Chapter 40

Safety Climate in Australian Railways

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Introduction

Organizational safety cognition measures – mainly perceptions of, and attitudes towards safety, commonly take the form of safety climate self-completion surveys, of which there are many examples (e.g., Cheyne *et al*, 1998; Cooper, & Phillips, 1994; Cox & Cox, 1991; Cox *et al*, 1998; Coyle *et al*, 1995; Davies *et al*, 2001; Dedobbeleer, & Béland, 1991; Donald & Canter, 1994; Flin *et al*, 2000; Glendon & Litherland, 2001; Janssens *et al*, 1995; Niskanen, 1994; Silva *et al*, 2004; Varonen, & Mattila, 2000; Williamson *et al*, 1997; Zohar, 1980). For reviews, see Cooper and Phillips (2004), Glendon *et al* (2006), Guldenmund (2000), and Seo *et al* (2004). These measures typically find between two and seven separate factors or safety climate scales. For example, Griffin and Neal (2000) identified five first-order factors, which in turn loaded onto a common higher-order factor, relating to perceptions of safety climate. Their first-order factors were: 'Management values', 'Safety communication', 'Safety practices', 'Safety training', and 'Safety equipment'.

However, no consistent factor structure has yet emerged for safety climate, which Seo *et al* (2004) attributed to not specifying the influence of two critical safety dimensions – management commitment and supervisor support. Seo *et al* (2004) demonstrated the importance of developing psychometrically robust safety climate scales. Of over 30 empirical safety climate studies published since 1980, most have developed their own measure. This opportunistic approach has resulted in no systematic study, for example by sector, which could provide an opportunity for customised valid safety climate measures that could be used, *inter alia*, to compare occupational groups within and between rail sector organizations, to benchmark different rail sector organizations – both nationally and internationally, and for rail sector organizations to evaluate safety interventions by comparing their safety climate between time periods.

There is dispute over defining safety climate, and how it links with other important factors to influence safety performance. Glendon and Litherland (2001) proposed that safety climate could be conceptualized as operating on three levels:

- *Operational* – accessing factors impacting most directly upon work performance and dealing exclusively with perceptions (e.g., Glendon & Stanton, 2000; Wilson, 1998).
- *Intermediate* – comprising perception-oriented measures but with some attitudinal items, reflecting generic factors, such as 'management commitment' and 'safety system' (e.g., Clarke, 2000; Flin *et al*, 2000; Williamson *et al*, 1997).
- *Highest* – using purely attitudinal measures (e.g., Donald & Canter, 1993; Niskanen, 1994), which could tap into some aspects of safety culture.

At the highest level described by Glendon and Litherland (2001), safety climate reflects to some extent the underlying culture of the organization with respect to safety. For example, Cox and Flin (1998) considered safety climate to be a manifestation of safety culture expressed through workers' attitudes and behavior, a description also given by Cheyne *et al* (2003).

'Safety culture' is generally taken to be more embracing than 'safety climate', although the two terms have similar meanings. Whilst culture implies a notion of residing within an organization, climate has more passive connotations, reflecting attitudes and perceptions of organization members to both internal (e.g., management actions) and external (e.g., economic) influences (Glendon, 2005). For example, the Ladbroke Grove rail accident inquiry concluded that: "climate is the observable, tangible part of culture. Culture is the understanding of people's fundamental values with respect to say, risk and safety" (Cullen, 2001, p. 2). Thus, safety climate can be defined as reflecting shared attitudes and perceptions of organizational members towards internal and external influences on safety. It may be regarded as an, 'indicator of safety culture within the workforce as a whole' (Mearns *et al*, 2003), but only provides a 'snapshot' picture of the longer-term, more enduring safety culture of an organization. Cheyne *et al* (2003) regarded safety attitudes to be a component of safety climate, which in turn was a manifestation of safety culture.

Some researchers have sought to determine whether different groups of workers within an organization or sector report different attitudes or perceptions of safety, or whether management and workers express different attitudes to safety. Cox *et al* (1998) found differences between safety attitudes of workers, supervisors and managers in the UK manufacturing sector, for example that permanent workers had more positive attitudes on some issues than did other groups. Similar findings have also been reported in the UK rail industry (Clarke, 1999) and for US haulage firms (Arboleda *et al*, 2003). Different sub-cultures or sub-climates are liable to exist at different levels within an organization (Gonzales-Roma *et al*, 1999; Harvey *et al*, 1999; Trice & Beyer, 1993). This can result in differences in safety attitudes at different levels (e.g., managers, supervisors, workers) within an organization, and between different groups of workers (Alexander *et al*, 1995; Cox *et al*, 1998). Gillen *et al* (2002) found different perceptions of safety climate between unionized and non-unionized workers. Cheyne *et al* (2003) found that while managers, supervisors and workers shared the same safety climate factor structure, their perceptions of the factors and their inter-relationships were quite different. Sampling different employee groups from the Australian rail sector, Glendon and Evans (2005) and McInerney (2005) found significant differences between employee groups, including managers and supervisors, on a safety climate measure designed for the rail sector.

Although studies have obtained varied results, there is growing evidence that safety climate reflects differences in safety performance, either directly or through some other channel, such as organizational climate – for a review, see Glendon *et al* (2006). Kopelman *et al* (1990) proposed that the influence of climate on behavior is mediated by cognitive and affective states, through particular pathways – for example, climate perceptions impact on work motivation, which in turn affects job performance, or climate perceptions impact on job satisfaction, which in turn affects psychological well-being and withdrawal. Irrespective of any behavioral link, a safety climate survey provides a valuable tool for identifying trends in an organization's safety performance (Cox & Cheyne, 2000; Coyle *et al*, 1995; Seo *et al*, 2004). Recent work has focused on group-level safety climate (Zohar, 2000, 2002), as opposed to organizational safety climate, where climate is defined in terms of how supervisors prioritize safety issues.

Method

The NSW rail organization was surveyed as part of the Special Commission of Inquiry into the Waterfall rail accident, in which seven people were killed (McInerney, 2005). The questionnaire included 34 questions on various aspects of safety, which respondents answered on a 5-point scale ranging from '1 Strongly disagree' to '5 Strongly agree'. Main occupational groups surveyed were: Train drivers, Train guards, Signalling staff, Maintenance staff (rolling stock & track), Station staff, Customer service staff, Management and supervisory staff, and New employees (having less than 12 months service). A Commission staff member visited a number of locations to ask groups of employees to complete the questionnaire. This ensured both a very good response rate (459 employees completed safety climate questionnaires; only one of those asked declined), an adequate sample size for statistical analysis, and reasonable representation across key occupational groups. New employees comprised 11.5% of the sample. Mean length of employment within the NSW rail industry of the other respondents was 15.4 years.

In the second survey, questionnaires were mailed to the entire rail membership of the Queensland branch of the Rail Tram and Bus Union (RTBU), which represents about 6000 (95%) rail workers in Queensland. The survey yielded 514 usable responses (9% response rate). Sixty-four percent of respondents dealt directly with train operations (e.g., Train drivers, Track maintenance staff, Rolling stock maintenance staff, Train guards, Train controllers, Signalling staff) while another 22 percent were engaged in management and other support roles (e.g., Station staff, Management/ supervisory, Administration staff, Truck drivers, Customer service officers, Procurement officers, and other onboard service officers). Mean time worked in the rail sector by respondents was 21.4 years (SD 9.88 years).

The survey was modified to reflect NSW study findings. Some original items were rephrased and, in response to comments to an open-ended question, further items on communication, equipment, maintenance, and shifts and rosters were included. The final survey contained questions on five topic areas hypothesised to predict safety climate at an organizational level (management commitment to safety, organizational communications, equipment and maintenance, shifts and rosters, safety training). Both samples exceeded the minimum number of cases required to conduct the proposed analysis (Hair *et al*, 1995). Table 40.1 shows the occupational breakdown of respondents in the two surveys.

Table 40.1 Respondents' occupational group

Occupational group	NSW	QLD
Train drivers	56	91
Train guards	69	36
Signalling staff	48	18
Maintenance (Rolling stock/Track) staff	50	51/84
Station staff/Customer service staff	72	46/13
Management & supervisory staff	69	46
New employees	63	-
Others	32	129
Totals	459	514

Findings

NSW sample

Factor analyses reduced the questionnaire items to two main factors to represent safety climate. Factor 1, 'Management & Staff Safety' had 14 items and explained 54.74% of the variance (α .95). Factor 2, 'Safety Training & Rules' had 10 items and explained 5.75% of the variance (α .93). More detail is given in McInerney (2005). Table 40.2 shows mean scores for the seven occupational groups on the two factors.

Table 40. 2 Mean scores for seven occupational groups on two safety climate factors (NSW sample, N=459)

	Factor	
Occupational group	1	2
Train drivers	2.28[a]	2.82[a]
Train guards	2.66[b]	2.98[a]
Signalling staff	2.96[c]	3.11[a,c]
Maintenance staff	2.88[b,c]	2.88[a]
Station staff/Customer service staff	3.42[d]	3.52[b]
Management & supervisory staff	3.60[d,e]	3.27[b,c]
New employees (< 12 months)	3.75[e]	3.94[d]
Overall	3.11	3.24

Table 40.2 shows that mean scores for all respondents (excluding the 'Others' group) were 3.11 for the 'Management & staff safety' factor, and 3.24 for the 'Safety training & rules' factor. This means that overall, respondents perceived both safety climate factors to be just above the mid-point of the 5-point scale, where a score of '3' indicated 'Neutral'. Scores on both factors also show more than a 20% difference between the highest (New employees in both cases) and lowest (Train drivers in both cases) group scores, suggesting substantial differences between occupational groups' perceptions of the organization's safety climate. MANOVA showed significant differences between groups on both factors, indicated by different superscripts in the columns of Table 40.2.

In respect of their perceptions of Factor 1 'Management & staff safety', there are three separate clusters. Train drivers are in a 'cluster' of their own – agreeing with no other group in their perceptions of this safety climate factor. While Train guards and Signalling staff differ significantly in their perceptions of this factor, both agree with the perceptions of Maintenance staff. However, these groups' perceptions differ significantly from those of the other three groups. While there is no agreement between Station/ Customer service staff and New employees, the Management & supervisory group is in broad agreement with the perceptions of both these groups.

The picture in respect of Factor 2 'Safety training & rules' is one of greater agreement between Train drivers, Train guards, Maintenance staff, and Signalling staff, all of whom have similar perceptions of this factor. Signalling staff and the Management & supervisory group also share common perceptions. Management & supervisory respondents and Station & Customer service staff also share perceptions on this safety climate factor. However, the New employees group is completely isolated in terms of their perceptions of this safety climate factor.

QLD sample

Factor analysis yielded five factors with eigenvalues greater than 1, accounting for 61.6 percent of explained variance. These were '1 Communication & safety information' (11 items, 35.51% of variance, α .90), '2 Rosters & shifts' (6 items, 12.00%, α .91), '3 Signalling equipment' (2 items, 6.13%, α .80), '4 Equipment & maintenance' (5 items, 4.26%, α .80), and '5 Management commitment to safety' (4 items, 3.72%, α .87).

A MANOVA was conducted to identify any differences between occupational group means. Although 514 cases were available for analysis, because MANOVA is sensitive to differences in cell sizes, numbers of respondents in each occupational group were reduced by randomly deleting cases until cell sizes were approximately equal. The reduced sample means did not differ significantly from the larger sample means. Significant main effects were found for all factors apart from '3 Signalling equipment', which was dropped from subsequent analyses. Table 40.3 shows means for the various occupational groups on the four remaining safety climate factors.

Table 40.3 Mean scores for seven occupational groups on four safety climate factors (QLD sample, N=321)

	Factor			
Occupational group	1	2	4	5
Train drivers (N=53)	2.85[a]	2.24[a]	1.84[a]	2.96[a]
Train guards (N=36)	2.81[a]	2.32[b]	2.49[b]	2.54[b]
Station staff (N=46)	2.64[b]	2.49[b]	2.01[c]	2.97[a]
Track maintenance staff (N=53)	3.04[c]	3.26[c]	2.18[c]	3.32[c]
Rolling stock maintenance (N=51)	3.05[c]	3.17[c]	2.28[b]	3.20[c]
Management & supervision (N=46)	3.31[d]	3.37[c]	2.34[b]	3.20[d]
Administration staff (N=36)	3.32[d]	3.26[c]	2.97[d]	3.08[e]

Summarizing significant differences between occupational groups (means in Table 40.3):

- On '1 Communication and safety information', Station staff mean score was significantly lower than those of Managers/supervisors and Administration staff.
- On '2 Rosters and shifts' Train guards, Train drivers' and Station staff mean scores were significantly lower than those of Track maintenance staff, Rolling stock maintenance staff, Managers/supervisors and Administration staff.
- On '4 Equipment maintenance' Administration staff scores were significantly higher than those of all other groups. Train drivers' mean scores were significantly lower than those of all other groups. Station staff and Track maintenance staff were significantly lower than Train guards, Rolling stock maintenance staff and Management/supervision.
- On 'Management commitment to safety' Train guards' mean scores were significantly lower than those of Track maintenance staff, Rolling stock maintenance staff and Managers/supervisors. Train drivers', Station staff and Administration staff mean scores were significantly lower than that of Managers/supervisors.

A non-significant ANOVA result to determine whether differences existed between occupational groups on the combined safety climate scores indicated no differences between occupational groups on the summed safety climate scales.

Discussion

The finding from the first study of different occupational groups recording different scores on the safety climate factors within a rail sector organization was replicated in the second (State-wide) study. Occupational groups closer to daily operations tended to have lower scores than did groups further removed from daily operations. Train drivers' and Station staff scores differed significantly from those of Administration staff and Management/supervision on four of the five safety climate factors. The importance of measuring group differences on the separate scales was highlighted by the non-significant result across the combined scales.

The first factor, 'Communication and safety information', comprised mostly communication items with some training items. The scale seems to represent a need for good communication channels and for safety information to be communicated throughout the organization. The second factor was based on rostering and the impact of shiftwork on fatigue. This factor emerged as a strong and discrete factor, possibly due to the fact that only some operational groups work shifts, producing polarized responses. Although this factor may only apply to some workplace groups, its importance was evident from qualitative data gathered in the first study. The third factor, ‘Signalling equipment maintenance’, was also remarkably discrete, comprising only two items ‘Signalling equipment is never left in use with safety critical faults’, and ‘Signalling equipment is maintained to a safe standard’. This rail-sector specific factor could not be part of a generic safety climate measure. As it did not discriminate between occupational groups in this study and, as factors with less than three items are not robust, this factor is problematic. Future development of a scale for the rail sector may benefit from additional items on this topic, or it might be better explored in other ways (e.g., via focus groups). The ‘Management commitment to safety’ factor emerges from most safety climate studies. ‘Equipment maintenance’, although not common to other studies, is relevant to a range of settings.

Conclusions

In the NSW sample, the overall perception of the sample was barely above the mid-points of both safety climate scales. Perceptions of Train drivers, Train guards, Signalling staff and Maintenance staff were all below both scale mid-points. Train drivers perceived safety climate to be significantly worse than did all other occupational groups sampled. Maintenance staff, Train guards and Signalling staff generally perceived safety climate to be significantly worse than did Station/Customer service staff, Management and supervisory staff, and New employees.

The second study yielded four stable factors that could be considered generic, that is, usable within different transport industries and other sectors. The ‘Signalling equipment maintenance’ factor is too specific to be useful outside the rail sector. Future studies could balance generic factors that produce useful comparisons across organizations or industries, with sector-specific safety measures. The four generic factors extracted in this analysis were: ‘Communications and safety information’, ‘Rosters and shifts’, ‘Equipment maintenance’ and ‘Management commitment to safety’. Generic factors are required for comparing safety climate measures both within and between sectors. Inventories developed for other sectors could add sector specific scales to generic safety climate scales.

The two studies represent steps in the development of a rail safety climate measure. Both studies identified consistent differences between occupational groups. In the second study Train drivers’, Train guards’ and Station staff mean scores were significantly different from those of Managers/supervisors and Administration staff on three of the four factors discriminating between occupational groups (‘Communications & safety information’, ‘Rosters & shifts’, ‘Management commitment to safety’). Differences on ‘Communication and safety information’ and ‘Management commitment to safety’ may be due to the nature of groups different work environments. Train drivers, Train guards and Station staff perform their roles at a physical distance, sometimes remotely, from management supervision, and staff in these roles often work alone or with one or two other people. This may foster a sense of isolation from management and from the organization’s communication mechanisms. Track maintenance staff and Rolling stock maintenance staff tend to work under closer management supervision and in larger teams. As a result, they may feel more informed about management’s commitment to safety and current information in the organization. Management contact influencing safety climate was demonstrated by Clarke (1999) and Glendon and Litherland (2001).

Differences on the 'Rosters and shifts' factor is most likely to be due to managers, supervisors and administration staff for the most part not being required to undertake shiftwork. Track maintenance staff and Rolling stock maintenance staff work limited shifts, hence their intermediate scores on this factor. Train drivers reported lower levels of acceptable 'Equipment maintenance' than did all other groups. This factor, among other things, asked whether there was sufficient money and staff for maintenance and whether maintenance was carried out in a timely manner.

Researchers are increasingly using sophisticated statistical modelling techniques to unravel some of the complex relationships and interactions between safety climate components (e.g., Cheyne *et al*, 1998, 2003; Griffin, & Neal, 2000; Neal *et al*, 2000; Seo *et al*, 2004; Siu *et al*, 2004; Tomás *et al*, 1999). Future research is likely to involve more detailed models of the operation of safety climate, its impact on safety-related behaviors, and its relationship with other facets of the work environment. The next stage of this research involves further development of the safety climate inventory for repeat use with a larger sample within the same NSW rail organization as in the first study described in this paper. This is being undertaken as part of a larger safety culture project, which also includes qualitative measures.

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