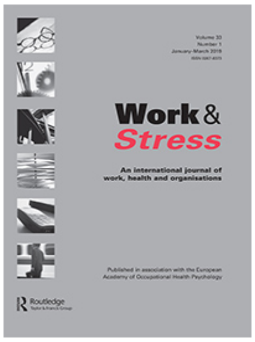

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Safety climate and safety outcomes: A meta-analytic comparison of universal vs. industry-specific safety climate predictive validity

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ABSTRACT
Previous research has demonstrated that safety climate is a robust predictor of safety-related outcomes. However, there is little consensus about the optimal strategy to measure safety climate. One of the main issues has been whether safety climate measures should be universal or industry-specific. As such, this study was designed to examine the criterion-related validity of universal and industry-specific safety climate measures by conducting a meta-analytic comparison of their relationships with a variety of safety-related outcomes (i.e. safety behaviour, risk perceptions, accidents and injuries, and other adverse events). With 120 independent samples ($N = 81{,}213$), we found that the industry-specific safety climate measures displayed better predictive power when predicting safety behaviour and risk perceptions than the universal safety climate measures. On the other hand, the universal safety climate measures displayed better predictive power when predicting other adverse events (but not accidents and injuries) than the industry-specific safety climate measures. We discuss these findings in light of the intended use of organisational safety climate surveys.

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Safety climate; meta-analysis; injuries; accidents; safety performance; safety behaviour

The International Labor Organization (2016) reports that globally "every 15 seconds, a worker dies from a work-related accident or disease; every 15 seconds, 153 workers have a work-related accident." In the United States, there were nearly 3 million nonfatal work injuries and more than 4600 fatal work injuries reported in 2014 (Bureau of Labor Statistics, 2015). Despite these staggering figures, a recent audit of workplace injuries reported to the Occupational Safety and Health Administration suggested that up to two-thirds of all workplace injuries and illnesses go unreported (U. S. Government Accountability Office, 2009). Consequently, the cited statistics drawn from international and national surveillance methods only represent the tip of the proverbial iceberg because actual workplace injury rates may be far greater than indicated by existing injury records. This is a major concern for organisations because workplace injuries can cause substantial direct and indirect costs. Organisations pay almost $1 billion per week for direct workers' compensation costs alone, and the annual cost to organisations in

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the United States for work-related accidents and injuries exceeds $125 billion (Occupational Safety and Health Administration, 2008). In addition, for every dollar spent on the direct costs of the incident, 2–17 times more dollars are spent to cover the indirect, uninsured costs, such as training replacement employees, lost productivity, and repairs of damaged equipment and property (Pearce, 2002).

These statistics highlight the continuing need to identify strategies to reduce workplace accidents and injuries and to improve overall workplace safety. Toward that end, companies are paying increasing attention to safety assessment. The past 35 years have witnessed a shift away from safety monitoring solely based on "lagging indicators" or retrospective data such as accidents and injuries, towards the measurement of "leading indicators" or predictive measures such as safety climate. Assessing safety climate is advantageous because it enables organisations to proactively monitor safety conditions and take corrective action before the system fails (Flin, 1988). This shift in focus has been driven by the recognition that organisational, managerial, and social factors rather than purely technical failures are prime causes of accidents (Weick, Sutcliffe, & Obstfeld, 1999). Indeed, organisations often attempt to prevent workplace accidents and injuries by building a positive safety climate (Zohar, 1980) because a positive safety climate has been demonstrated to be related to increased safety compliance and participation (Clarke, 2006) and to decreased workplace accidents and injuries (Hofmann & Stetzer, 1996). To this end, reliably and validly assessing workplace safety climate and maximising the predictive power of safety climate scales are crucial.

Recent academic interest in the measurement of safety climate has resulted in a proliferation of assessment instruments, typically in the form of self-report questionnaires administrated as large-scale surveys. Although the important role of safety climate in predicting safety outcomes has been well established (Huang, Chen, & Grosch, 2010), there is little consensus about the optimal strategy to measure safety climate. One of the main issues has been whether the safety climate measure should be universal or industry-specific (Zohar, 2014). Whereas universal measures provide context-free generic assessments of safety climate, industry-specific measures are embedded within a specific industry sector to provide contextualised assessments.

The aim of this study is to examine the criterion-related validity of universal and industry-specific safety climate measures by conducting a meta-analytic comparison to determine if either universal or industry-specific measures of safety climate offer better predictions of safety-related outcomes. Drawing from Ajzen and Fishbein's (1977) principle of correspondence, we argue that the strength of the criterion-related validity of universal vs. industry-specific safety climate measures might depend on the specificity of outcomes being predicted (i.e. "universal" safety outcomes vs. "specific" safety outcomes). From a practical perspective, an accurate estimate of the criterion-related validity of universal and industry-specific safety climate scales can also provide insights into the future development of workplace safety and interventions to improve safety climate.

The results derived from this project may make several contributions. First, this study may impact the trajectory of applied safety climate research. For example, if industry-specific measures are better, efforts should focus on developing and validating unique context-specific safety climate measures for each industry. These industry-specific safety climate measures must be shown to be reliable, valid, sufficiently comprehensive, and theoretically justifiable. On the other hand, if universal safety climate measures perform equally well (or better), then aggregation of data across industries may be warranted.

This would allow safety researchers to create large standardised databases and to develop national and global benchmarks that can be used to draw comparisons between and track changes within organisations.

Second, this study may impact practitioners' choices of safety climate measures. Based on the result of this meta-analysis summarising existing studies from diverse industries, practitioners across various industries will be able to make an informed decision regarding the optimal measurement of safety climate most suited for their unique industry and aligned with their goals for measuring the organisational safety climate.

Third, because organisations are primarily interested in what they should do to promote a strong safety climate based on the safety climate profiles and climate survey feedback, this study may also impact safety climate intervention strategies. For example, if industry-specific safety climate measures incorporating various items pertaining to a unique industry have higher criterion-related validity, then the context-rich information can be used among participating companies to show where improvements can be made, and, as such, may offer a valuable starting point for future safety interventions and have an actionable plan. On the other hand, if the universal safety climate measures have better predictive power, the strategies to improve safety climate should potentially be focused on the core meaning of safety climate (Zohar, 2010), such as ensuring management commitment to safety (Flin, Mearns, O'Connor, & Bryden, 2000).

Taken together, the knowledge gained from this meta-analysis may impact the future direction of the workplace safety research by: (1) encouraging researchers either to develop and validate industry-specific safety climate measures or to build large standardised databases based on studies using universal safety climate measures, (2) informing practitioners of the optimal safety climate measure (either universal or industry-specific) in their applied work, and (3) providing insight into developing potential intervention strategies designed at safety climate improvement.

We begin our review below by discussing in greater depth the safety climate construct, the two main approaches (industry-specific and universal) to measuring this construct, and conclude with an assessment of the potential advantages and disadvantages of each.

Safety climate

Safety climate is defined as employees' perceptions of policies, procedures, and practices as they relate to the value, importance, and actual priority of safety in the workplace (Neal & Griffin, 2006; Zohar, 2003). Given that safety issues often compete with other operational issues such as speed or flow of production, safety climate reflects the priority that employees perceive the organisation gives to safety issues, which provide employees with a parsimonious means for assessing the relevance of enforced policies (i.e. identifying what is really important around here). A positive safety climate provides employees with cues that safe behaviours and outcomes are supported, expected, and rewarded in the workplace. According to the expectancy-valence theory (Vroom, 1964), employees are motivated to comply with safety procedures and to participate in safety activities if they believe that these behaviours will lead to valued outcomes (Neal & Griffin, 2006). As such, under a positive safety climate, workers are less likely to engage in unsafe acts (Hofmann & Stetzer, 1996).

Indeed, a more positive safety climate has been shown to predict fewer workplace accidents. For example, 5 meta-analyses including up to 203 independent samples (Beus, Payne, Bergman, & Arthur, 2010; Christian, Bradley, Wallace, & Burke, 2009; Clarke, 2006, 2010; Nahrgang, Morgeson, & Hofmann, 2011) conclude that safety climate predicts accidents, injuries, safety knowledge, safety motivation, safety compliance (e.g. obeying safety regulations, following the correct procedures, using appropriate equipment), and safety participation (e.g. helping co-workers resolve safety problems, volunteering to attend safety meetings, making suggestions to improve safety; Neal, Griffin, & Hart, 2000). As such, there is little doubt that safety climate is a robust predictor of safety behaviour and safety-related outcomes. The specific outcomes examined in this study are safety behaviour, risk perceptions, accidents and injuries, and other adverse events. Thus, in line with the large extant literature, we expect to replicate previous findings that:

> *Hypothesis 1 (replication)*: Safety climate is positively related to safety behavior (H1a), and negatively related to risk perceptions (H1b), accidents and injuries (H1c), and other adverse events (H1d).

Universal vs. industry-specific safety climate measures

As noted by Zohar (2010), there are two scale development approaches that can be used to measure employee safety climate perceptions. The first strategy relies on constructing universal or general scale items that ask participants to assess their organisation's safety climate. Such scale items reflect context-free perceptions or assessments of the organisational safety climate that are not dependent on the unique industry idiosyncrasies. For example, a widely used universal safety climate scale developed by Neal et al. (2000) includes items such as "Safety is given a high priority by management"; "There is open communication about safety issues within this workplace"; "Employees receive comprehensive training in workplace health and safety issues"; and "Safety procedures and practices are sufficient to prevent incidents occurring." Another universal measure, the Nordic Safety Climate Questionnaire (NOSACQ-50; Kines et al., 2011) includes similarly generic items such as "Management accepts workers taking risks when the work schedule is tight."

On the other hand, a second strategy contextualises the measurement of safety climate by using industry-specific items reflecting the unique risks, hazards, or procedures within that industrial context. Such scales are often based on detailed observations and interviews with front-line workers, managers, and industry experts to appropriately reflect the manifestations of safety climate in that unique context. For example, within the healthcare industry (Singer et al., 2007), climate has been measured using items such as "I am provided with adequate resources (personnel, budget, and equipment) to provide safe patient care." Within aviation, an industry-specific measure developed by Ciavarelli (2003) includes an item reading, "All of our aircraft mechanics are well trained and meet stringent certification standards." In a recent safety climate scale developed by Huang et al. (2013) for the trucking industry, an industry-specific item reads, "Company management cares more about on-time delivery than my safety."

A comparison of universal vs. industry-specific safety climate measures

Assuming that both are similarly predictive of the organisation's safety outcomes of interest (an assumption that is tested in this paper), there are acknowledged advantages and disadvantages of both strategies (Zohar, 2003, 2010). Publicly available, universal safety climate measures such as the Neal et al. (2000) measure and the Zohar (1980) measure are well validated, allow for comparisons between industries and countries as well as "apples-to-apples" aggregation of data for meta-analyses, and offer advantages associated with having large standardised databases and conceptual parsimony. Despite these, self-report measures of universal safety climate are not without their disadvantages. For example, universal safety climate measures may be too general to provide actionable information for the participating organisations.

Industry-specific scales, on the other hand, enable researchers to create industry-specific norms and benchmarks and provide rich feedback to participating companies because of their context-rich information. While industry-specific scales offer the advantages of collecting rich diagnostic information, increasing sensitivity for within-industry comparisons, uncovering the nature of cues and the information employees use to assess safety climate, and testing hypotheses regarding context-dependent targets of climate perceptions, industry-specific scales usually have unknown reliabilities and validities because few organisations have resources to rigorously develop and validate such scales empirically.

A crucial question in this comparison concerns predictive validity. Specifically, which scale type (either universal or industry-specific) of the safety climate measure has better predictive power? We argue that the criterion-related validity of the measurement of the safety climate construct might depend on the outcome being predicted (i.e. "universal" safety outcomes vs. "specific" safety outcomes). We derive our argument from the principle of compatibility (or correspondence) offered by Ajzen and Fishbein (1977). In trying to understand why observed relationships between attitudes and behaviours were stronger in some circumstances than others, they noticed that the correspondence of specificity influenced the strength of those relationships. Specifically, stronger relationships were observed when looking at general–general or specific–specific attitude–behaviour relationships than general–specific or specific–general ones. Ones and Viswesvaran (1996) raise a similar point in their consideration of the bandwidth-fidelity dilemma in the arena of using personality assessment to predict job performance. Specifically, they note that broader global personality measures have stronger criterion-related validity when predicting overall job performance. On the other hand, Cronbach (1960) argued that narrow bandwidth measures should be used to predict narrowly defined specific criteria. It may be that a similar correspondence in the degree of specificity is important when considering the relationship between safety climate perceptions and safety-related outcomes.

When defining job performance (and other safety-related outcomes) within the safety context, accidents and injuries can be argued to be more general constructs (e.g. a broken bone from a fall is a broken bone regardless of the industry context in which the fall occurred). Thus, general/universal measures of safety climate may be more predictive of such general outcomes (e.g. accidents and injuries). On the other hand, the performance-related behaviours that reflect safety participation and safety compliance are often very specific to a particular industry, and therefore, may be better predicted by industry-specific measures of climate. For example, safety compliance in a dental office might require placing the drill burr face down, whereas compliance in a pulp and paper mill might require wearing hearing protection. Thus, the specificity in climate measures reflecting those industry-level idiosyncrasies might better predict behavioural measures such as compliance and participation. Thus, we predict that:

Hypothesis 2: Industry-specific safety climate measures will exhibit stronger relationships with safety behavior (H2a) and risk perceptions (H2b) than universal safety climate measures.

Hypothesis 3: Universal safety climate measures will exhibit stronger relationships with accidents and injuries (H3a) and other adverse events (H3b) compared to industry-specific safety climate measures.

We use meta-analysis to examine our hypotheses. Meta-analysis offers a methodology for summarising results from existing studies to report an overall effect size over studies (e.g. correlates between safety climate and safety-related outcomes) and then to report breakdowns of effect sizes by subgroups (e.g. universal vs. industry-specific safety climate). In meta-analysis, analysing differences in effect size between two subgroups is a test for a moderator variable. As such, this meta-analysis is to examine whether the scale type of safety climate moderates the relationships between safety climate and safety-related outcomes. In other words, this study explores whether the relationships between safety climate and safety-related outcomes are stronger when using either a universal or an industry-specific safety climate scale.

Method

Literature search

We conducted an online literature search for studies that have addressed the relationship between safety climate and safety-related outcomes. A five-fold approach was used to locate primary studies. First, through April 2016, we conducted electronic literature searches of databases, including PsycINFO, ProQuest, MEDLINE, and Academic Search Premier, using the keywords "safety climate," "climate of safety," and "safety culture." Although safety culture and safety climate are theoretically distinct constructs, they are often used interchangeably within the literature and in practice (Denison, 1996). Therefore, following Beus et al.'s (2010) recommendation, we included safety culture in our literature search to identify relevant articles that may have purportedly measured "safety culture" but in practice utilised scales measuring perceptions of safety climate. Second, manual searches of the conference programmes for: (1) the Society for Industrial and Organizational Psychology, (2) the Academy of Management, (3) the American Society of Safety Engineers, (4) the Work, Stress, and Health, (5) the American Public Health Association, and (6) the American Association of Occupational Health Nurse were carried out for the years 2000 through 2015. Third, the references sections of all pertinent safety climate meta-analyses (i.e. Beus et al., 2010; Beus, Dhanani, & McCord, 2015; Christian et al., 2009; Clarke, 2006, 2010; Nahrgang et al., 2011) were reviewed for potentially useful citations. Fourth, requests for unpublished safety climate studies were posted on two Listservs (i.e. OBlistserv, OHPList). Fifth, prominent safety climate researchers were directly contacted to request any unpublished or under-review research. These initial searches led to 723 potential articles.

Inclusion criteria

After collecting the articles, the abstract of each identified article was reviewed. Theoretical work, literature reviews, studies only examining the antecedents of safety climate, and studies outside of the context of the workplace were eliminated for inclusion in the meta-analysis. The remaining empirical articles were then examined for appropriate content. If the study reported a relationship between a measure of safety climate and a measure of at least one of the criterion variables (i.e. safety behaviour, safety compliance, safety participation, safety violation, injuries, accidents, errors, near misses, and other adverse events) and included an appropriate correlation, it was included in the meta-analysis. We used Wood's (2008) recommended procedures to detect duplicate study effects. When two studies reported the same relations from the same sample, we coded the study with the larger sample size, and included unique effect sizes only from the smaller sample study. When a doctoral/Master's dissertation/thesis and a later published study reported the same data, we coded the published study. Our final set includes 109 studies with 11 articles reporting more than one independent sample for a total of 120 independent samples (total $N = 81{,}213$). A list of studies that were included in the meta-analysis is available upon request.

Coded criterion variables

Safety behaviour includes safety performance, safety compliance, safety participation, and safety violation (reverse coded). *Risk perception* is the perceived risk level of one's job or job site. *Accidents and injuries* were combined because definitions of accidents are often confounded with injuries (cf. Visser, Pijl, Stolk, Neeleman, & Rosmalen, 2007; also see Christian et al., 2009). *Other adverse events* include errors, near misses, and other safety-related events.

Coding of studies

We coded pertinent sample information and information on the predictor and criterion measures. Specifically, we recorded the primary study's sample size, study design, the industry sector in which the data were collected, the observed correlation between safety climate and its hypothesised outcome (i.e. safety behaviour, safety performance, safety compliance, safety participation, safety violation, risk perception, accidents/injuries, errors, near misses, and other safety-related events), the reliability of both safety climate and its hypothesised outcome, and whether the safety climate measurement used was universal or industry-specific. These data were used to compute mean sample-weighted corrected correlations. When reliability data were available, we corrected the studies individually.

We were interested in the relationships between the overall safety climate constructs and safety-related outcomes (i.e. safety behaviour, risk perception, accidents and injuries, and other adverse events). Thus, in cases in which correlations between multiple facets of the overall safety climate construct (e.g. action, expectation; Zohar, 2000) and multiple dimensions of an overall criterion variable (e.g. safety compliance, safety participation; Neal & Griffin, 2006) were offered within the same sample, composite formulas (Ghiselli, Campbell, & Zedeck, 1981, pp. 163–164) were used to estimate the overall correlation. For studies that provided multiple estimates of the same relationships, these estimates were combined into a single correlation using the composite formulas when possible or averaging the estimates, which prevented a study being "double counted" in the meta-analysis.

If a reverse scored measure of a variable was reported, the sign was reversed during coding (e.g. safety violation). On the other hand, studies that included multiple independent samples were separately coded. Moreover, whether the safety climate measure was universal ($N = 84$) or industry-specific ($N = 36$) was coded as a potential moderator variable.

Although the correlations between safety climate at the individual-level, group-level, and organisation-level and safety-related outcomes were coded, this meta-analysis only included the correlations between individual-level safety climate and safety-related outcomes due to the small number of independent samples with correlations of safety climate at the group-level ($N = 32$) and organisational-level ($N = 9$) and safety-related outcomes.

The coding process was conducted by the first author and two graduate students. The first author coded all studies and each graduate student coded half of the studies. The first author trained these two graduate students and provided a detailed coding protocol. The training continued until the team consistently reached an agreement of 90% or more. Finally, the first author compared her coding and two graduate students' coding. For any discrepancies, the first author revisited the articles in question and recoded them carefully.

Control variables

Industry sector

Using the North American Industry Classification System (NAICS), we first coded each sample according to its industry sector: chemical processing ($N = 3$), construction ($N = 11$), hospital/health care ($N = 21$), hospitality/restaurant/accommodations ($N = 12$), manufacturing ($N = 18$), maritime ($N = 1$), mining ($N = 6$), nuclear ($N = 4$), offshore and gas production ($N = 7$), transportation ($N = 18$), and "mixed" ($N = 19$).

In order to control for the risk level within each industry sector, we obtained the most recent recordable injury rate for each NAICS industry sector classification from the Bureau of Labor Statistics (2015) and used this as a control variable in our analysis. The recordable injury rate can be viewed as an indicator of the level of risk faced by employees since it represents the average number of work-related illnesses and injuries experienced (per 100 full-time workers) within the previous year by workers in that industry sector.

Study design

Additionally, Clarke (2006) argued that study design (retrospective or prospective) was a significant moderator in the relationship between safety climate and accident involvement. Specifically, her meta-analysis found that prospective design generates a larger effect size of the relationship between safety climate and accident involvement ($r_c = -.35$; $k = 6$) than retrospective design ($r_c = -.22$; $k = 25$). However, Beus et al. (2010) argued that retrospective (i.e. accident involvement → safety climate) vs. prospective (i.e. safety climate → accident involvement) designs represent two competing theoretical frameworks: safety climate → injury vs. injury → safety climate. They also argue that Clarke did not distinguish between studies of organisational-level safety climate and studies of individual-level safety climate. Addressing these concerns, Beus et al.'s meta-analysis (2010) found that injuries were more predictive of *organisational* safety climate ($r_c = -.29$; $k = 10$)

than safety climate was predictive of injuries ($r_c = -.24$; $k = 11$). However, they could not draw any conclusion about the individual safety climate because of the limited sample size. Building on these previous findings, we controlled for the measurement time of accidents and injuries as well as other adverse events (i.e. before vs. after measuring safety climate).

Meta-analytic calculations

We utilised Hunter and Schmidt's (2004) meta-analysis method to conduct the meta-analytic comparison. The observed correlations were corrected for sampling error and for measurement unreliability in both the predictor and the criterion scores using Cronbach's alpha coefficient (when applicable). When objective measures were used in the study (i.e. accident rates from archival records), measurement error was not corrected. In line with prior meta-analysis (e.g. Berry, Ones, & Sackett, 2007), meta-analytic corrections between safety climate and one of the variables of interest were calculated only if at least three independent samples examined a given relationship.

For the moderator analyses, studies were sorted into different categories on the basis of study characteristics (i.e. whether the safety climate measure was universal or industry-specific), and meta-analyses were carried out within each moderator category. To determine whether correlations differ significantly across moderator categories while simultaneously controlling for the risk level of the industry sector and the measurement time for outcomes of accidents/injuries as well as other adverse events, we used the weighted least-squares (WLS) regression by Wilson (2005) and Lipsey and Wilson (2001) that correctly estimates standard errors (also see Berry, Lelchook, & Clark, 2012). Using Monte Carlo stimulations, Steel and Kammeyer-Mueller (2002) show that WLS provides the most accurate estimates and is least impacted by collinearity, even with small sample sizes. Specifically, the correlation coefficient between the safety climate and safety outcome was regressed on the safety-climate type, the risk level of the industry sector, and the measurement time for outcomes of accidents/injuries and other adverse events.

Results

As shown in Table 1, significant corrected correlations ($p < .05$) where the 95% confidence interval does not include zero were found between safety climate and its outcomes. Consistent with previous meta-analytic research, safety climate was positively related to safety behaviour ($r_c = .49$), but negatively related to risk perceptions ($r_c = -.40$), accidents and injuries ($r_c = -.14$), and other adverse events ($r_c = -.17$). Thus, we replicated previous research and found support for our Hypothesis 1.

Moderator analysis

Table 1 also lists the corrected correlations between industry-specific safety climate and safety outcomes as well as between universal safety climate and safety outcomes. We used the WLS regression to determine whether the safety climate type significantly moderates the relationships between safety climate and safety-related outcomes controlling for the risk level of the industrial sector and the measurement time of outcomes when applicable. Specifically, after weighting by the inverse square root of the sampling error (Steel &

Table 1. Meta-analysis results for the relationships between safety climate and safety-related outcomes.

Moderator	k	N	r_m	r_c	SDr_c	CI_L	CI_U	CV_L	CV_U	% var.
Safety behaviour										
All samples	86	53,647	.42	.49	.15	.38	.44	.30	.67	7.10
Moderator										
Industry-specific	24	20,269	.42	.53	.15	.38	.47	.34	.71	6.15
Universal	62	33,378	.40	.47	.15	.37	.44	.28	.65	7.61
Risk perceptions										
All samples	20	9056	−.33	−.40	.16	−.39	−.27	−.59	−.20	9.80
Moderator										
Industry-specific	4	1099	−.44	−.51	.11	−.51	−.37	−.63	−.39	45.64
Universal	16	7957	−.32	−.38	.16	−.38	−.25	−.58	−.19	9.07
Accidents and injuries										
All samples	47	29,003	−.13	−.14	.14	−.17	−.10	−.31	.03	9.33
Moderator										
Industry-specific	11	11,286	−.09	−.10	.10	−.15	−.04	−.21	.01	12.47
Universal	36	17,717	−.16	−.17	.15	−.20	−.11	−.36	.03	9.22
Other adverse events										
All samples	22	9792	−.16	−.17	.18	−.23	−.10	−.39	.05	8.61
Moderator										
Industry-specific	9	6073	−.08	−.09	.11	−.15	−.02	−.21	.04	15.62
Universal	13	3719	−.30	−.32	.18	−.38	−.22	−.54	−.01	13.39

Notes: k = the number of independent effect sizes included in each analysis; N = sample size; r_m = mean sample-size-weighted correlation (correlated for unequal *ns*); r_c = mean same-size-weighted correlation corrected for unreliability in the predictor and criterion; SDr_c = standard deviation of r_c; CI_L and CI_U = lower- and upper-bound 95% confidence intervals, respectively; CV_L and CV_U = lower- and upper-bound 80% credibility intervals, respectively. % of var. sampling error = percentage of variance attributed to sampling error.

Kammeyer-Mueller, 2002), we regressed observed effect sizes on the potential moderator (i.e. safety climate type) and two control variables (when applicable) in the equation. Our hypotheses were tested using two-tailed tests, and we employed $p < .05$ as our critical value throughout.

Table 2 shows that the standardised regression weights for the safety climate type were sizeable and significant. Specifically, industry-specific safety climate demonstrated a higher

Table 2. WLS regressions wherein the safety climate-safety outcomes were regressed on the safety-climate type and dummy-coded industry.

Dependent variable	Predictors	B (SE)	β	R
Safety climate-safety behaviour				.48
	Safety-climate type	.08 (.01)	.27***	
	Industrial risk level	−.03 (.00)	−.17***	
Safety climate-risk perception				−.40
	Safety-climate type	−.13 (.04)	−.26***	
	Industrial risk level	.01 (.01)	.03	
Safety climate-accidents and injuries				−.14
	Safety-climate type	−.00 (.02)	−.00	
	Industrial risk level	−.00 (.00)	−.01	
	Measurement time of the outcome	.13 (.02)	.38***	
Safety climate-other adverse events[a]				−.17
	Safety-climate type	.13 (.03)	.34***	
	Industrial risk level	−.07 (.03)	−.20**	
	Measurement time of the outcome	.24 (.03)	.61***	

Notes: B, unstandardised WLS regression coefficients; SE, standard errors of B; β, standardised regression weight; R, multiple correlation; for "safety-climate type," 1 means industry-specific safety climate, 0 means universal safety climate; for the "measurement time of the outcome," 1 means "safety climate → outcome," 0 means "outcome → safety climate."
**$p < .01$.
***$p < .001$.

correlation coefficient with safety behaviour ($r_c = .53$) than universal safety climate ($r_c = .47$; Table 1), and the difference in these correlation coefficients was statistically significant, $\beta = .27$, $p < .001$ (Table 2). Similarly, industry-specific safety climate demonstrated a significant higher correlation coefficient with risk perceptions ($r_c = -.51$) than universal safety climate ($r_c = -.38$; Table 1), and the difference in these two correlation coefficients was statistically significant, $\beta = -.26$, $p < .001$ (Table 2). Thus, these findings provided support for Hypothesis 2 in that industry-specific safety climate measures had a stronger relationship with "specific" safety-related outcomes, including safety behaviour and risk perceptions.

On the other hand, although universal safety climate showed a higher correlation coefficient with accidents and injuries ($r_c = -.17$) than studies relying on industry-specific safety climate measures ($r_c = -.10$; Table 1), the difference in these correlation coefficients was not statistically significant after controlling for the industry sector risk level and measurement time of accidents and injuries (Table 2). Additionally, universal safety climate was more highly correlated with other adverse events ($r_c = -.32$) than industrial-specific safety climate ($r_c = -.09$; Table 1), and the difference in these correlation coefficients was statistically significant, $\beta = .34$, $p < .001$ (Table 2). Therefore, we also found partial support for Hypothesis 3 in that universal safety climate had a stronger relationship with other adverse events (H3b), but not accidents/injuries (H3a).

Discussion

The assessment of organisational safety climate is critical because it allows organisations to proactively monitor a variable that has been shown to be a leading indicator of a variety of safety outcomes (e.g. safety compliance, safety participation, workplace accidents and injuries, and other adverse events; Clarke, 2006; Hofmann & Stetzer, 1996). Despite a proliferation in measures of safety climate, very little research has examined whether incorporating industry-specific contextual information into the measurement of safety climate enhances (or is even necessary for) the predictive validity of the developed measures. Therefore, the purpose of the current study was to meta-analytically examine the differential predictive validity of two different forms of safety climate measures: universal (i.e. context-free measures) and industry-specific measures.

Each type of measure has its potential advantages and disadvantages. For example, universal measures and the aggregation of data based on those measures allow for the creation of benchmarking norms that can be used in a variety of industries. On the other hand, Zohar (2014) noted that the choice between universal and industry-specific measures may depend on the organisational objectives for measuring climate. For example, industry-specific measures might better enable employees to provide accurate and informed information about their workplace climate due to the inclusion of such industry-relevant exemplars. Therefore, an empirical assessment of the differential validity of these two types of measures can fruitfully contribute to researcher and managerial decision-making when selecting the appropriate measure for their purpose, as both universal and industry-specific measures are currently in use without an understanding of which is more appropriate.

Interestingly, our results indicate that neither universal nor industry-specific measures consistently outperform the other. Rather, universal safety climate measures appear to better predict "universal" safety-related outcomes (i.e. other adverse events) than industry-specific safety climate measures. On the other hand, industry-specific measures seem to better predict "specific" safety-related outcomes such as safety behaviour and risk perceptions.

Theoretical and practical implications

Our observed results indicate that universal measures are more valid for the prediction of the most commonly examined lagging indicators that organisational managers track (i.e. other adverse safety events), whereas industry-specific measures may be more predictive of the psychosocial predictors of these lagging outcomes (i.e. safety attitudes and behaviours). While these results are tentative due to the limited number of studies in our meta-analysis, they nonetheless have potential implications for safety management within organisations.

Specifically, if the organisational goal of measuring safety climate is to serve as a leading indicator of subsequent injury rates (a lagging, yet critical, outcome), then the use of well-developed and validated universal measures of safety climate might be preferable. On the other hand, if the goal is to predict and/or modify employee attitudes and self-reported behaviours, then industry-specific measures might provide more actionable knowledge to further that goal due to the context-specificity of these scales. Thus, informing researchers and practitioners alike that both universal and industry-specific scales are necessary tools, depending on the outcomes of interest.

From a theoretical perspective, our results also indicate that the criterion-related validity of the measurement of the safety climate construct is influenced by the outcome variables being predicted. Thus, safety climate does not appear to be a "context-free" construct that can be equally validly measured using either universal or industry-specific items. Rather, the validity of one's choice of measure appears to hinge in part upon the purpose of the measurement of safety climate (i.e. prediction of "universal" safety outcomes vs. prediction of more "specific" safety-related attitudes and behaviours). These findings are consistent with the principle of correspondence suggested by Ajzen and Fishbein (1977) as well as empirical findings by Ones and Viswesvaran (1996) in that the universal safety climate measure was a better predictor of "universal" safety outcomes (i.e. other adverse events) while the industry-specific safety climate measure was a better predictor of "specific" safety-related outcomes (i.e. safety participation; risk perceptions).

Limitations and directions for future research

While this is the first meta-analytic test of the differential validity of universal vs. context-specific measures of safety climate and the results are intriguing, there are nonetheless some limitations to acknowledge that might offer directions for future research in this area. Perhaps most importantly, as with any meta-analysis, there were numerous judgment calls to make (Guzzo, Jackson, & Katzell, 1987). Although recent research (e.g. Aguinis, Dalton, Bosco, Pierce, & Dalton, 2011; Tarrahi & Eisand, 2016) suggests that such judgment calls have little impact on the resulting estimates of the size of the effects, they are important to acknowledge. In the current study, perhaps the most difficult judgment call was whether to classify a measure as "universal" or "industry specific."

While the universal measures were often easy to identify (e.g. due to using established general measures such as Neal et al., 2000, or the NOSACQ), industry-specific measures often varied greatly in the extent to which they were tailored and provided context-specific cues. For example, a measure for use in the healthcare setting might range from "In your health care setting, managers emphasize the importance of safety" (which provides very little context-specific information but does reference the industry itself) to "Health care administrators regularly emphasize the importance of hand-washing after each patient exam" (which provides very detailed cues specific to that industry context). In other cases (particularly with less validated and/or one-off measures), a scale might incorporate a mix of universal items with some context-specific items. In the current study, we coded measures to be "industry-specific" if they provided any degree of contextual cuing regardless of the level or specificity of those cues. Given this potential for ambiguity in classifying measures as universal or industry-specific, future researchers examining the efficacy of universal vs. industry-specific measures might fruitfully attempt a more sophisticated coding scheme that reflects a continuous approach to evaluating the context-specificity of safety climate scales, rather than the categorical approach used in the current study. Although currently there are too few independent samples to do so in a rigorous fashion, once more independent samples become available this may be a worthwhile endeavour to extend our results.

Safety climate has been recently redefined as a multi-level construct (Zohar, 2000, 2008; Zohar & Luria, 2005). Both theoretical rationale and empirical data suggest that there is significant variation in safety climate among workgroups within a single organisation, which speaks to the distinction between organisational policies and workgroup practices (Zohar, 2008). In our current study, however, we only focused on criterion-related correlations between individual-level measures of safety climate (sometimes referred to as "psychological safety climate"; Christian et al., 2009) and safety-related outcomes. In other words, we did not include any correlation coefficients that were derived from aggregated measures of safety climate (either at the group level or organisational level). Doing so avoided a potential confound between type of climate measure (industry specific vs. universal) and level of aggregation (individual, group, organisation) used in the primary articles; nonetheless, it does limit our results to only individual-level assessments of safety climate perceptions, which are different from safety climate at the group or organisational level representing the collective perceptions of workplace safety (Griffin & Curcuruto, 2016). Moreover, variation in safety climate between workgroups vs. homogeneity within workgroups could impact estimates of the relationships between safety climate and safety outcomes. Upon a greater accumulation of primary studies, future research would benefit from an assessment of the extent to which correspondence at the level of aggregation between the measure of safety climate and safety outcomes is crucial as well. For example, perhaps individual-level psychological climate (i.e. safety climate in our case) assessments are better predictors of individual-level safety behaviours, whereas group safety climate might better predict group-level safety outcomes (e.g. workgroup accident rates).

Given the nature of organisations, it is evident that factors at one hierarchical level can influence factors at another hierarchical level. Building on previous findings on the relationship between organisational safety climate and safety outcomes, future research may explore the underlying mechanisms explaining how organisational safety climate influences safety outcomes. Beyond the mediating role of supervisor safety climate in the association between organisational safety climate and safety outcomes (Zohar & Luria, 2005), recent studies found that co-worker safety climate can also explain the relation between organisational safety climate and safety outcomes (e.g. Brondino, Silva, & Pasini, 2012). Upon accumulating enough primary studies, scholars may use meta-analytic structural equation modelling to understand the underlying linkages between organisational safety climate and safety outcomes.

Another unsolved issue associated with safety climate is the appropriate content domain and dimensionality of the safety climate construct (Beus et al., 2010; Christian et al., 2009). In the extant literature and in our current meta-analysis, measures of safety climate have a low of one dimension (Neal & Griffin, 2006) to a high of 12 dimensions (Krispin, 1997). However, there is no consensus on the best way to conceptualise the safety climate construct and there is a reason to suggest that some of these dimensions may not represent safety climate at all (Beus et al., 2010). Although Beus et al. (2010) conclude that perceived management commitment to safety is the most robust predictor of occupational injuries, future safety climate meta-analyses may compare the predictive validity of the safety climate measurements with different content domains with regards to a variety of outcomes. Meanwhile, when conducting primary studies, it is crucial for future safety climate researchers to clearly define the content domain of the safety climate measure.

Finally, the meta-analysis was based on studies deriving from a variety of industrial sectors. Although the generalisability of the study conclusion is high because of the inclusion of data from a variety of industries, each industry sector may have its own features. Future research may conduct meta-analyses within each industry sector in an attempt to deeply understand a particular industry and provide industry-specific recommendations.

Conclusion

In summary, this is the first examination of the criterion-related validity of industry-specific vs. universal measures of safety climate. We found that universal safety climate measures appear to better predict "universal" safety-related outcomes such as adverse events, whereas industry-specific measures better predict "specific" self-report safety-related outcomes such as safety behaviour and risk perceptions. Our findings have theoretical and practical implications for researchers and practitioners who utilise safety climate measures in organisations to predict relevant employee safety outcomes.

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References

Aguinis, H., Dalton, D. R., Bosco, F. A., Pierce, C. A., & Dalton, C. M. (2010). Meta-analytic choices and judgment calls: Implications for theory building and testing, obtained effect sizes, and scholarly impact. *Journal of Management*, *37*, 5–38.

Ajzen, I., & Fishbein, M. (1977). Attitude–behavior relations: A theoretical analysis and review of empirical research. *Psychological Bulletin*, *84*, 888–918.

Berry, C. M., Lelchook, A. M., & Clark, M. A. (2012). A meta-analysis of the interrelationships between employee lateness, absenteeism, and turnover: Implications for models of withdrawal behavior. *Journal of Organizational Behavior*, *33*, 678–699.

Berry, C. M., Ones, D. S., & Sackett, P. R. (2007). Interpersonal deviance, organizational deviance, and their common correlates: A review and meta-analysis. *Journal of Applied Psychology*, *92*, 410–424.

Beus, J. M., Dhanani, L. Y., & McCord, M. A. (2015). A meta-analysis of personality and workplace safety: Addressing unanswered questions. *Journal of Applied Psychology*, *100*, 481–498.

Beus, J. M., Payne, S. C., Bergman, M. E., & Arthur, W. (2010). Safety climate and injuries: An examination of theoretical and empirical relationships. *Journal of Applied Psychology*, *95*, 713–727.

Brondino, M., Silva, S. A., & Pasini, M. (2012). Multilevel approach to organizational and group safety climate and safety performance: Co-workers as the missing link. *Safety Science*, *50*, 1847–1856.

Bureau of Labor Statistics. (2015). *Employer-reported workplace injury and illness summary*. Retrieved from http://www.bls.gov/news.release/osh.nr0.htm

Christian, M. S., Bradley, J. C., Wallace, J. C., & Burke, M. J. (2009). Workplace safety: A meta-analysis of the roles of person and situation factors. *Journal of Applied Psychology*, *94*, 1103–1127.

Ciavarelli, A. (2003). *Organizational risk assessment: The role of safety culture*. Human Performance Laboratory. Moffett Field, CA: NASA-Ames Research Center.

Clarke, S. (2006). The relationship between safety climate and safety performance: A meta-analytic review. *Journal of Occupational Health Psychology*, *11*, 315–327.

Clarke, S. (2010). An integrative model of safety climate: Linking psychological climate and work attitudes to individual safety outcomes using meta-analysis. *Journal of Occupational and Organizational psychology*, *83*(3), 553–578.

Cronbach, L. J. (1960. *Essentials of psychological testing* (2nd ed.). New York, NY: Harper & Row.

Denison, D. R. (1996). What is the difference between organizational culture and organizational climate? A native's point of view on a decade of paradigm wars. *Academy of Management Review*, *21*, 619–654.

Flin, R. (1998). Safety condition monitoring: Lessons from "Man-made disasters". *Journal of Contingencies and Crisis Management*, *6*, 88–92.

Flin, R., Mearns, K., O'Connor, P., & Bryden, R. (2000). Measuring safety climate: Identifying the common features. *Safety Science*, *34*, 177–192.
Ghiselli, E. E., Campbell, J. P., & Zedeck, S. (1981). *Measurement theory for the behavioral sciences*. San Francisco, CA: W. H. Freeman.
Griffin, M. A., & Curcuruto, M. (2016). Safety climate in organizations. *Annual Review of Organizational Psychology and Organizational Behavior*, *3*, 191–212.
Guzzo, R. A., Jackson, S. E., & Katzell, R. A. (1987). Meta-analysis. In B. M. Suw & L. L. Cummings (Eds.), *Research in organizational behavior* (pp. 407–442). Greenwich, CT: JAI Press.
Hofmann, D. A., & Stetzer, A. (1996). A cross-level investigation of factors influencing unsafe behaviors and injuries. *Personnel Psychology*, *49*, 307–339.
Huang, Y. H., Chen, P. Y., & Grosch, J. W. (2010). Safety climate: New developments in conceptualization, theory, and research. *Accident Analysis & Prevention*, *42*, 1421–1422.
Huang, Y. H., Zohar, D., Robertson, M. M., Garabet, A., Lee, J., & Murphy, L. A. (2013). Development and validation of safety climate scales for lone workers using truck drivers as exemplar. *Transportation Research Part F: Traffic Psychology and Behaviour*, *17*, 5–19.
Hunter, J. E., & Schmidt, F. L. (2004). *Methods of meta-analysis: Correcting error and bias in research findings* (2nd ed.). New York, NY: Sage.
International Labor Organization. (2016). *Safety and health at work*. Retrieved from http://www.ilo.org/global/topics/safety-and-health-at-work/lang--en/index.htm
Kines, P., Lappalainen, J., Mikkelsen, K. L., Olsen, E., Pousette, A., Tharaldsen, J., … Törner, M. (2011). Nordic Safety Climate Questionnaire (NOSACQ-50): A new tool for diagnosing occupational safety climate. *International Journal of Industrial Ergonomics*, *41*, 634–646.
Krispin, J. V. (1997). *The construction and validation of a measure of safety climate: Exploring the link between attitudes and perceptions around safety and safe performance* (Unpublished Doctoral dissertation), Temple University, Philadelphia, PA.
Lipsey, M. W., & Wilson, D. B. (2001). *Applied social research methods series; Vol. 49. Practical meta-analysis*. Thousand Oaks, CA: Sage Publications, Inc.
Nahrgang, J. D., Morgeson, F. P., & Hofmann, D. A. (2011). Safety at work: A meta-analytic investigation of the link between job demands, job resources, burnout, engagement, and safety outcomes. *Journal of Applied Psychology*, *96*, 71–94.
Neal, A., & Griffin, M. A. (2006). A study of the lagged relationships among safety climate, safety motivation, safety behavior, and accidents at the individual and group levels. *Journal of Applied Psychology*, *91*, 946–953.
Neal, A., Griffin, M. A., & Hart, P. M. (2000). The impact of organizational climate on safety climate and individual behavior. *Safety Science*, *34*, 99–109.
Occupational Safety and Health Administration. (2008). *Recording and reporting occupational injuries and illness* (Part No. 1904). Retrieved from http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id_16312&p_table_FEDERAL_REGISTER
Ones, D. S., & Viswesvaran, C. (1996). Bandwidth-fidelity dilemma in personality measurement for personnel selection. *Journal of Organizational Behavior*, *17*, 609–626.
Pearce, M. E. (2002). *Employer resources: What your boss needs to know*. Retrieved from http://worksafey.8m.com/employer.html
Singer, S., Meterko, M., Baker, L., Gaba, D., Falwell, A., & Rosen, A. (2007). Workforce perceptions of hospital safety culture: Development and validation of the patient safety climate in healthcare organizations survey. *Health Services Research*, *42*, 1999–2021.
Steel, P. D., & Kammeyer-Mueller, J. D. (2002). Comparing meta-analytic moderator estimation techniques under realistic conditions. *Journal of Applied Psychology*, *87*, 96–111.
Tarrahi, F., & Eisand, M. (2016). The influence of judgment calls on meta-analytic findings. *Multivariate Behavioral Research*, *51*, 314–319.
U.S. Government Accountability Office. (2009). *Workplace safety and health (GAO-10–10)*. Washington, DC: Author.
Visser, E., Pijl, Y. J., Stolk, R. P., Neeleman, J., & Rosmalen, J. G. (2007). Accident proneness, does it exist? A review and meta-analysis. *Accident Analysis & Prevention*, *39*, 556–564.
Vroom, V. H. (1964). *Work and motivation*. New York, NY: Wiley.

Weick, K., Sutcliffe, K., & Obstfeld, D. (1999). Organizing for reliability: Processes of collective mindfulness. *Research in Organizational Behavior*, *21*, 81–123.

Wilson, D. B. (2005). *Meta-analysis macros for SAS, SPSS, and Stata*. Retrieved from http://mason.gmu.edu/~dwilsonb/ma.html

Wood, J. (2008). Methodology for dealing with duplicate study effects in a meta-analysis. *Organizational Research Methods*, *11*, 79–95.

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

Zohar, D. (2000). A group-level model of safety climate: Testing the effect of group climate on microaccidents in manufacturing jobs. *Journal of applied psychology*, *85*(4), 587–596.

Zohar, D. (2003). Safety climate: Conceptual and measurement issues. In J. C. Quick & L. E. Tetrick (Eds.), *Handbook of occupational health psychology* (pp. 123–142). Washington, DC: American Psychological Association.

Zohar, D. (2008). Safety climate and beyond: A multi-level multi-climate framework. *Safety science*, *46*(3), 376–387.

Zohar, D. (2010). Thirty years of safety climate research: Reflections and future directions. *Accident Analysis & Prevention*, *42*, 1517–1522.

Zohar, D. (2014). Safety climate: Conceptualization, measurement, and improvement. In B. Schneider & K. M. Barbera (Eds.), *The Oxford handbook of organizational climate and culture* (pp. 317–334). New York, NY: Oxford University Press.

Zohar, D., & Luria, G. (2005). A multilevel model of safety climate: Cross-level relationships between organization and group-level climates. *Journal of Applied Psychology*, *90*, 616–628.