintenance and construction organization. The clear factorial structure produced in a larger sample of Australian defence logistics workers was not replicated and factors splintered, possibly due to the subject-to-item ratio in the construction study. However, the internal reliability consistency of the factors produced in the earlier pilot study was found to be acceptable for the construction industry data. Two requisite conditions for the existence of group-level safety climates, i.e. (1) within-group homogeneity; and (2) between-group variation, were satisfied within the road construction and maintenance organization. The results indicate that distinct workgroup safety climates exist in construction, providing a theoretical explanation for why some workgroups perform better in OHS than others, despite having similar risk exposure.

Keywords: Co-workers, group dynamics, road maintenance, safety climate, supervisory leadership.

Introduction

OHS in construction

The construction industry is a high-risk industry for work-related death, injury and illness. Workers' compensation statistics show that the fatality rate in the Australian construction industry is 9.2 per 100 000 workers, compared to 3.1 for all industries and since 1997/98, an average of 49 compensated construction fatalities has been recorded each year—nearly one per week (Fraser, 2007). Moreover, in the construction industry, occupational injuries and illnesses are associated with longer than average work absences (Larsson and Field, 2002) and higher rates of permanent impairment than in other sectors (Guberan and Usel, 1998).

The earliest efforts to improve OHS performance in construction focused on the provision of a safe physical environment, and addressed issues such as the provision of machinery guarding and safe mechanical equipment. Following this the focus shifted to the implementation of robust OHS management systems. These traditional approaches led to enormous improvements in OHS performance in the 20th century. However, writers on OHS now acknowledge that it is insufficient to implement a paper system, in which formal policy statements and plans establish company objectives because it is essential to win the 'hearts and minds' of workers to elicit a common commitment to the implementation of these policies and plans. For example, Flin (2003) and Thompson et al. (1998) emphasize the importance of managerial leadership in communicating the importance of OHS and in ensuring that OHS practices are consistently followed within workplaces. Early examples of this approach were investigations by Simonds and Shafai-Sahrai (1977) and Smith et al. (1978), which showed that assessments of managers' commitment to OHS and the quality of OHS communication distinguished workplaces with high levels from those with low levels of OHS performance. Hale and Hovden (1998) have referred to this development as the 'third age of safety', referring to the increased emphasis on cultural drivers of human behaviour in relation to OHS. In keeping with this new focus, the measurement of safety climate has become very prevalent in the OHS research community.

Aims

Much of the safety climate research has adopted the organization as the unit of analysis, implicitly assuming that workers in construction organizations share a homogeneous perception of the priority placed on OHS. However, there is a growing recognition that workers develop perceptions of safety climate at different levels within organizations and that workers' safety climate perceptions can vary significantly between organizational sub-units (Zohar, 2000). The aims of this research were twofold:

(1) to examine the extent to which unique group-level safety climates exist within a state-based road administration organization in Australia; and

(2) to extend Zohar's model of grouplevel safety climate by including aspects of co-worker safety stewardship, or the extent to which co-workers are supportive of one another's safety.

For the purposes of this research, the existence of group-level safety climates was determined on the basis of two criteria established by Zohar (2000). These are:

(1) within-group homogeneity (i.e. whether members of workgroups supervised by the same individual have shared perceptions regarding supervisors' safety practices); and

(2) between-group variance (i.e. whether grouplevel safety climates differ significantly between sub-units within a single organization).

Safety climate

What is safety climate?

Safety climate was first defined by Zohar (1980) as ‘a summary of molar perceptions that employees share about their work environments … a frame of reference for guiding appropriate and adaptive task behaviors’ (p. 96). Since this seminal paper, the concept of safety climate has been developed and 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’. Safety climate is distinguished from safety culture in that the latter refers to underlying core organizational beliefs, while the former represents employees’ attitudes and perceptions of OHS at a given point in time (Flin et al., 2000). Given this interpretation, an organization’s safety culture is expressed through its safety climate (Guldenmund, 2000). If this interpretation is accepted, then the development of a positive safety culture should be the most important aim for those who wish to improve OHS performance, while the measurement of the safety climate can be viewed as a useful diagnostic tool and method for measuring the safety culture. Safety climate surveys are frequently used to provide a ‘snapshot assessment’ of the state of the safety culture within an organization or at a particular site. Researchers have studied organizational safety climate in many different industrial environments, including construction (Dedobbeleer and Béland, 1991; Gillen et al., 2002; Larsson et al., 2008; Melia et al., 2008), manufacturing (Zohar, 1980; Brown and Holmes, 1986; Griffin and Neal, 2000; Clarke 2006), road administration (Niskanen, 1994), wood processing (Varonen and Mattila, 2000) and airport ground handling (Diaz and Cabrera, 1997). These studies confirm that the concept of organizational safety climate has validity in a diverse range of industrial settings.

Safety climate ‘outcomes’

Cooper and Phillips (2004) suggest that the concept of safety climate is important insofar as it predicts safety performance within organizations. Researchers have empirically investigated the relationship between safety climate and various aspects of safety-related behaviour and/or safety performance. The results have generally (but not always) supported a link between safety climate and performance. For example, Tharaldsen et al. (2008) report a significant inverse correlation between safety climate perceptions and accident rates in offshore oil platforms. Varonen and Mattila (2000) similarly report that dimensions of safety climate describing the prevailing attitude towards OHS within an organization (organizational responsibility and safety supervision) and its safety precautions are inversely correlated with the accident rate in a sample of eight wood processing companies. These studies suggest that safety climate can predict incident occurrence.

Some researchers have relied on self-report measures of safety performance, again generally supporting a positive relationship between safety climate and performance. For example, Mearns et al. (2003) report favourable safety climate scores to be associated with installations with a lower proportion of self-reported accident involvement in the offshore oil industry. Griffin and Neal (2000) and Neal and Griffin (2002) examined the relationship between safety climate and two types of self-reported safety behaviour, safety compliance and participation. They report safety climate to be positively related to both self-reported compliance with safety procedures and self-reported voluntary participation in safety-related activities, but that this relationship was partially mediated by safety knowledge and motivation. Safety climate has also been linked to an organization's ability to appropriately attribute incident causes and learn lessons from safety incidents (Hofmann and Stetzer, 1998).

Several researchers have examined the extent to which the safety climate moderates the relationship between other variables of interest and safety outcomes. For example, Smith-Crowe et al. (2003) report that safety knowledge was more likely to be translated into practice in positive safety climates, indicating that safety climate is likely to be a key determinant of safety training transfer. Hofmann et al. (2003) report that safety climate moderated the relationship between leader–member exchange and safety citizenship behaviour, suggesting that high quality relationships between supervisors and subordinates contribute to improved safety performance only when perceptions of the safety climate are positive. However, not all studies have shown a significant link between safety climate and performance. For example, Glendon and Litherland (2001) failed to find a significant relationship between safety climate and observations of workers' safety behaviour, leading them to suggest that the choice of measurement method for safety performance is important in safety climate research.

Most studies linking safety climate with safety performance have been cross-sectional. Consequently, it has been impossible to eliminate the possibility of reverse causation, i.e., the possibility that high levels of OHS performance cause the development of positive safety climates. Notwithstanding the tendency to undertake cross-sectional studies, recent longitudinal research has provided empirical support for the hypothesis that safety climate causes improved OHS performance. 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 at time 2, seven months later (after controlling for safety behaviour at time 1). Similarly, based upon data collected in an Australian hospital, Neal and Griffin (2006) report 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.

The generally positive and significant relationship between safety climate and various aspects of safety performance indicates that safety climate is a useful concept. In particular, the emergence of evidence from longitudinal studies permits researchers to make inferences about the direction of the causal relationship, i.e. safety climate shapes OHS performance rather than the other way around. This evidence suggests that organizations should focus upon the strategic development of positive organizational safety climates as part of their occupational health and safety management activities.

Multi-level safety climates

Most safety climate studies have focused on workers' perceptions of organization-level issues, for example the status of specialist safety staff, resources allocated to safety, top management commitment and the quantity and usefulness of safety training. However, modern organizations are large and complex and the notion of a single uniform safety climate seems overly simplistic. Differences in safety climate among groups of employees within the same organization have been identified by several researchers. For example, Tharaldsen et al. (2008) found that safety climate in the Norwegian oil industry varied by oil platform, work area, company type and platform type and concluded that safety climate dimensions are related to actual and natural working units within organizations. Glendon and Litherland (2001) also report significant differences between the safety climate perceptions of workers in different functional areas (i.e. maintenance and construction) within a single road construction organization. Workers' employment arrangements (i.e. whether they are directly employed or contract employees) also appears to have an impact upon perceptions of safety climate. Both Findley et al. (2007) and Tharaldsen et al. (2008) report lower perceptions of safety climate among contracted workers in the offshore oil industry. Finally, perceptions of the safety management effort are also found to differ between vertical levels within an organizational hierarchy. For example, Clarke (1999) reports significant variation in the perceptions of safety management held by managerial, supervisory and operational employees in a single rail organization.

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 and the workgroup safety climate. Zohar suggests that group-level safety climates relate to patterns of supervisory safety practices, or ways in which organization-level policies are implemented within each workgroup or sub-unit.

Geller et al. (1996) explored the opportunity to improve OHS through encouraging employees to 'actively care' about the safety of their co-workers. Similarly, the willingness of employees to approach other members of their workgroups regarding safety-related concerns was recognized as being an important facet of organizational behaviour by Hofmann and Stetzer (1996). Previous models of group-level safety climate (for example, Zohar's model of group safety climate) have focused upon perceptions of supervisory expectations and actions. Burt et al. (2008) suggest that the extent to which employees care about their coworkers' safety is potentially one dimension of the workgroup-level safety climate. Consequently the questionnaire developed for use in the present study included items relating to perceptions of both supervisors' and co-workers' safety attitudes and behaviours.

Research methods

Data collection

Data collected from two organizations are reported in this paper. First, a pilot study was undertaken at a national logistics company to determine the reliability and validity of the questionnaire survey for measuring group-level safety climate in the Australian context. Second, data were collected from employees within a regional construction and maintenance works district of a large, state-based road administration authority in Australia. Four work centres make up the works district. Each work centre consists of a number of work crews. Each work crew has a team leader, reporting to a works supervisor, who typically oversees multiple work crews. Owing to the large geographical area covered by the works district, work is highly decentralized with most of the road construction and maintenance work undertaken at sites remote from the work centres or satellite corporate offices of the road administration organization. Figure 1 depicts a typical work centre. The unit of analysis in this research is the work crew.

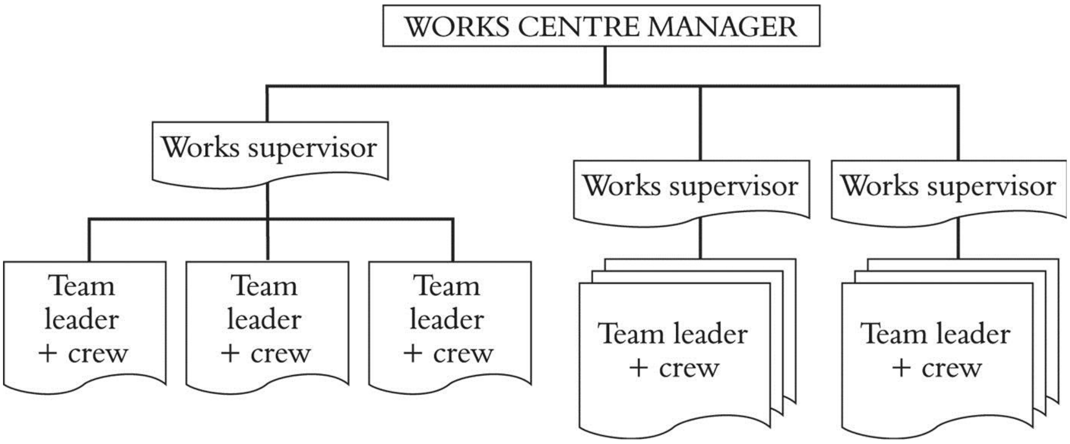

Figure 1: Typical work centre organization chart

Safety climate is commonly measured using multidimensional questionnaires (Flin *et al.*,2000). For the purpose of this study a 44-item questionnaire was developed to measure group-level safety climate. All items included in the questionnaire were adopted verbatim from previously tested and validated safety climate surveys. The first part of the survey (About Your Supervisor) utilized an 11-item scale developed by Zohar (2000). 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’. The second part of the survey was designed to measure ‘co-worker safety stewardship’ and utilized questions from two sources. Twenty-one items were adopted from Burt *et al.*'s considerate and responsible employee (CARE) scale (Burt *et al.*, 1998). Example items are ‘Workers should avoid creating hazards for co-workers’, and ‘Workers should assist each other with tasks to ensure safety’. The remaining 12 questions, which also measured co-worker safety stewardship, were adopted from the UK Health and Safety Executive (HSE) safety climate survey. Example items are ‘My workmates encourage others to be safe’ and ‘Workmates in my crew sometimes pressure me to work unsafely’ (reverse scored) (HSE, 2002). All items were rated by respondents using a five-point Likert scale ranging from 5 (strongly agree) to 1 (strongly disagree).

Questionnaires were administered during work hours. A member of the research team visited worksites, distributing and collecting the surveys in person. Respondents were advised that completion of the questionnaire was voluntary and confidentiality and anonymity were assured.

Data analysis

The structure of the data was explored using a principal components analysis with varimax rotation. 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 a one way analysis of variance (ANOVA). Within-group homogeneity of safety climate perceptions was examined by calculating the intra rater agreement (IRA). The IRA is used to measure the interchangeability or the absolute consensus in scores between members. It estimates whether responses from one participant are ‘similar’ to the responses provided by others in the same workgroup, thus relating to the degree of ‘sharedness’ in group climate scores (James *et al.* 1993; LeBreton and Senter,2008).

According to this test, within-group consensus (i.e. an acceptable level of consistency between the safety climate perceptions of different employees within the same group) is deemed to exist if $r_{wg(j)} \geqslant 70$. To adequately reflect team dynamics and protect participants' anonymity, crews with fewer than three members were excluded from the workgroup safety climate analysis.

Results

The road administration sample

One hundred and one completed surveys were returned from the road administration organization, representing a response rate of 63%. Of these, 30 respondents were supervisors, while the remaining 71 were non-supervisory workers. Twenty-two different workgroups were represented in the sample. The minimum workgroup size was one and the maximum workgroup size was seven. The mean workgroup size was four (standard deviation = 1.3). Seven workgroups were eliminated from the analysis because they had fewer than three members, leaving a total of 15 workgroups. Less than 3% of data were missing and missing values were replaced by the item mean.

Principal components analysis (PCA)

Unfortunately the results of the initial unforced principal components analysis were not easily interpretable for the road administration organization dataset. No clear factor structure emerged and there was a high degree of ‘splintering’. An unforced PCA with varimax rotation yielded nine principal components, with fewer than three items loading on several of these components.

Splintering is a problem associated with small samples in principal components or factor analysis. This occurs when factors split into smaller groupings of items that really constitute a larger factor, yielding misleading results that do not reflect the true ‘structure’ of the data. Research has shown only 10% of samples with very small subject-to-item ratios (2:1) produce correct factor structures (Costello and Osborne, 2005). In the road administration organization the subject-to-item ratio of 2:1 did not satisfy the recommended minimum of 5:1 with a minimum of 100 respondents (Lingard and Rowlinson, 2006).

Prior to collecting data in the road administration authority, the group safety climate questionnaire was tested in a national defence logistics organization. Owing to the size of the workforce at the defence logistics organization, the sample size of this pilot study was considerably larger (N = 423), yielding a subject-to-item ratio greater than 9:1. The PCA in this analysis yielded a strong three-factor factor structure with consistently high item communalities, factors exhibiting high loadings on a substantial number of items (at least three or four) and a small number of easily interpretable factors (Guadagnoli and Velicer, 1988). The rotated component matrix for the pilot study data is shown in Table 1.

Survey items	**Component**		
	Co-workers' ideal safety	**Supervisory safety leadership**	**Co-workers' actual safety**
Workers should assist each other with tasks to ensure safety (Burt et al., 2008)	0.751	0.055	0.113
Safety comes from worker cooperation (Burt et al., 2008)	0.739	0.047	0.074
Supervisors should be notified of hazards (Burt et al., 2008)	0.733	0.031	0.088
Co-workers should be warned when their actions are unsafe (Burt et al., 2008)	0.727	0.083	0.1
Workers should assist each other with tasks to ensure safety (Burt et al., 2008)	0.751	0.055	0.113
Safety depends on everyone following safety procedures (Burt et al., 2008)	0.708	0.092	0.103
Co-workers should discuss changes that could improve safety (Burt et al., 2008)	0.707	0.132	0.086
Supporting co-workers ensures everyone's safety (Burt et al., 2008)	0.704	0.097	0.144
Accidents should be reported to management (Burt et al., 2008)	0.702	0.021	0.048
Co-workers should discuss near misses (Burt et al., 2008)	0.648	0.092	0.075
Workers should avoid creating hazards for co-workers (Burt et al., 2008)	0.641	0.053	0.039
Co-workers' limitations should be recognized (Burt et al., 2008)	0.639	−0.038	0.000
Workers should point out hazards to co-workers (Burt et al., 2008)	0.639	0.087	0.105
Near misses should be reported to management (Burt et al., 2008)	0.561	0.107	0.030
Workers should immediately remove hazards if possible (Burt et al., 2008)	0.546	0.072	0.180
Co-workers should give each other informal safety instruction (Burt et al., 2008)	0.506	0.120	0.017
A worker should never be too busy to help a co-worker (Burt et al., 2008)	0.479	−0.032	0.165
Co-workers should discuss past accidents (Burt et al., 2008)	0.301	.097	0.012
Workers should lend tools to ensure safety (Burt et al., 2008)	0.279	0.018	0.151
What co-workers do on the job is their business (R) (Burt et al., 2008)	0.271	0.209	0.195
A worker's responsibilities are confined to their job (R) (Burt et al., 2008)	0.188	0.140	-0.054
As long as work remains on schedule, my supervisor doesn't care how this has been achieved (R) (Zohar, 2000)	0.049	0.801	0.130
As long as there is no accident, my supervisor doesn't care how work is done (R) (Zohar, 2000)	0.045	0.748	0.087
My supervisor seriously considers any worker's suggestions for improving safety (Zohar, 2000)	0.169	0.683	0.252
Whenever pressure builds up, my supervisor wants us to work faster, rather than by the safe work procedures (R) (Zohar, 2000)	0.092	0.680	0.121
My supervisor approaches workers during work to discuss safety issues (Zohar, 2000)	0.050	0.661	0.226

My immediate supervisor often talks to me about health and safety (Zohar, 2000)	0.098	0.652	0.230
My supervisor pays less attention to safety issues than most other supervisors in this company (R) (Zohar, 2000)	0.159	0.638	0.099
My supervisor says a good word whenever he sees a job done according to the safe work procedures (Zohar, 2000)	0.186	0.612	0.203
My supervisor only keeps track of major safety problems and overlooks routine problems (R) (Zohar, 2000)	0.060	0.587	0.137
My supervisor gets annoyed with any worker ignoring safety procedures, even minor safety procedures (Zohar, 2000)	0.166	0.520	0.275
<u>Sometimes physical conditions at the workplace restrict people's ability to work safely (R) (HSE, 2002)</u>	<u>−0.213</u>	<u>0.337</u>	<u>0.215</u>
All people who work in my team are fully committed to health and safety (HSE, 2002)	0.037	0.092	0.761
I trust my workmates with my safety (HSE, 2002)	0.126	0.143	0.745
People here always work safely even when they are not being supervised (HSE, 2002)	0.095	0.108	0.727
I can trust most people in my team to work safely (HSE, 2002)	0.115	0.125	0.700
My workmates encourage others to be safe (HSE, 2002)	0.187	0.212	0.636
My workmates would react strongly against people who break health and safety procedures (HSE, 2002)	0.091	0.174	0.587
Some of my workgroup pay little attention to health and safety (R) (HSE, 2002)	−0.020	0.303	0.569
People in my workgroup refuse to do work if they feel the task is unsafe (HSE, 2002)	0.131	0.175	0.558
It is important for me to work safely if I am to keep the respect of the others in my team (HSE, 2002)	0.312	0.077	0.538
<u>People here think health and safety is not their problem – its up to management and others (R) (HSE, 2002)</u>	<u>0.008</u>	<u>0.301</u>	<u>0.452</u>
<u>Workmates in my team sometimes pressure me to work unsafely (R) (HSE, 2002)</u>	<u>0.009</u>	<u>0.325</u>	<u>0.421</u>
<u>My supervisor comments more often when a worker has not followed a safety procedure (Zohar, 2000)</u>	<u>0.171</u>	<u>0.193</u>	<u>0.235</u>

*Notes:*R denotes reverse scored items underlined items failed to load sufficiently highly on the relevant factor (loading <0.5).

Table 1. Rotated PCA matrix from the pilot survey showing item loadings for the three group-level safety climate factors

In the pilot study, Zohar's group safety climate scale yielded one distinct factor, relating to perceptions of supervisors' safety leadership and two distinct factors relating to co-workers' safety stewardship. Examination of the items loading on these two factors revealed that items loading on the factor labelled ‘co-workers' ideal safety’ were those adopted from the CARE scale developed by Burt e*t al.*(1998). These items reflect perceptions of how co-workers *should* behave in an ideal situation. Items loading on the factor labelled ‘co-workers' actual safety’ were those adopted from the HSE safety climate survey (HSE, 2002). Examination of these items revealed that they reflect how co-workers *actually* behave.

The logistics organization and road administration organization have similar workforce profiles, i.e. both organizations have predominantly male, blue collar workers and undertake work within small workgroups in regional areas of Australia. Given these similarities, the road administration organization data were re-examined to force a three-factor solution in an attempt to replicate the factor structure derived from the pilot study. The rotated component matrix for this forced solution is shown in Table 2.

Table 2. Rotated PCA matrix from the road administration sample showing item loadings for the three group-level safety climate factors

Survey items	Component		
	Co-workers' ideal safety	Co-workers actual safety	Supervisory Safety Leadership
Workers should assist each other with tasks to ensure safety (Burt et al., 2008)	0.798	0.004	−0.023
Co-workers should be warned when their actions are unsafe (Burt et al., 2008)	0.760	−0.020	0.113
Workers should point out hazards to co-workers (Burt et al., 2008)	0.726	0.188	−0.145
Safety comes from worker cooperation (Burt et al., 2008)	0.707	−0.049	0.207
All workers should understand emergency procedures (Burt et al., 2008)	0.691	0.250	0.123
Supervisors should be notified of hazards (Burt et al., 2008)	0.678	−0.083	0.117
Co-workers should discuss near misses (Burt et al., 2008)	0.672	−0.006	0.223
Accidents should be reported to management (Burt et al ., 2008)	0.666	−0.037	0.147
Workers should avoid creating hazards for co-workers (Burt et al., 2008)	0.638	0.189	−0.133
Co-workers should discuss changes that could improve safety (Burt et al., 2008)	0.636	−0.160	0.079
Safety depends on everyone following safety procedures (Burt et al., 2008)	0.633	0.194	−0.095
Co-workers' limitations should be recognized (Burt et al ., 2008)	0.629	−0.199	0.205
Workers should immediately remove hazards if possible (Burt et al., 2008)	0.595	0.323	−0.309
A worker should never be too busy to help a co-worker (Burt et al., 2008)	0.505	−0.271	0.216
What co-workers do on the job is their business (R) (Burt et al., 2008)	0.459	0.015	0.121
Near misses should be reported to management (Burt et al., 2008)	0.381	0.116	0.253
A worker's responsibilities are confined to their job (R) (Burt et al., 2008)	0.345	−0.034	0.054
Workers should lend tools to ensure safety (Burt et al., 2008)	0.331	0.014	0.226
Co-workers should discuss past accidents (Burt et al., 2008)	0.242	−0.129	0.137
All people who work in my team are fully committed to health and safety (HSE, 2002)	−0.222	0.711	0.318
People here always work safely even when they are not being supervised (HSE, 2002)	−0.256	0.664	0.112
People in my workgroup refuse to do work if they feel the task is unsafe (HSE, 2002)	0.103	0.658	−0.040
Some of my workgroup pay little attention to health and safety (R) (HSE, 2002)	−0.200	0.653	0.376
I trust my workmates with my safety (HSE, 2002)	−0.253	0.638	0.101
It is important for me to work safely if I am to keep the respect of the others in my team (HSE, 2002)	0.251	0.620	−0.046
People here think health and safety is not their problem—it's up to management and others (R) (HSE, 2002)	−0.061	0.620	0.171
My workmates encourage others to be safe (HSE, 2002)	0.124	0.617	0.260
I can trust most people in my team to work safely (HSE, 2002)	−0.045	0.479	−0.003
My workmates would react strongly against people who break health and safety procedures (HSE, 2002)	0.034	0.463	0.083

My supervisor gets annoyed with any worker ignoring safety procedures, even minor safety procedures (Zohar, 2000)	0.348	0.390	0.307
My supervisor comments more often when a worker has not followed a safety procedure (Zohar, 2000)	0.230	0.359	−0.213
Sometimes physical conditions at the workplace restrict people's ability to work safely (R) (HSE, 2002)	−0.011	0.358	0.326
My supervisor seriously considers any worker's suggestions for improving safety (Zohar, 2000)	0.079	0.185	0.163
My immediate supervisor often talks to me about health and safety (Zohar, 2000)	0.046	0.145	0.696
Whenever pressure builds up, my supervisor wants us to work faster, rather than by the safe work procedures (R) (Zohar, 2000)	0.143	−0.040	0.687
My supervisor approaches workers during work to discuss safety issues (Zohar, 2000)	0.025	0.248	0.669
Workmates in my team sometimes pressure me to work unsafely (R) (HSE, 2002)	−0.141	0.395	0.649
My supervisor says a good word whenever he sees a job done according to the safe work procedures (Zohar, 2000)	−0.012	0.065	0.627
As long as work remains on schedule, my supervisor doesn't care how this has been achieved (R) (Zohar, 2000)	0.114	0.182	0.584
As long as there is no accident, my supervisor doesn't care how work is done (R) (Zohar, 2000)	0.233	0.143	0.574
My supervisor seriously considers any worker's suggestions for improving safety (Zohar, 2000)	0.195	0.114	0.573
Supporting co-workers ensures everyone's safety (Burt et al., 2008)	0.430	−0.096	0.457
Co-workers should give each other informal safety instruction (Burt et al., 2008)	0.357	−0.118	0.445
My supervisor pays less attention to safety issues than most other supervisors in this company (R) (Zohar, 2000)	0.180	0.173	0.407

*Notes:*R denotes reverse scored items. Underlined items failed to load sufficiently highly on the relevant factor (loading <0.5).Items shown in bold are items for which factor loadings were consistent with the pilot survey data.

Items loaded clearly and consistently, with minimal double loading. There was a high level of consistency between the road administration sample and the logistics sample in terms of the factors upon which items loaded. Items loading on the same factors in both the pilot and the road administration organization survey are shown in bold in Table 2. Consistency was found for 14 of the items taken from the CARE scale, 8 of the items taken from the HSE survey and 7 of the items from Zohar's group safety climate scale. With the exception of one item, ‘Workmates in my team sometimes pressure me to work unsafely’, all items yielding significant factor loadings in the road administration sample loaded on the same factor as they did in the pilot study. Given the inadequate subject-to-item ratio in the road administration sample, a small number of ‘rogue’ items could be expected. The high degree of consistency with the large sample pilot data suggests a good degree of ‘replicability’ of the group safety climate factor structure and generalizability from the logistics organization to construction organizations. The internal consistency of the three group safety climate factors that emerged clearly in the pilot study PCA was also examined for the road administration data. The internal consistency reliability for the three group safety climate dimensions are presented in Table 3. All of the group safety climate dimensions arising from the pilot study PCA possessed acceptable internal consistency reliability in the road administration organization, lending further support to the validity of a three-factor solution.

Table 3. Internal consistency reliability for group safety climate dimensions in the logistics and road administration organizations

	Logistics organization (pilot study) α	Road administration organization (construction sample) α
Factor 1: Supervisor safety leadership	0.882	0.836
Factor 2: Co-workers' actual safety	0.854	0.834
Factor 3: Co-workers' ideal safety	0.918	0.883

Within-group homogeneity

The IRA scores were calculated for each of the group safety climate dimensions according to a procedure described by James *et al.* (1993). The threshold value for $r_{wg(j)}$ required to establish within-group homogeneity is 0.70. Assuming a null distribution the $r_{wg(j)}$ was above this threshold value for all three dimensions of group safety climate. For ‘co-workers' actual safety’ and ‘co-workers' ideal safety’ the $r_{wg(j)}$scores were 0.95 and 0.98 respectively. ‘Supervisory safety leadership’ also revealed an acceptably high level of within-group homogeneity, with a $r_{wg(j)}$ score of 0.97.

Between-group differences

One way analyses of variance (ANOVAs) were conducted to test for between-group differences in perceptions of group safety climate within the road administration organization. Figure 2 shows the mean scores for the ‘supervisory safety leadership’ dimension for the 15 workgroups included in the analysis. The ANOVA revealed statistically significant between-group differences in workers' perceptions of ‘supervisory safety leadership’ (F = 2.41, p = 0.012).

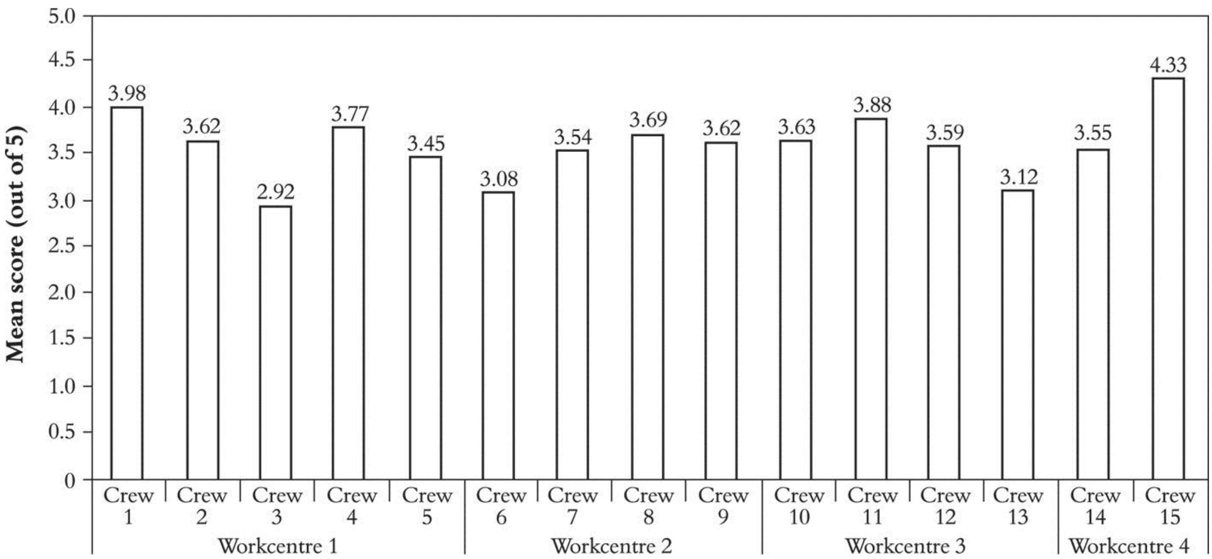

Figure 2: Group-level variation in perceptions of supervisors' safety leadership

Figure 3 shows the mean scores for the ‘co-workers' ideal safety’ dimension for the 15 workgroups included in the analysis. The ANOVA revealed no significant between-group differences for this dimension of group safety climate.

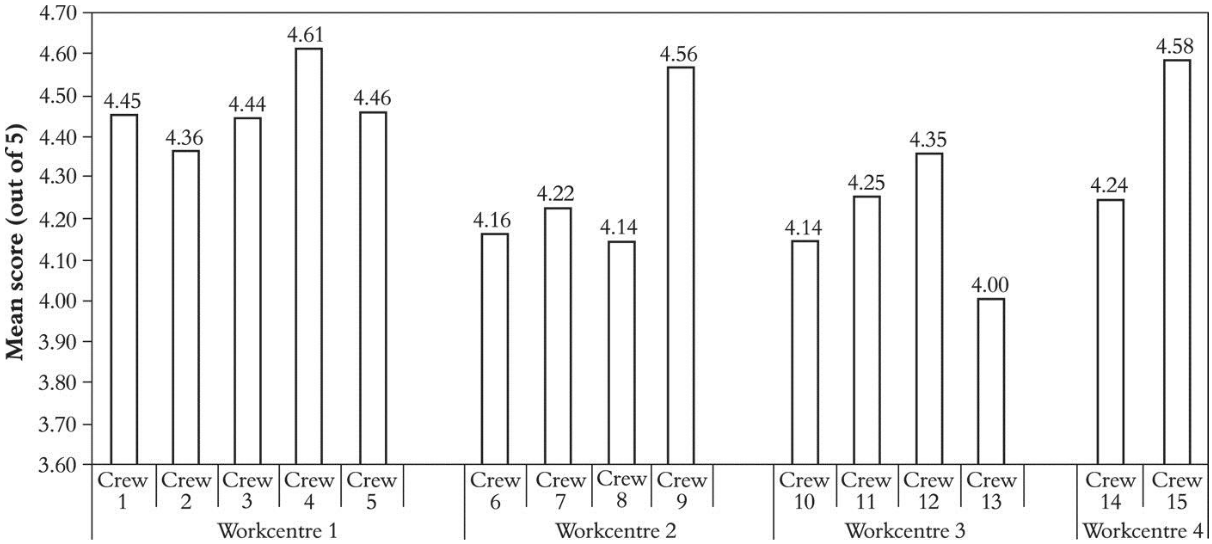

Figure 3: Group-level variation in perceptions of co-workers' ideal safety behaviour

Figure 4 shows the mean scores for the ‘co-workers' actual safety’ dimension for the 15 workgroups included in the analysis. The ANOVA revealed statistically significant between-group differences in workers' perceptions of ‘co-workers' actual safety’ (F = 3.09, $p = 0.002$).

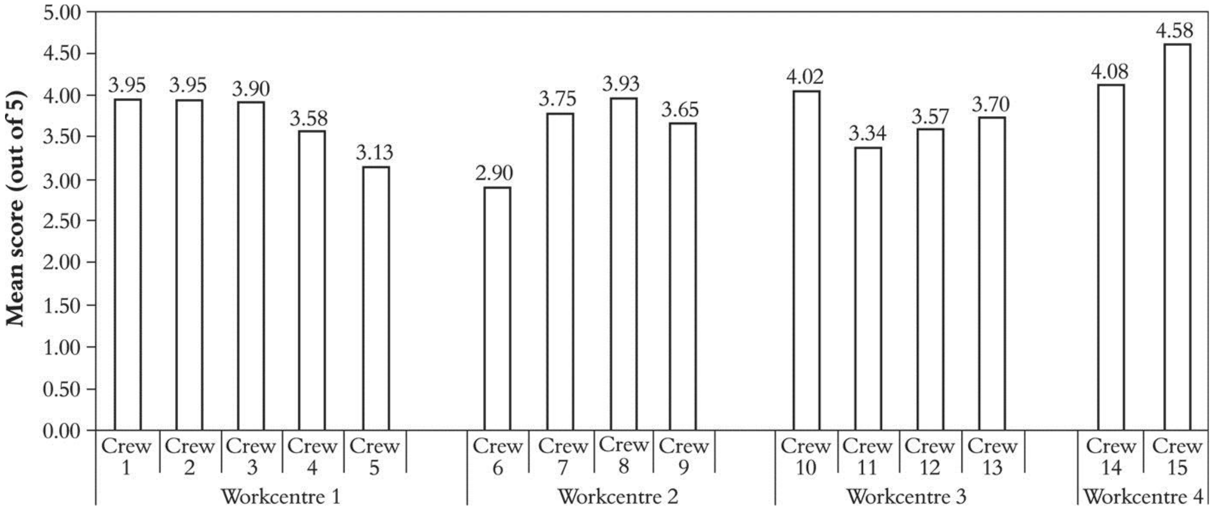

Figure 4: Group-level variation in perceptions of co-workers' actual safety behaviour

Finally, an exploratory bivariate correlation analysis was undertaken to test whether the size of a workgroup (in terms of the number of members) was significantly correlated with any of the dimensions of group-level safety climate. No *a priori* hypotheses informed this analysis, which revealed a significant negative relationship between perceptions of ‘co-workers' actual safety’ and the number of members within a workgroup ($r = -0.252$, $p = 0.043$). Thus, as the size of a workgroup increases, perceptions of ‘co-workers' actual safety’ become less positive.

Discussion

The existence of group safety climates

All three group-level safety climate dimensions indicated high levels of within-group homogeneity, indicating that members of the same workgroup shared consistent perceptions of ‘supervisory safety leadership’, ‘co-workers' actual safety’ and ‘co-workers' ideal safety’ behaviour. However, the analyses of variance revealed significant between-group differences in perceptions of ‘supervisory safety leadership’ and ‘co-workers' actual safety behaviour’. No significant between-group difference was found for perceptions of ‘co-workers ideal safety behaviour.’ Members of different workgroups shared a consistent view about the ideal safety behaviours of co-workers, i.e. what co-workers *should do* to support the safety of others in their workgroup, but significant between-group differences exist in perceptions of the actual safety behaviours demonstrated by co-workers. In all instances, perceptions of co-workers' ideal OHS behaviour were higher than perceptions of co-workers' actual OHS behaviour and, in some groups, this ‘gap’ between ideal and actual was more exaggerated than in others. Interestingly, perceptions of co-workers' ideal and actual safety behaviours were negatively correlated, albeit very weakly, in the road administration organization. This indicates that workers discriminate between perceptions of how co-workers should behave and perceptions of their actual behaviour.

The conditions established by Zohar for group-level safety climate were satisfied for two of the three group safety climate dimensions measured. Workers within the road administration organization indicated consistent perceptions of their supervisors' safety leadership behaviour and their co-workers' actual safety behaviour and the perceptions of these two aspects of safety climate vary significantly between workgroups within the organization. This finding has important implications for research and practice.

Implications for practice

This finding has significant implications for OHS management because it suggests that the role played by supervisors is likely to have a significant impact upon safety climate, over and above the impact of top managers who define organizational safety policy and safety managers who develop corporate OHS procedures. This is consistent with findings of Simard and Marchand (1994; 1995; 1997) who report that senior management actions did have a positive effect on employees' OHS behaviours but that this effect was an *indirect* one. Macro-level factors positively influenced employees' OHS behaviour, but this relationship occurred *through* supervisors' adoption of participative safety management approaches within workgroups. Zohar (2000) reported that workgroup safety climate scores predicted the safety performance of workgroups in the months following the climate assessment, i.e. those workgroups with more positive safety climates subsequently experience fewer incidents.

The strength and quality (i.e. supportive or unsupportive of safety) of group-level climates is reported to influence workgroups' safety performance through shaping members' safety behaviour (Zohar, 2002). The existence of variation between workgroup safety climate (driven by supervisors' and co-workers' actual behaviour) can therefore support or undermine organizational safety management efforts. Strategies to develop supervisors' and co-workers' safety leadership behaviour, to foster strong and supportive group safety climates and promote consistency in the safety climates between workgroups within an organization can contribute to better organizational performance in safety and help to bridge the gap between organizational OHS policy statements and safety-relevant practice (Zohar, 2002; Zohar and Luria, 2004).

Implications for research

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. The findings highlight the importance of clearly specifying the unit of analysis of theoretical interest in safety climate research. Safety climate researchers have often incorporated co-worker safety stewardship and supervisory safety leadership in their survey design. For example, Lu and Shang (2005) incorporate both perceptions of co-worker safety and perceptions of supervisors' safety leadership in a safety climate survey of container terminal operators in Taiwan. However, these researchers have aggregated these scores to the level of the entire organization. With regard to supervisory and co-worker facets of safety climate, the workgroup is a more appropriate unit of analysis. In large and complex organizations, it is expected that employees develop shared perceptions of co-worker safety stewardship and supervisory safety leadership. Attempts to aggregate scores for these dimensions at the organization level are likely to mask important between-group differences.

The significance of group-level safety climates is likely to be particularly significant when work teams enjoy a high level of autonomy and work is decentralized and non-routine, as in the construction industry. Given the characteristics of construction work, which is undertaken within small workgroups, and in which members exercise considerable discretion in the interpretation of organizational safety policy and procedures, the role of first level supervisors and co-workers in shaping group-level safety climates is likely to be significant.

Future safety climate research in the construction industry should ensure that climate dimensions of interest are analysed at the appropriate organizational level.

Size of workgroup

The significant negative correlation between perceptions of co-workers' actual safety and workgroup size is noteworthy. Burt *et al.* (2008) suggest that the acquisition of knowledge about co-workers and the development of friendships and social relationships between members of a workgroup will increase the extent to which co-workers develop considerate and responsible attitudes. They attribute this to the ‘bystander apathy effect’ which describes a tendency not to help strangers in difficulty. Drawing on a study of construction and forestry workers, Burt *et al.* (2008) cite evidence to support their hypothesis. There is some evidence from construction researchers that smaller workgroups, in which workers enjoy good social relationships, demonstrate better safety performance (Hinze,1981). In a recent study by Zohar and Tenne-Gazit (2008), the density of friendship networks (i.e. the volume of non-work-related interactions between workgroup members) was a direct predictor of group safety climate strength. In large workgroups, the opportunities for acquiring knowledge about one's co-workers, developing friendships and for non-work-related interactions are likely to be lower than in smaller workgroups which perhaps explains the negative correlation between group size and perceptions of co-workers' actual safety. The influence of workgroup size and within-group social interactions should be incorporated into future group-level safety climate studies in construction.

Conclusions

The results of the research support the existence of group-level safety climates within the Australian construction industry. First, the results have shown that workgroup members develop uniform perceptions concerning safety within their own teams; and second, these perceptions vary between workgroups, resulting in significantly different safety climate perceptions between members of different workgroups (i.e. between-group variance). The existence of distinct workgroup safety climates provides a theoretical explanation for why some organizational workgroups consistently perform better in OHS than others (despite having very similar risk exposures), and suggests that interventions designed to develop strong and positive group-level safety climates could benefit the Australian construction industry.

Limitations and future research

Limitations inherent in the research include the fact that the factor structure derived in the pilot study was not replicated in an unforced analysis of the road administration organization data and had to be assumed on the basis of workforce similarities and satisfactory structure of a forced three-factor solution and high level of internal consistency reliability scores for the group safety climate dimensions in both samples. ‘Borrowing’ the factor structure derived from the pilot study data is not ideal but can be justified on the grounds that there exist key points of similarity in the characteristics and work circumstances of respondents in the pilot study and those in the construction sample. The high level of consistency between factor loadings in the pilot and road administration surveys and the acceptable internal consistency reliability of the factors in each dataset suggest that the three-factor solution can be generalized from the logistics organization to the construction sample. However, the research is ongoing with other construction organizations to examine the extent to which the group safety climate factor structure can be replicated in larger construction samples to provide more robust evidence for the generalizability of a three-factor group safety climate model.

The research was undertaken in regional Australia and thus the findings cannot be generalized to international settings. However, the results illustrate the importance of specifying one or more organizational levels as the unit of analysis in safety climate research and it is recommended that attempts are made to test for group-level safety climate in the construction industries of other countries. The research was also limited in the ability to determine whether group safety climate was linked to group safety performance. No objective OHS performance data were available within the road administration organization at a workgroup level. Data were only available at the level of work centre which prevented a fine-grained analysis of the link between group safety climate and performance. Research is ongoing in this organization and with two private sector contracting organizations. This research adopts a longitudinal design and involves the collection of prospective OHS performance data at a workgroup level.

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