Coworkers' response to occupational health and safety: An overlooked dimension of group-level safety climate in the construction industry?

Lingard, Helen; Cooke, Tracy; Blismas, Nick

https://researchrepository.rmit.edu.au/esploro/outputs/9921858051401341/filesAndLinks?institution=61RMIT_INST&index=null

Lingard, H., Cooke, T., & Blismas, N. (2011). Coworkers' response to occupational health and safety: An overlooked dimension of group-level safety climate in the construction industry? *Engineering Construction and Architectural Management*, 18(2), 159–175.

<https://doi.org/10.1108/09699981111111139>

Document Version: Accepted Manuscript

Published Version: <https://doi.org/10.1108/09699981111111139>

Repository homepage: <https://researchrepository.rmit.edu.au>

© Emerald Group Publishing Limited

Downloaded On 2023/04/26 20:52:08 +1000

Thank you for downloading this document from the RMIT Research Repository.

The RMIT Research Repository is an open access database showcasing the research outputs of RMIT University researchers.

RMIT Research Repository: <http://researchbank.rmit.edu.au/>

Citation:

Lingard, H, Cooke, T and Blismas, N 2011, 'Coworkers' response to occupational health and safety: An overlooked dimension of group-level safety climate in the construction industry?', *Engineering Construction and Architectural Management*, vol. 18, no. 2, pp. 159-175.

See this record in the RMIT Research Repository at:

<https://researchbank.rmit.edu.au/view/rmit:12371>

Version: Accepted Manuscript

Copyright Statement:

© Emerald Group Publishing Limited

Link to Published Version:

<http://dx.doi.org/10.1108/09699981111111139>

PLEASE DO NOT REMOVE THIS PAGE

Coworkers' response to occupational health and safety: An overlooked dimension of group-level safety climate in the construction industry?

Helen Lingard, Tracy Cooke and Nick Blismas

School of Property, Construction and Project Management, RMIT University, Melbourne, Australia

Abstract

Purpose – The paper's aim is to document a survey of Australian construction workers that was conducted to examine whether conditions of within-group homogeneity and between-group heterogeneity in perceptions of coworkers' safety response were satisfied. The factor structure of coworkers' safety response is to be explored and the relationship between workgroup members' perceptions of their coworkers' safety response and the workgroups' injury rate is to be examined in three organizations.

Design/methodology/approach – A safety climate survey was conducted within three organizations. Retrospective and prospective workgroup injury data were collected from company records. The factor structure of coworkers' safety response was analysed using principal components analysis (PCA). Within-group homogeneity and between-group heterogeneity were examined using inter-rater agreement and analyses of variance respectively. Bivariate correlations were used to explore linkages between perceptions of coworkers' safety response and workgroup injury rates.

Findings – Two distinct factors were indicated by the PCA were labeled "Coworkers' actual safety response" and "Coworkers' ideal safety response". "Coworkers' actual safety response" demonstrated significant between-group variance and within-group consensus in two of the three organizations. No significant between-group variation was found for 'Coworkers' ideal safety response'. Neither aspect of coworkers' safety response was consistently significantly correlated with workgroup injury rate.

Research limitations/implications – Further research should examine the relationship between coworkers' safety response and workgroup safety performance using measures other than reportable injury rates.

Practical implications – The confirmation that "Coworkers' actual safety response" is a facet of group safety climate suggests that interventions to develop coworkers' support for safety within workgroups may be helpful. In particular, strategies to speed up the process of assimilation into workgroups through induction and teambuilding exercises should be evaluated.

Originality/value – The study builds on previous research examining group safety climate in construction, providing further evidence that coworkers' safety response items should be included along with supervisors' safety response items in the measurement of group safety climate. The findings suggest important directions for future empirical evaluation of the impact of coworkers' response on workgroup safety climate and performance in the construction industry.

Keywords Australia, Teambuilding, Construction industry, Performance management

Introduction

Safety climate

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 believed to shape workers’ behaviour through the expectations they form about how organizations value and reward safety (Zohar and Luria, 2005). A great deal of interest has been given to the extent to which safety climate predicts safety performance within organizations (Cooper and Phillips, 2004). There is considerable evidence that strong and positive safety climates are linked to higher levels of safety performance. For example, Tharaldsen et al. (2008) report a significant inverse correlation between safety climate perceptions and accident rates in the offshore industry, while Mearns et al. (2003) showed that offshore installations returning a lower proportion of self-reported accidents were characterized by more favourable safety climates. Varonen and Mattila (2000) report safety climate to be inversely correlated with the accident rate in wood processing companies and, in the Australian health sector, Neal and Griffin (2006) report that safety climate measured at one point in time positively predicted subsequent safety motivation and self-reported safety-related behaviour (Neal and Griffin, 2006). Clarke (2006) conducted a comprehensive meta-analysis of safety climate research and reports a consistent positive link between safety climate and safety performance in prospective studies (i.e. those in which safety performance was monitored after the measurement of safety climate was undertaken). 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).

Safety climate in construction

The safety climate concept has been examined in the construction industry (Dedobbeleer and Be´land, 1991). Consistent with research in other industries, there is empirical evidence to support a positive link between safety climate and the safety performance of construction organizations (Gillen et al., 2002). In Hong Kong, Siu et al. (2004) measured how construction workers perceived the safety responses of themselves, their colleagues, management, company safety officers and their supervisors, reporting that aggregated safety climate scores were directly related to self-reported injury rate. Also in Hong Kong, Zhou et al. (2008) report that two climate dimensions (management commitment and workmates’ influence) exerted 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 significantly predicted self-reported safety behaviours seven months later (after controlling for safety behaviour at time one).

Group-level safety climates

The majority of safety climate studies have focused on the organization as the unit of analysis. However, in large and complex 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.
- (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 (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. In support of this, Johnson (2007) revealed that perceptions of supervisors' safety actions predicted safety behaviour and the occurrence of incidents in the manufacturing sector.

Arguably, the GSC should be a stronger predictor of safety performance than organization level safety climate, especially in large organizations, because most workers have little contact with senior management and are more likely to be influenced on a day-to-day basis by the local GSC. The strength of group-level influences on safety was highlighted by a study of the influence of macro-(organizational) and micro-(group level) factors on workers' safety performance conducted by Simard and Marchand (1994). In this research, supervisory practices were reported to be the strongest predictor of workgroups' propensity to take safety initiatives (Simard and Marchand, 1995) and to comply with safety rules (Simard and Marchand, 1997). The effect of workgroup and supervisory practices were considerably higher than macro-(organizational) factors, such as top management commitment or the appointment of a full-time company safety professional. Further, Simard and Marchand (1995) found that these macro-(organization-level) factors did influence workers' safety behaviour but this effect was indirect, mediated by group-level safety factors. This is consistent with the assertion of Christian et al. (2009) that proximal antecedents of safety performance will have a stronger influence than distal antecedents.

Group level safety climate in construction

Lingard et al. (2009) recently tested Zohar's GSC scale, which measures supervisory actions and expectations concerning safety, in the Australian construction context. They report significant between-group variance and within-group homogeneity, i.e. the two criteria established by Zohar (2002) as requisite indicators of group-level climate were satisfied. Consistent with the view that group level safety climate is a stronger, more proximal predictor of safety performance than organizational safety climate, GSC has also been found

to mediate the relationship between organizational safety climate and subcontractors' injury frequency rates in the Australian construction industry (Lingard et al., n.d.).

Coworkers' safety response

Much safety climate research has measured perceptions of the safety response of persons in possession of formal power within the organization who have a defined responsibility for others (such as senior managers and supervisors). For example, the most widely used group level safety climate scale contains items relating to supervisors' expectations and actions (Zohar, 2000). However, those without formal power can also substantially influence organizational climates and group norms.

Chiaburu and Harrison (2008) suggest that it is through exchanges with coworkers that individuals develop clear beliefs about what is expected of them, i.e. what they should and should not do in their work role. Drawing on the work of Latane' (1981), Tucker et al. (2008) suggest that social impact is a function of the strength, proximity and number of sources of influence. Although supervisors and managers have formal power (i.e. strength of influence), coworkers arguably have a greater ability to influence, as they are perceived to be work task "experts". Also, coworkers are closer in proximity to other workers and relatively larger in number than managers and supervisors. All these factors combine to make coworkers an important source of influence. Coworkers also provide feedback and advice about appropriate behaviour when there is tension between different job-role requirements, such as productivity and safety. In a comprehensive meta-analysis, Chiaburu and Harrison (2008) report that coworkers' exert a unique influence on workgroup outcomes, over and above the influence of the group supervisor.

Burt et al. (2008) suggest that variation in workers caring about their coworkers' safety should be treated as a separate facet of safety climate. There is considerable empirical evidence to suggest that coworkers influence safety within workgroups. For example, Hofmann and Stetzer (1996) report that coworkers' willingness to approach a group member engaged in unsafe behaviour was a critical linking mechanism through which group processes predicted safety behaviour. More recently, Breslin et al. (2007) report that young workers in male dominated industries do not express their concerns about health and safety risks in order to appear mature to their older coworkers.

Similarly, Tucker et al. (2008) found that bus drivers' willingness to voice safety concerns was dependent on the extent to which the organization was perceived to be supportive of safety, but that perceptions of coworkers' support for safety fully mediated this relationship. Westaby and Lowe (2005) report coworkers' tolerance for risk-taking to be a significant predictor of risk-taking orientation among workers across a wide cross section of jobs. Further, coworker risk-taking is reported to be a stronger predictor of workers' personal risk-taking orientation than supervisory influence (Westaby and Lowe, 2005).

In construction there is likely to be a particularly weak connection between persons with formal power and the workforce due to the multi-tiered subcontracting system and prevalence of semi-autonomous workgroups. In this context, the influence of coworkers relative to incumbents of positions of formal authority is likely to be strong. Previous safety climate studies have highlighted the importance of coworkers' safety response. For example, in a study by Melia et al. (2008), construction workers' perceptions of their coworkers' safety actions and attitudes significantly predicted their own self-reported safety responses. Although the safety attitudes survey used by Siu et al. (2004) contained 11 items measuring colleagues' safety attitudes, these were combined with 22 items measuring the safety attitudes of managers, supervisors, workers themselves and others to create an aggregate safety attitude score, which was negatively correlated with occupational injuries. Consequently, it is impossible to ascertain whether coworkers' safety attitudes had any unique influence in this study. The safety climate survey deployed by Zhou et al. (2008) included three items measuring "workmates' influences". They report that 4.7 per cent of a large sample of Hong Kong construction workers indicated that their workmates have a negative influence on safety behaviour, compared to 46.0 per cent who indicated their workmates have a positive influence. Using Bayesian analysis, Zhou et al. (2008) conclude that workers' safety behaviour is more sensitive to influence by workmates than by other personal characteristics, such as work experience and education.

Aim

The aim of the research reported in this paper was to examine the role played by coworkers in shaping group-level safety climates in the Australian construction context. Specifically, the research objectives were to:

- (1) examine the factor structure of a coworkers' safety response scale;
- (2) test whether the two conditions required to demonstrate the existence of group-level safety climate (i.e. within-group homogeneity and between-group variance) are satisfied with respect to workers' perceptions of their coworkers' safety responses; and
- (3) examine the relationship between perceptions of coworkers' safety response and the safety performance of workgroups in the Australian construction industry.

Research methods

Data collection

The survey was designed to measure coworkers' safety response and utilised questions from two sources. Five items were adopted from Burt et al.'s (1998) considerate and responsible employee (CARE) scale. Example items are "Coworkers should be warned when their

actions are unsafe”, and “Workers should assist each other with tasks to ensure safety”. The remaining ten questions, which also measured coworkers’ safety response, were adopted from the UK Health and Safety Executive Safety Climate Survey (HSE, 2002). Example items are “My workmates encourage others to be safe” and “Some of my team pay little attention to health and safety” (reverse scored). All items were rated by respondents, using a five-point Likert scale, ranging from 5 (strongly agree), to 1 (strongly disagree).

Data collection sites

Data were collected within three organizations operating in the Australian construction industry. Prior to the commencement of data collection, workers were advised that participation was voluntary and that their responses would be anonymous. No inducements were given to participants. Study one was undertaken within the regional construction and maintenance works district of a state-based road construction and maintenance organization in the Southeast of Australia. Four work centres make up the works district. Each work centre consists of a number of work crews. Paper-based questionnaires were administered during work hours. A member of the research team visited worksites within the region to distribute and collect the surveys. Workers not available during the survey administration were invited to complete the questionnaire at a later date.

Completed surveys were placed in self-sealed envelopes and returned directly to the research team, via the regional site safety coordinator. Study two was undertaken at a hospital construction project in Melbourne, Victoria. Surveys were administered using the “TurningPoint” automated response system with “KeyPad” hand-held devices. The use of this system helps to overcome issues of literacy as survey questions are projected onto a screen and read out by the researcher. The response system can be set, so that if a respondent presses an “out of range” value (for example, six), 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 minimisation of human error in data entry (de Quiros et al., 2008). Participants were invited, by the principal contractor’s site safety coordinator to participate in the survey during normal work hours. Surveys were completed in the site office.

Study three was undertaken at the Melbourne operations of a national steel reinforcement manufacturing organization. Data were collected from 16 workgroups across four sites in metropolitan Melbourne. As in study two, surveys were administered using the “TurningPoint” automated response system with “KeyPad” hand-held devices. Workers unable to complete the initial survey were invited to complete a paper-based version of the questionnaire at a later date. Completed surveys were placed in self-sealed envelopes and returned directly to the research team, via the National Manager – Partnering.

Data analysis

To identify the structure of the data, a principal components analysis (PCA) with varimax rotation was initially conducted. The internal consistency reliability of the coworkers' safety response components was then assessed using Cronbach's alpha. The extent to which coworkers' safety response can be considered a facet of group-level safety climate was determined on the basis of two criteria established by Zohar (2000). These are:

- (1) Between-group variance (i.e. whether safety climates differ significantly, between workgroups, within the same organization).
- (2) Within-group homogeneity (i.e. whether workers within a workgroup, share similar perceptions, of the safety climate).

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 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 scores. According to this test, within-group consensus is deemed to exist if $r_{wg(j)} \leq 70$. To adequately reflect team dynamics and protect participants' anonymity, workgroups with less than three workers at the project were excluded from the analysis. Finally, Pearson product moment (bivariate) correlations were performed to explore the relationship between perceptions of coworkers' safety response and workgroup injury rates.

Results

The sample

A total of 307 surveys were received from the three organizations. The breakdown of respondents and workgroups is summarised in Table I. In total, 71 useable responses (23.1 per cent) were received from the state road construction and maintenance organization. A total of 99 (32.2 per cent) useable responses were received from the hospital construction project and 137 (44.6 per cent) of responses were received from the steel reinforcement manufacturing organization.

Organization	Road construction and maintenance organization	Number of workgroups
Road construction and maintenance organization	71	15
Hospital construction project	99	9
National steel reinforcement organization	137	16

Table I. Responses and workgroups by organization

Factor structure of coworkers' safety response

Data from the three studies were combined (n = 307) and subjected to a principal components factor analysis (PCA) with varimax rotation. The decision to combine the data, were based on the need to achieve an acceptable subject-to-item ratio appropriate for PCA. Prior to performing the PCA, the suitability of the data, were assessed. The Kaiser-Meyer-Olkin value was 0.85, exceeding the recommended value of 0.60 and Bartlett's Test of Sphericity reached statistical significance, confirming that it was appropriate to conduct a PCA.

An initial unforced PCA revealed the presence of three factors with eigenvalues exceeding 1, explaining 30.6, 18.5 and 7.4 per cent of the variance respectively. However, an inspection of the scree plot revealed a clear break after the second component. A two-factor structure was further supported by the results of Parallel Analysis (Horn, 1965), which showed only two factors with eigenvalues exceeding the corresponding criterion values for a randomly generated data matrix of the same size (15 X 307). The two-factor solution explained 49.1 per cent of the variance, with factor one contributing 30.6 per cent and factor two contributing 18.5 per cent. Thus, a forced two-factor solution was examined. Table II indicates the factor loadings. All items loaded clearly one or other of the two factors. There was no double loading of items and all item loadings were greater than the threshold value of 0.40. An examination of the wording of these items revealed an interesting conceptual distinction. Items loading on the first component reflected the actual safety response of respondents' coworkers, while items loading on the second component reflected how coworkers should ideally respond in relation to safety. Thus, the factors were labelled "Coworkers' actual safety response" and "Coworkers' ideal safety response" and treated as separate variables in further analysis.

Item	Component 1	Component 2
All people who work in my team are fully committed to health and safety (HSE, 2002)	0.844	-0.047
People here always work safely even when they are not being supervised (HSE, 2002)	0.777	0.016
I trust my workmates with my safety (HSE, 2002)	0.761	0.035
My workmates would react strongly against people who break health and safety procedures (HSE, 2002)	0.684	-0.023
My workmates encourage others to be safe (HSE, 2002)	0.682	0.195
I can trust most people in my team to work safely (HSE, 2002)	0.639	0.153
People in my team refuse to do work if they feel the task is unsafe (HSE, 2002)	0.588	0.198

It is important for me to work safely if I am to keep the respect of the others in my team (HSE, 2002)	0.560	0.266
People here think health and safety is not their problem – it is up to management and others (reverse scored) (HSE, 2002)	0.511	-0.006
Some of my team pay little attention to health and safety (reverse scored) (HSE, 2002)	0.477	-0.212
Workers should assist each other with tasks to ensure safety (Burt et al., 2008)	-0.009	0.813
Safety comes from worker co-operation (Burt et al., 2008)	0.076	0.730
Co-workers should be warned when their actions are unsafe (Burt et al., 2008)	0.045	0.729
Supporting co-workers ensures everyone's safety (Burt et al., 2008)	0.057	0.716
Workers should point out hazards to co-workers (Burt et al., 2008)	0.080	0.710

Table II. Coworkers' safety response item loadings for principal components analysis with varimax rotation

Cronbach's alpha coefficients for "Coworkers' actual safety response" and "Coworkers' ideal safety response" were 0.85 and 0.80 respectively, indicating acceptably high internal consistency reliability.

Study 1: road construction and maintenance organization

Before conducting any group-level analysis, workgroups with fewer than three respondents were removed. As a result, eight responses were eliminated from the road construction and maintenance organization sample, leaving 63 workers, representing 15 different workgroups, i.e. an average number of workers per group of 4.2.

First, one way analyses of variance were performed to ascertain whether there was significant variation in perceptions of coworkers' safety response between workgroups. The analyses of variance indicated significant between-group differences between perceptions of "Coworkers' actual safety response" ($F = 3.093$; $p = 0.002$), shown in Figure 1. No significant between-group difference was found for "Coworkers' ideal safety response" at the road construction and maintenance organization.

Figure 1: Between-group variation in perceptions of coworkers' actual safety response at the road construction and maintenance organization

Second, an assessment of the level of agreement between members of the same workgroup was calculated using the inter-rater agreement (IRA) formula. The results of this analysis are presented in Table III. Within-group agreement is deemed to be acceptably high if $r_{wg(j)} \leq 70$. Assuming a null distribution, a high degree of within-group agreement concerning perceptions of "Coworkers' actual safety response" was found for all 15 workgroups. One workgroup failed to agree on their perceptions of "Coworkers' ideal safety response", with the remaining 14 workgroups displaying high levels of agreement for this factor.

Between-group variation in perceptions of coworkers' actual safety response at the road construction and maintenance organization response" was found for all 15 workgroups. One workgroup failed to agree on their perceptions of "Coworkers' ideal safety response", with the remaining 14 workgroups displaying high levels of agreement for this factor.

Workgroup	Coworkers' ideal safety response	Coworkers' actual safety response
1	0.98	0.96
2	0.89	0.96
3	0.95	0.80
4	0.96	0.90
5	1.00	0.96
6	0.00	0.96
7	0.86	0.79
8	0.92	0.80
9	0.98	0.88
10	0.97	0.96
11	0.93	0.92
12	0.92	0.89
13	0.97	0.95
14	0.96	0.85
15	0.95	0.96

Table III. Inter-rater agreement within workgroups at the road construction and maintenance organization

Study 2: hospital construction project

As all nine workgroups at the hospital project returned more than three responses, no groups were excluded from the group-level analysis at this site. Thus the average number of responses per workgroup was 11.0. Again, one way analyses of variance were performed to ascertain whether there was significant variation in perceptions of coworkers' safety response between workgroups (in this case, subcontractors). The analyses of variance indicated no significant between-group differences in either "Coworkers' ideal safety response" or "Coworkers' actual safety response" at the hospital construction project.

Second, an assessment of the level of agreement between members of the same workgroup was calculated using the inter-rater agreement (IRA) formula. The results of this analysis are presented in Table IV. Assuming a uniform null distribution, a high level of within-group homogeneity was found for "Coworkers' ideal safety response" in all nine subcontracted workgroups. However, in relation to perceptions of "Coworkers' actual safety response", one workgroup (subcontractor 5) returned an IRA score of zero, indicating no group consensus was evident in this workgroup for this dimension of coworker safety response.

Subcontractor	Coworkers' ideal safety response	Coworkers' actual safety response
1	0.92	0.86
2	0.96	0.97
3	0.97	0.93
4	0.97	0.95
5	0.97	0.00
6	0.87	0.86
7	0.85	0.91
8	0.94	0.79
9	0.94	0.82

Table IV. Inter-rater agreement within workgroups at the hospital construction project

Study 3: steel reinforcement manufacturing organization

As all 16 workgroups at the steel reinforcement manufacturing organization returned more than three responses, no groups were excluded from the group-level analysis in this organization. Thus the average number of responses per workgroup was 8.6.

One way analyses of variance were performed to ascertain whether there was significant variation in perceptions of coworkers' safety responses between workgroups. The analyses of variance indicated significant between-group differences in perceptions of "Coworkers' actual safety response" ($F = 1.966$; $p = 0.024$), which is shown in Figure 2. No significant between-group difference was found for "Coworkers' ideal safety response". Second, an assessment of the level of agreement between members of the same workgroup was calculated using the inter-rater agreement (IRA) formula. The results of this analysis are presented in Table V. Assuming a uniform null distribution, a high level of within-group homogeneity was found for "Coworkers' ideal safety response" in all 16 workgroups. However, in relation to "Coworkers' actual safety response" one workgroup (workgroup ten) returned an IRA score below the threshold value of 0.70, indicating a low level of group consensus existed in this workgroup in relation to this dimension of coworkers' safety response.

Figure 2. Between-group variation in perceptions of coworkers' actual safety response at the steel reinforcement manufacturing organization

Workgroup	Coworkers' ideal safety response	Coworkers' actual safety response
1	0.98	0.97
2	0.98	0.97
3	0.99	0.98
4	0.98	0.96

5	0.94	0.79
6	0.97	0.97
7	0.98	0.78
8	0.99	0.92
9	0.98	0.94
10	0.97	0.54
11	0.98	0.92
12	0.98	0.83
13	0.96	0.90
14	0.98	0.95
15	0.97	0.95
16	0.94	0.93

Table V. Inter-rater agreement within workgroups at the steel reinforcement manufacturing organization

Coworkers' safety response and injury frequency rate

Finally, bivariate Pearson product moment correlations were performed to examine the relationships between perceptions of coworkers' safety response and the injury frequency rate of workgroups in the three studies. The results of this analysis are presented in Table VI.

Table VI shows the correlation between coworkers' safety response scores and the combined lost time and medical treatment injury rates for all three organizations. For the road construction and maintenance organization and the hospital construction project both retrospective and prospective injury data are provided. Retrospective data relates to the injury rate for a period of 12 months prior to the survey. Prospective data relates to the injury rate for a period after the survey was conducted. Unfortunately prospective injury data were not available for the road construction and maintenance or the steel reinforcement manufacturing organizations. A limited amount (four months) of prospective injury data were available for the hospital construction project as the project was coming to an end and most subcontractors involved in the survey left the site four months after the survey.

Further, at the road construction and maintenance organization injury data could not be obtained at the workgroup level. The most fine-grained injury data available related to the work centre. A standard work centre consists of a number of work crews, with hierarchical reporting links via the team leader and works supervisor, then on to the work centre manager. This data were used to test whether workers in groups with more favourable perceptions of coworkers' safety response were located within work centres with lower injury frequency rates. When based on retrospective injury data, perceptions of "Coworkers' ideal safety response" were significantly positively correlated with the work centre incident rate ($r = 0.264$; $p = 0.031$), i.e. workgroups located within work centres with higher incident rates, reported significantly higher mean scores for "Coworkers' ideal safety response". The retrospective injury rate was not significantly related to perceptions of "Coworkers' actual safety response".

At the hospital construction project there was no significant correlation between the combined lost time and medical treatment injury and either "Coworkers' actual safety

response” or “Coworkers’ ideal safety response” when considering retrospective or prospective injury data.

	Combined lost time and medical treatment injury frequency rate			
	Retrospective		Prospective	
	r	p	r	p
Study 1				
Coworkers’ ideal safety response	0.264	0.031 *	NA	
Coworkers’ actual safety response			NA	
Study 2				
Coworkers’ ideal safety response	0.005	0.956	-0.037	0.609
Coworkers’ actual safety response	0.036	0.706	-0.004	0.462
Study 3				
Coworkers’ ideal safety response	-0.155	0.132	NA	
Coworkers’ actual safety response	0.265	0.009 **	NA	

Note: N/A denotes injury data not available

Table VI. Bivariate correlations between perceptions of coworkers’ safety response and workgroup injury rates

At the steel reinforcement manufacturing organization, there was a significantly positive correlation between workgroups’ retrospective injury frequency and perceptions of “Coworkers’ actual safety response” ($r = 0.265$; $p = 0.009$). No significant correlation was found between retrospective injury frequency rate and perceptions of “Coworkers’ ideal safety response”. No prospective injury data were available for the steel reinforcement manufacturing organization at the time of writing this paper.

Discussion

Factor structure of coworkers’ safety response

With respect to the first research objective, the results suggest that perceptions of coworkers’ safety responses are comprised of two facets, “Coworkers’ ideal safety response” and “Coworkers’ actual safety response”. The clear factor loadings and absence of double loading indicate that these two facets are conceptually distinct. Further, the two-dimensional structure of the coworkers’ safety response survey was aligned with the scale from which survey items were drawn. Thus, items that loaded on the factor labeled “Coworkers’ actual safety response” were those taken from the HSE Safety Climate survey, while items that loaded on the “Coworkers’ ideal safety response” scale were those taken from Burt et al.’s CARE scale (Burt et al., 2008). In all three organizations, mean scores for “Coworkers’ ideal safety response” were higher than mean scores for “Coworkers’ actual safety response” indicating

that workers perceive their coworkers to be less supportive of safety than they should be. Coworkers' safety response as a facet of group-level safety climate With respect to the second research objective, the results were mixed. In order to conclude that group safety climates exist, two conditions must be satisfied (Zohar, 2000). These are:

- (1) Between-group variance (i.e. whether safety climates differ significantly, between workgroups, within the same organization).
- (2) Within-group homogeneity (i.e. whether workers within a workgroup, share similar perceptions, of the safety climate).

With the exception of one workgroup in the road construction and maintenance organization, all of the workgroups in the analysis had IRA scores for Coworkers' ideal safety response in excess of the threshold value of 0.70, indicating high levels of within-group consensus. However, in none of the three studies was there significant between-group variation in perceptions of "Coworkers' ideal safety response". Thus, for this aspect of coworkers' safety response the first requisite group safety climate condition was not met.

In two of the three studies (the road construction and maintenance organization and the steel reinforcement manufacturing organization), both of the requisite conditions for the existence of group safety climate were met for "Coworkers' actual safety response". That is, there was significant between-group variation and, with the exception of one workgroup in study three, all workgroups within these organizations demonstrated high IRA scores. Thus, in relation to "Coworkers' actual safety response" the requisite conditions for group safety climate were met in two of the three organizations. At the hospital construction project, the IRA scores for all workgroups for "Coworkers' actual safety response" was in excess of 0.70, indicating a high level of within-group consensus. However, at this project there was no significant between-group variation in perceptions of "Coworkers' actual safety response", indicating that perceptions of "Coworkers' actual safety response" is not a facet of group-level safety climate at the hospital construction project. Coworkers' safety response and injury frequency rate Burt et al. (2008) suggest a strong and positive coworker response to safety should be negatively related to the rate of incidents and injuries. Previous research has shown that the timing of safety performance measurement in relation to the administration of safety climate surveys is significant. For example, Clarke (2006) reports that safety climate measures are positively related to safety performance in prospective but not retrospective studies. The data collected in the present study did not show this pattern of relationships. In none of the three organizations was there a significant negative correlation between perceptions of coworkers' safety response and workgroup injury rates, as suggested by Burt et al. (2008). Further, in the hospital construction project, for which prospective injury data were available, no significant correlation was found.

Unfortunately, the ability to test the relationship between workgroup members' perceptions of coworkers' safety response and prospective injury rates was limited because prospective data were not available for the road construction and maintenance and steel reinforcement manufacturing organizations.

When considering retrospective injury data aspects of coworkers' safety response was significantly correlated with workgroup injury rates but the relationship was in the opposite direction to that expected. In the road construction and maintenance organization, perceptions of "Coworkers' ideal safety response" were significantly positively correlated with the retrospective workgroup injury rate and, in the steel reinforcement manufacturing organization, perceptions of "Coworkers' actual safety response" were significantly positively correlated with the retrospective workgroup injury rate. This unexpected finding must be treated cautiously as these linkages involved different facets of coworkers' safety response and the significant relationships were not found in the hospital construction project. However, it is possible that the past experience of injuries within a workgroup could increase group members' safety-related expectations and actions in the future. Further research is recommended to examine this possibility.

The absence of a significant negative correlation between perceptions of coworkers' safety response and workgroup injury rates may be due to the fact that lost time and medical treatment injury rates are not sufficiently sensitive a measure of safety performance to reflect changes in safety performance at a workgroup level. Reportable injuries are statistically rare events and may not be a useful measure of subtle changes in safety performance at the level of the workgroup. Hopkins (2009) writes of the "zoom effect", whereby serious incidents may occur too infrequently to be a useful measure of safety at the company or workplace level. Hopkins suggests that where harmful events are rare, a more frequently occurring indicator of safety performance is needed. It is possible that at the level of the workgroup, lost time and medical treatment injury rates are too infrequent to be a useful measure of safety performance due to the "zoom effect". Thus further research should be conducted to examine the relationship between coworkers' safety response and injury rates using a more fine-grained measure of workgroup safety performance, such as micro-accidents or minor (non-reportable) injuries (Zohar, 2000; Zohar and Luria, 2005).

However, there are also other theoretically possible reasons for the failure to find a direct correlation between perceptions of coworkers' safety response and workgroups' prospective injury rates, which also warrant further investigation. For example, it is possible that the relationship between coworkers' safety response and workgroup safety performance is moderated by the extent to which workgroup members trust their employing organizations' commitment to safety. Thus, if workers do not trust higher level managers' commitment to safety and they believe that there is possibility that they could be viewed unfavourably if they leave their task to help a coworker or if they report a hazard that could affect the safety of others in their workgroup, then the relationship between coworkers' safety response and workgroup safety performance will be disrupted (Burt et al., 2008). The importance of trust in safety research was demonstrated by Conchie and Donald (2009) who report that the relationship between safety leadership and safety citizenship behaviour was moderated by safety-specific trust in management.

Implications for research

In providing preliminary evidence that perceptions of “Coworkers’ actual safety response” satisfy the criteria for group safety climate, the findings have important implications for researchers investigating safety climate within organizations. The identification of between-group variation and within-group homogeneity for “Coworkers’ actual safety response” in two of the three organizations suggests that future group-level safety climate evaluation in the construction industry should extend beyond the focus on supervisors and include items relating to coworkers’ safety responses. The results of the principal components factor analysis also suggest that researchers investigating coworkers’ safety responses in organizations should make careful choices about their methods of measurement as there appears to be a clear conceptual distinction between perceptions of “Coworkers’ actual safety response” and “Coworkers’ ideal safety response”. The former satisfied both of Zohar’s criteria for group safety climate in two of the three construction organizations, while the latter did not satisfy the criteria of between-group variation in any of the three construction organizations. Thus, questions framed in terms of the safety behaviours that should be demonstrated by coworkers may not be useful measures of group safety climate in the construction context. Finally the absence of a significant correlation between coworkers’ safety response and prospective workgroup injury rates suggests that future research should use more fine-grained measures of safety performance, based on events that are sufficiently frequent to calculate a meaningful rate in the timeframe of interest. Also, more complex theoretical models relating to the role of safety-specific trust as a moderator of the relationship between coworkers’ safety response and workgroup safety performance should be developed and tested.

Implications for practice

The findings also have implications for organizations interested in the development of strong and supportive safety climates at all levels within their operations. Burt et al. (2008) provide evidence that the acquisition of knowledge about one’s coworkers is an important precursor to the development of a caring and considerate attitude to workgroup safety. Thus, interventions to support the development of knowledge of coworkers, such as team building exercises, social events involving workers and their families and other events designed to develop friendships, cohesion and social relationships within workgroups, might help to promote positive coworkers’ safety responses. The construction context is particularly challenging as there is a high degree of turnover and “churn” among group members. This increases the potential for latent errors, which, in turn, elevate the likelihood of injury to new or existing workgroup members (Burt et al., 2009). In this context, efforts to speed up the process of new workers’ assimilation into workgroups through carefully designed induction processes might also be helpful.

Conclusions

The results provide preliminary evidence that perceptions of “Coworkers’ actual safety response” should be considered a dimension of group-level safety climate in the construction industry. There is also an important conceptual distinction between Australian construction workers’ perceptions of the way that coworkers behave in relation to safety and the way they should behave. This distinction is important for the future measurement of group safety climate because the criteria for inclusion as a dimension of group safety climate were not met for perceptions of “Coworkers’ ideal safety response”.

Limitations and future research

The research was limited by the reliance on reportable lost time and medical treatment injury rates as the measure of workgroup safety performance. The “zoom effect” and relative infrequency of these events could explain the failure to find a consistent and significant relationship between perceptions of coworkers’ safety response and workgroup safety performance. Future research, using prospective designs and more sensitive measures of workgroup safety performance are needed.

Acknowledgement

This research was funded by the Australian Research Council under Linkage Project Grant LP0668012. The researchers would also like to thank Boulderstone Pty Ltd, the Roads and Traffic Authority (New South Wales) and The Australian Reinforcing Company for participating in this research.

References

- Breslin, F.C., Polzer, J., MacEachen, E., Morrongiello, B. and Shannon, H. (2007), “Workplace injury or ‘part of the job’? Towards a gendered understanding of injuries and complaints among young workers”, *Social Science and Medicine*, Vol. 64, pp. 782-93.
- Burt, C.D.B., Gladstone, K.L. and Grieve, K.R. (1998), “Development of the considerate and responsible employee (CARE) scale”, *Work and Stress*, Vol. 12, pp. 362-9.
- Burt, C.D.B., Sepie, B. and McFadden, G. (2008), “The development of a considerate and responsible safety attitude in work teams”, *Safety Science*, Vol. 46, pp. 79-91.
- Burt, D.B., Chmiel, N. and Hayes, P. (2009), “Implications of turnover and trust for safety attitudes and behaviour in work teams”, *Safety Science*, Vol. 47, pp. 1002-5.
- Chiaburu, D.S. and Harrison, D.A. (2008), “Do peers make the place? Conceptual synthesis and meta-analysis of coworker effects on perceptions, attitudes, OCBs and performance”, *Journal of Applied Psychology*, Vol. 93, pp. 1082-103.
- Christian, M., Bradley, J., Wallace, C. and Burke, M. (2009), “Workplace safety: a meta-analysis of the roles of person and situation factors”, *Journal of Applied Psychology*, Vol. 94, pp. 1103-27.

- Clarke, S. (2006), "The relationship between safety climate and safety performance: a meta-analytic review", *Journal of Occupational Health Psychology*, Vol. 11, pp. 315-27.
- Conchie, S.M. and Donald, I.J. (2009), "The moderating role of safety-specific trust on the relation between safety-specific leadership and safety citizenship behaviors", *Journal of Occupational Health Psychology*, Vol. 14, pp. 137-47.
- Cooper, M.D. and Phillips, R.A. (2004), "Exploratory analysis of the safety climate and safety behaviour relationship", *Journal of Safety Research*, Vol. 35, pp. 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.), *Proceedings of the 24th Annual ARCOM Conference*, 1-3 September, Association of Researchers in Construction Management, Cardiff, pp. 687-96.
- Dedobbeleer, N. and Be'land, F. (1991), "A safety climate measure for construction sites", *Journal of Safety Research*, Vol. 22, pp. 97-103.
- Gillen, M., Baltz, D., Gassel, M., Kirsch, L. and Vaccaro, D. (2002), "Perceived safety climate, job demands and coworker support among union and non-union injured construction workers", *Journal of Safety Research*, Vol. 33 No. 1, pp. 33-51.
- Hofmann, D.A. and Stetzer, A. (1996), "A cross-level investigation of factors influencing unsafe behaviours and accidents", *Personnel Psychology*, Vol. 49, pp. 307-39.
- Hofmann, 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*, Vol. 41, pp. 644-57.
- Hopkins, A. (2009), "Thinking about process safety indicators", *Safety Science*, Vol. 47, pp. 460-5.
- Horn, J.L. (1965), "A rational and test for the number of factors in factor analysis", *Psychometrika*, Vol. 30, pp. 179-85.
- Johnson, S.E. (2007), "The predictive validity of safety climate", *Journal of Safety Research*, Vol. 38, pp. 511-21.
- Latane', B. (1981), "The psychology of social impact", *American Psychologist*, Vol. 36, pp. 343-56.
- 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*, Vol. 27, pp. 419-32.
- Lingard, H., Cooke, T. and Blismas, N. (n.d.), "Safety climate in conditions of construction subcontracting: a multi-level analysis", *Construction Management and Economics*, in press.
- Mearns, K., Whitaker, S.N. and Flin, R. (2003), "Safety climate, safety management practice and safety performance in offshore environments", *Safety Science*, Vol. 41, pp. 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*, Vol. 46, pp. 949-58.
- 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*, Vol. 91, pp. 946-53.
- Pousette, A., Larsson, S. and To'rner, M. (2008), "Safety climate cross-validation, strength and prediction of safety behaviour", *Safety Science*, Vol. 46, pp. 398-404.
- Simard, M. and Marchand, A. (1994), "The behaviour of first-line supervisors in accident prevention and effectiveness on occupational safety", *Safety Science*, Vol. 17, pp. 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*, Vol. 21, pp. 113-29.

- Simard, M. and Marchand, A. (1997), "Workgroups' propensity to comply with safety rules: the influence of micro-macro organizational factors", *Ergonomics*, Vol. 40, pp. 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*, Vol. 36, pp. 359-66.
- Tharaldsen, J.E., Olsen, E. and Rundmo, T. (2008), "A longitudinal study of safety climate on the Norwegian continental shelf", *Safety Science*, Vol. 46, pp. 427-39.
- Tucker, S., Chmiel, N., Turner, N., Hershcovis, M.S. and Stride, C.B. (2008), "Perceived organizational support for safety and employee safety voice: the mediating role of co-worker support for safety", *Journal of Occupational Health Psychology*, Vol. 13, pp. 319-30.
- 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*, Vol. 32, pp. 761-9.
- Westaby, J.D. and Lowe, J.K. (2005), "Risk-taking orientation and injury among youth workers: examining the social influence of supervisors, coworkers and parents", *Journal of Applied Psychology*, Vol. 90, pp. 1027-35.
- 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*, Vol. 46, pp. 1406-19.
- 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*, Vol. 85, pp. 587-96.
- Zohar, D. (2002), "The effects of leadership dimensions, safety climate and assigned priorities on minor injuries in work groups", *Journal of Organizational Behavior*, Vol. 23, pp. 75-92.
- 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*, Vol. 90, pp. 616-28.