The Safety Climate Assessment Tool (S-CAT): A rubric-based approach to measuring construction safety climate

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A B S T R A C T

Introduction: This paper presents the development and validation of a new rubric-based Safety Climate Assessment Tool (S-CAT). The S-CAT gives companies the opportunity to use rubric descriptors, rather than traditional Likert scale responses, to self-assess their level of safety climate maturity and receive a composite score benchmarked against others in the S-CAT database. *Method:* The S-CAT is composed of 37 separate indicators of 8 safety climate factors identified by construction industry subject matter experts. The eight factors have between three and six indicators each with its own rubric-based response-scale. The scales comprise descriptors for five levels of safety climate maturity ranging from "inattentive" to "exemplary." Nine hundred and eighty-five respondents working in the construction industry completed the S-CAT via our online safety climate website. We used company recordable incident rates (RIR) to assess the S-CAT's criterion-related validity. *Results:* Cronbach alphas for each factor ranged from 0.77 to 0.90 and a confirmatory factor analysis supported the hypothesized eight factor structure with a higher-order safety climate factor. Seven of the eight factor scores, as well as the overall S-CAT score, were significantly negatively correlated with RIR. Moreover, a relative weights analysis indicated that a weighted combination of the eight safety climate factors explained 27% of the variance in organizational RIR. *Conclusions:* These findings provide evidence that the S-CAT is a reliable tool allowing construction companies to self-assess their safety climate along eight different factors. Moreover, the S-CAT was significantly associated with organizational injury rates. *Practical applications*: We discuss how companies can use the rubric descriptors to strengthen their safety management systems and improve their safety climate maturity.

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Over the past few decades, the construction industry has made significant advances and implemented new methods to improve worker safety and health. These include having a more sophisticated understanding and use of prevention through design, enhanced engineering controls, increased regulatory compliance, and improved personal protective equipment. Despite these advances, construction remains one of the most hazardous industries, representing less than 7% of employment in 2016 (Bureau of Labor Statistics, 2016b), yet accounting for nearly 20% of all occupational fatalities that year (Bureau of Labor Statistics, 2016a), with employees facing daily hazards that result in an experienced injury rate that is 44% higher than the national average (Bureau of Labor and Statistics, 2016).

These data have led many in the industry to consider additional strategies that may provide vital information for predicting adverse outcomes before they occur. In particular, a growing body of research has demonstrated that the leading indicator of "organizational safety climate"" (defined as shared perceptions among employees regarding what is rewarded, expected, valued, and reinforced in the workplace

with respect to safety; Zohar, 1980), can positively influence employee safety knowledge, motivation, attitudes, and behaviors, as well as reduce injury outcomes (e.g., Clarke, 2010; Probst, Brubaker, & Barsotti, 2008; Probst & Estrada, 2010; Zohar, 2010). Shifting the focus from lagging indicators such as recordable incidence rates (RIR) and experience modification rates (EMR) to leading indicators such as safety climate gives organizations the opportunity to proactively identify and mitigate safety-related issues that may cause future harm to workers on the jobsite.

Unfortunately, translational research-to-practice efforts that would enable organizations to more readily understand and self-assess their own safety climate have been limited. While many larger contractors may be able to hire safety consultants to assist with such an assessment, 80% of construction establishments have fewer than 10 employees (Choi & Spletzer, 2012; CPWR, 2013) often rendering such an investment cost-prohibitive. Thus, the practical application of two decades of safety climate research has remained largely out of reach for the vast majority of construction firms. The purpose of the current project was to begin addressing this need by developing and validating a new rubric-based measurement tool that construction companies of any size could use to self-assess their level of safety climate maturity and

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identify ways to continually improve along the spectrum from being a company that is inattentive to a wide range of safety issues to one that is exemplary in their efforts to protect workers' health.

Below we begin our literature review by discussing the concept of safety climate in greater depth and reviewing traditional approaches to the measurement of safety climate. Following this, we propose and discuss the advantages of using a rubric-based tool as an alternative approach.

1. The importance of safety climate

Organizational safety climate has been defined as employee perceptions regarding organizational policies, practices, and procedures that signal the value and importance of safety within the workplace (Neal, Griffin, & Hart, 2000). Given that safety often competes with other organizational priorities such as productivity or customer service, an organization's safety climate reflects the extent to which employees perceive that safety is prioritized within the workplace allowing employees to ascertain the enacted rather than merely the espoused relevance of safety within their company (Zohar, 2003). In other words, a positive safety climate provides employees with cues that safe behaviors and outcomes are valued, supported, and rewarded in the workplace.

Not surprisingly, numerous meta-analyses of safety climate (Beus, Payne, Bergman, & Arthur Jr, 2010; Christian, Bradley, Wallace, & Burke, 2009; Clarke, 2006, 2010; Jiang, Lavaysse, & Probst, 2019; Nahrgang, Morgeson, Hofmann, & Kozlowski, 2011) have shown that safety climate is predictive of workplace accidents, injuries, underreporting of safety incidents, near misses, safety knowledge, safety motivation, safety compliance, and safety-related organizational citizenship behaviors. Given the clear relevance of safety climate to worker safety behavior and important safety-related outcomes, it is critical for organizations to be able to easily measure, assess, and take steps to continually improve their safety climate.

1.1. Approaches to measuring safety climate

Numerous measures of organizational safety culture and climate can be found in the literature (e.g., Brown & Holmes, 1986; Dedobbeleer & Béland, 1991; Coyle, Sleeman, & Adams, 1995; Flin, Mearns, O'Connor, & Bryden, 2000; Seo, Torabi, Blair, & Ellis, 2004; see Schwatka, Hecker, & Goldenhar, 2016 for a review). These measures have been designed to be used in a variety of industries and are diverse in their measurement approach. Namely, there are three distinguishing characteristics. First, one category of safety climate measures can be labeled "universal" measures (e.g., Neal et al., 2000) in that they capture the general facets of safety climate that are common across many occupations and industries. Others – labeled "industry-specific" – are tailored to the specific hazards and contextual features of work in a particular industrial setting (e.g., the construction industry vs. health care or aviation; Ciavarelli, 2003; Dedobbeleer & Béland, 1991; Singer et al., 2007).

In a meta-analytic comparison of universal versus industry-specific measures, recent research by Jiang et al. (2019) found that while both types of measures were equally predictive of accidents and injuries, the industry-specific measures of safety climate were more predictive of actual employee safety behavior and risk perceptions (i.e., the perceived risk level of one's job or job site) than the universal measures of safety climate. This implies that well-validated industry-specific tools may be more useful than reliance on universal measures of safety climate, since industry-specific measures perform *as well as* universal measures when predicting accidents and injuries, and they perform *better* when predicting employee behavior and risk perceptions.

Another distinction in safety climate measures can be reflected in the choice to use a referent-shift versus a direct consensus approach to operationalizing climate after collecting individual employee responses about the climate. For example, some measures (e.g., Kines et al., 2011)

ask respondents to indicate what they believe people within their workplace think about the safety climate (a referent-shift approach), whereas other measures (e.g., Neal et al., 2000) aggregate individual perceptions (i.e., what "I think") to the organizational level after statistically confirming that adequate within-group agreement exists (a direct consensus approach). Empirical research (Wallace et al., 2016) indicates that the referent-shift approach (i.e., one that utilizes items reflecting the collective rather than the individual) better predicts performance outcomes (including safety) than the direct consensus approach; whereas the direct consensus approach is better when predicting attitudinal outcomes (e.g., job satisfaction). This suggests that if the intended use of a safety climate measure is to predict a performance-based outcome (e.g., organizational RIR), a referent-shift approach may be preferred.

Finally, a third distinguishing characteristic of safety climate tools is reflected in their choice of response scales. The majority of safety climate measurement instruments ask respondents to record their safety climate perceptions using a Likert-based response scale typically ranging from "strongly disagree" to "strongly agree." Once all responses are gathered, an overall safety climate score is calculated by summing or computing the mean, which is then provided to company decision-makers. Although studies have demonstrated that safety climate scores are significantly related to employee safety attitudes, performance, and injury outcomes (e.g., Clarke, 2010; Jiang et al., 2019), the meaning and interpretation of such a safety climate score can be nonintuitive for practitioners and employees. Moreover, a safety climate score by itself does not provide normative information or guidance regarding how organizations can improve their safety climate. For example, if a score indicates that, on average, employees "slightly or somewhat agree" that management values safety, that score does not provide the organization with information on what steps it can take to strengthen that safety climate area.

A less common strategy has been to take a mixed quantitative-qualitative approach to self-assessing organizational safety climate using rubrics. A rubric is a scoring tool that lists the critical dimensions related to a construct of interest. Through the use of specific representative descriptors, a rubric articulates gradations of quality for each dimension ranging from poor to excellent. Although rubrics are most commonly used in educational settings to describe student mastery levels, they can be applied to nearly any appraisal context. The advantage of a rubric is that it not only can be used to evaluate performance, but it can also be used to provide guidance for *how to improve performance*. Thus, unlike the more traditional Likert measures of safety climate described above, a safety climate rubric score has the potential to provide organizations with richer, more informative, and actionable feedback about their strengths and areas for future improvement.

Although meta-analytic research provides guidance advocating for the use of industry-specific measures that utilize a referent-shift approach to operationalize climate, less is known about the validity of a rubric versus Likert-based response scale approach. Although the rubric approach is an innovative shift from the existing assessment methodology used to measure safety climate, it is an empirical question as to whether such a rubric assessment would be related to important lagging indicators such as organizational recordable incident rates. Toward that end, we now describe the conceptual foundation for developing a construction industry-specific rubric-based Safety Climate Assessment Tool (S-CAT), as well as the process used to validate it.

1.2. Conceptualization of construction safety climate and early development of high-level rubrics

As reviewed above, research (Jiang et al., 2019) indicates that when a central goal of measuring safety climate is to predict employee behavior and eventually reduce work-related accidents and injuries, industry-specific measures may be preferable to universal measures. Therefore, it was necessary for our team to create a safety climate assessment tool grounded in an industry-specific conceptualization of safety climate

within the construction industry. Toward that end, in June 2013, CPWR – The Center for Construction Research and Training in collaboration with the National Institute of Safety and Health (NIOSH), invited 70 stakeholders from the construction industry (e.g., contractors, labor/trade organizations, researchers, safety consultants) to a one-and-a-half-day workshop to discuss and agree on construction-specific safety climate definitions and the key factors of the safety climate that construction companies could target for their improvement efforts (CPWR, 2014b).

After a series of roundtable discussions among these subject matter experts, the following eight critical safety climate factors emerged from the workshop:

1. Demonstrating management commitment
2. Aligning and integrating safety as a value
3. Ensuring accountability at all levels
4. Improving site safety leadership
5. Empowering and involving workers
6. Improving communication
7. Training at all levels
8. Encouraging owner/client involvement

Workshop attendees then worked together to create descriptive text indicative of each factor that construction firms could use to evaluate their safety climate maturity. Specifically, this entailed creating descriptions reflective of each level of safety climate maturity ranging from "inattentive" to "exemplary" for each of the eight factors (see Parker, Lawrie, & Hudson, 2005 for a similar rubric-based approach to measuring safety culture in the oil and gas industry). These initial high-level rubrics and associated ideas for improvement for each factor were compiled into a practical workbook (CPWR, 2014a). Fig. 1 presents the high-level rubric for Demonstrating Management Commitment.

Although these initial high-level rubrics provided general descriptions of safety climate at each level of safety climate maturity, further refinements were needed to provide more actionable information organizations could use in order to progress from one level to the next. Below we describe how we developed the Safety Climate Assessment Tool (S-CAT) using the initial high-level rubrics generated in the workshop.

1.3. Development of the S-CAT

The first stage in developing the S-CAT was to review the high-level rubrics and extract the specific indicators associated with each of the eight factors. This involved an inductive and iterative content coding approach requiring consensus among the authors before finalizing the relevant activities. Fig. 2 presents an example from the Demonstrating Management Commitment factor. As can be seen, six factor indicators reflecting management commitment to safety were extracted from the general descriptions shown in Fig. 1. The indicators include: (a) being present and visible on the jobsite, (b) modeling appropriate safety behaviors on site, (c) identifying and reducing job hazards, (d) having established practices for needed corrective action, (e) compassionately reacting to experienced injuries on site, and (f) regularly reviewing safety trends and updating safety policies and procedures. Following this same iterative process, we identified between 3 and 6 indicators for each safety climate factor for a total of 37 indicators across the 8 factors.

Next, for each indicator we created safety climate descriptors representing each level of climate maturity, taking care to avoid content overlap across the eight safety climate factors. As with the initial high-level rubrics developed in the CPWR workshop, climate maturity descriptors for each indicator were developed to reflect each of the following safety climate levels: inattentive, reactive, compliant, proactive, and exemplary. As an example, for Demonstrating Management Commitment, in an inattentive organization, the indicator "being present and visible on the jobsite" is reflected by managers only rarely coming to the jobsite. On the other hand, in an exemplary organization, "being present and visible" would be exhibited by managers frequently visiting the jobsite and proactively seeking out interactions with employees. Again, creation of these climate maturity descriptors involved an iterative process of identifying the core theoretical concepts associated with each level of climate maturity, generating specific descriptors to represents those levels, and achieving consensus among the authors before finalizing the content of each of the climate maturity indicators.

1.4. Validation of the S-CAT

We used a multi-pronged approach to validating the new S-CAT tool. First, it was important to evaluate whether S-CAT data collected from individuals and organizations fit the hypothesized eight factor conceptualization of construction safety climate developed by the subject matter experts in the 2013 CPWR workshop. Therefore, we first tested our hypothesis that:

UNINFORMED $\longrightarrow$	REACTIVE $\longrightarrow$	COMPLIANT $\longrightarrow$	PROACTIVE $\longrightarrow$	EXEMPLARY
Representation from management rarely comes to the actual jobsite. When they are present, they often act as poor safety role models by breaking organizational safety policies and procedures. Management does not participate in safety audits. If employees bring concerns to any level of management they are not acted upon.	Management gets involved only after an injury occurs. They often blame employees for injuries, leading to suspension or even termination. Safety rules are enforced only after an incident or when audit results are negative.	Management conforms strictly to OSHA regulations, never more or less. Safety compliance is based on owner or regulatory directives. Managers participate in safety audits.	Management initiates and actively participates in safety audits. Managers meet with workers to ask for advice and feedback regarding hazard reduction. Management conducts spontaneous site visits and recognizes workers for identifying hazards, working safely, and keeping co-workers safe. Leaders participate in safety program development and provide adequate resources to ensure a positive safety climate. The safety management system is reviewed annually to ensure effectiveness and relevance.	Management integrates safety into every meeting and engages in continuous improvement regarding safety conditions and hazard reduction. External audits are conducted to evaluate top management's involvement in safety. Managers are held accountable for safety expectations through annual performance evaluations. Safety trends are analyzed. There is a formalized process for corrective actions.

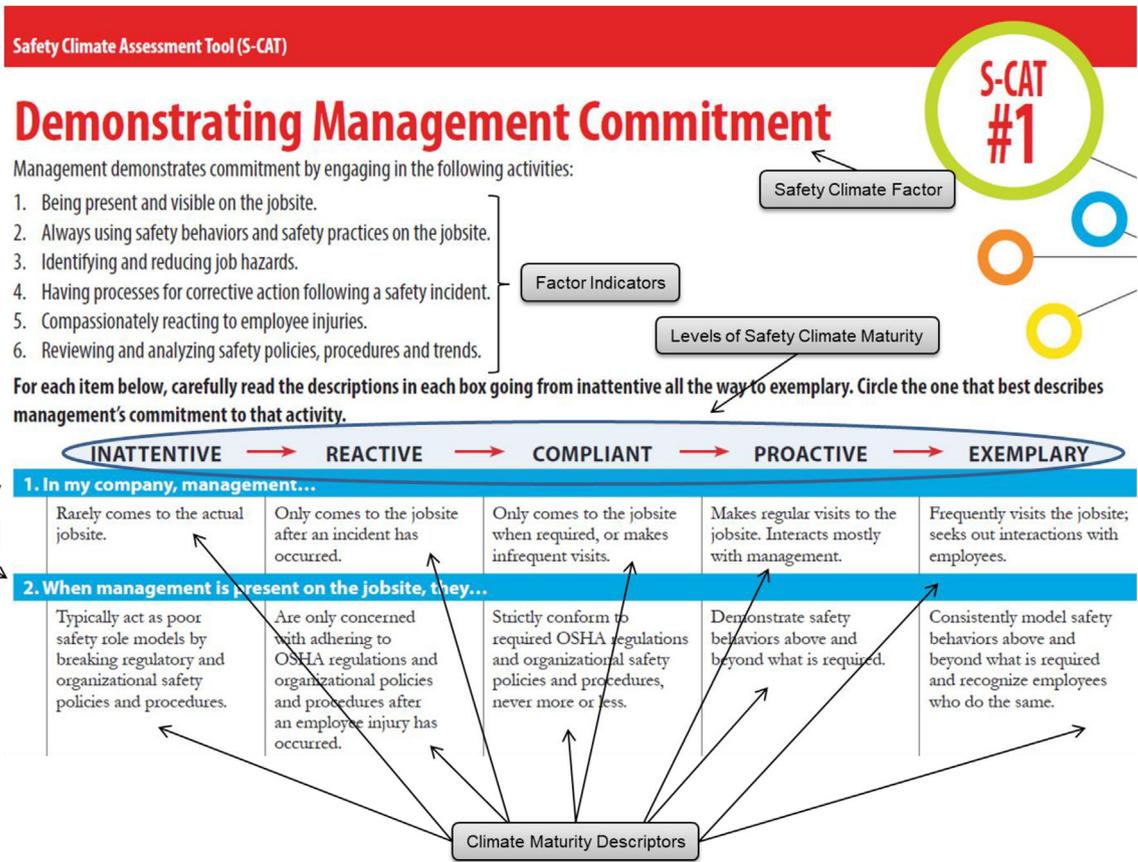**Fig. 1.** High-level rubric for Demonstrating Management Commitment factor.

Fig. 2. Sample S-CAT rubric snippet.

Hypothesis 1. An 8-factor model of safety climate will provide a better fit to the data than a single safety climate factor.

We also expected that there would be a general higher-order safety climate factor onto which the eight factors would load. Thus, we tested a second hypothesis:

Hypothesis 2. A higher-order safety climate model with eight factors will provide an equal or better fit to the data compared to an 8-factor model.

Finally, in addition to confirming the factor structure, we wanted to assess the S-CAT's criterion-related validity by determining the degree to which S-CAT scores are correlated with relevant organizational safety outcomes. Perhaps the most frequently cited indicator of organizational safety performance is the organizational recordable incidence rate (RIR). In order to make an apples-to-apples comparison on a common metric, the RIR represents a standardized method for computing the safety of an organization's work environment by measuring the number of safety incidents experienced in the company (per 100 full time workers) on an annualized basis (Occupational Safety and Health Administration, 2018). An organization's RIR is commonly used as a gauge for how safe a company is and can influence a company's competitiveness when bidding for contracts. It can also directly or indirectly influence a company's experience modification rate (EMR), which is used by insurance companies to determine the past cost of injuries, future risk assessment, and how high an organization's worker compensation premiums might be in the future.

Research has shown that safety climate is associated with subsequent safety performance and risk of injuries. For example, in their safety climate meta-analyses, both Clarke (2006) and Beus et al. (2010) reported a corrected population correlation of $\rho = -0.22$

between organizational safety climate and employee accidents/injuries. Given these previously identified relationships we hypothesized that criterion-related validity evidence would be demonstrated if:

Hypothesis 3. S-CAT scores are negatively associated with organizational recordable incidence rates.

2. Method

2.1. Participants and procedure

The S-CAT has been available in either paper-based or online formats[1] since autumn 2015. We have publicized its availability by presenting at construction conferences and directly to industry stakeholders. Following classification of the research as exempt by our Institutional Review Boards, completed S-CAT responses were collected from 985 individuals employed within the construction industry.[2] Many of the S-CAT surveys (N = 558 respondents) were completed as part of company's (n = 49) or other group's (e.g., local union, trade association; n = 9) effort to assess their safety climate. The remainder (N = 427) were completed by individuals employed within the construction industry but not as part of a company-wide assessment effort. Thus, the full data set was used to test Hypotheses 1 and 2, whereas only responses from those

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individuals who were nested within identifiable organizations with an obtainable RIR were used to test Hypothesis 3.

Of the 985 individual respondents, 24% self-identified as a safety manager/director; 15% as a supervisor; 9% as a foreman; 8% as a project superintendent; 3% as a project manager; 1% as a company owner; and 39% as other (e.g., apprentice, journeyman, carpenter, laborer, builder, lead). Approximately 44% of respondents worked for a general contractor, whereas 42% were employed by a sub-contractor; 12% indicated "Other" and 2% did not answer.[3] In order to gauge establishment size, we asked respondents to indicate how many hours their company worked annually. Nine percent responded fewer than 150,000 h annually; 9% indicated between 150,000 and 400,000 h; and 34% reported over 400,000 h annually. The remaining respondents (49%) either indicated they did not know the number of hours or did not respond to the question.

Fifty-five percent of respondents were working in a union environment; 29% non-union; 15% mixed union and non-union; and, 1% did not respond. The most frequently represented areas of construction work were: Nonresidential Construction (20%); Electrical (20%); Heavy Construction (10%); Industrial Buildings and Warehouses (9%); Plumbing/HVAC (8%); and, Special Trade Contractors (7%).

2.2. Measures

In addition to collecting the above demographic and organizational information from each respondent, we also gathered the following measures.

2.2.1. Safety climate

The Safety Climate Assessment Tool (S-CAT) is composed of eight safety climate factors with between 3 and 6 indicators for each factor. For each indicator, we developed a corresponding item for a total of 37 items, specifically: *Demonstrating management commitment* (6 items); *Aligning and integrating safety as a value* (6 items); *Ensuring accountability at all levels* (4 items); *Improving supervisor leadership* (3 items); *Empowering and involving employees* (3 items); *Improving communication* (3 items); *Training at all levels* (6 items); and *Encouraging owner/client involvement* (6 items). For each item, respondents select the climate maturity descriptor that best describes the level of safety climate maturity within their company. Fig. 2 shows items 1 and 2 from Demonstrating Management Commitment factor; the complete S-CAT is available from https://www.safetyclimateassessment.com.

As noted above, S-CAT scores for each item could range from 1 to 5 and were assigned based upon the safety climate maturity level descriptor selected by participants (i.e., Inattentive = 1 to Exemplary = 5). Factor scores were then calculated by taking the mean of their respective items (e.g., the six demonstrating management commitment items). For the purposes of testing the third hypothesis, a total S-CAT score was computed by calculating the mean of all 37 items.

2.2.2. Recordable incidence rate (RIR)

The Occupational Safety and Health Administration (OSHA, 2018) defines a recordable incident as any work-related injury or illness that results in death, loss of consciousness, days away from work, restricted job duty or transfer, or medical treatment beyond first aid). The RIR represents the number of annual work-related injuries and illnesses per 100 full-time workers (i.e., 40 h./wk., 50 wk./yr.) and is calculated using the following formula: $(N/EH) \times 200{,}000$, where $N =$ the number of injuries or illnesses recorded in the company's OSHA log, $EH =$ total hours worked by all employees during the calendar year and the value 200,000 is used as base number of hours for 100 equivalent full-time workers (Bureau of Labor Statistics, 2007). This results in a standardized incidence rate that can be used to draw comparisons across companies

regardless of the number of employees or hours worked (Bureau of Labor Statistics, 2007).

Company contacts (typically the safety manager) were asked to provide their most recent RIR resulting in N = 49 unique organizational RIRs ranging from 0 to 17.80 (M = 2.35, SD = 2.81).[4] This average RIR is slightly lower than the construction industry average of 3.20 (BLS, 2016), $t(48) = -2.11$, $p = .04$, indicating that our sample may be skewed slightly in favor of organizations with lower RIRs than more typical construction companies.

2.3. User feedback

After completing the S-CAT, companies receive a tailored report providing detailed feedback on how their organization scores on each safety climate factor, as well as how their scores compare to industry benchmarking norms based on all scores contained in the S-CAT database. Companies are also provided guidance and ideas for how to improve in each area. As a result, they can use the S-CAT scores to longitudinally track and evaluate the effectiveness of any company-wide safety-related interventions implemented as a result of the S-CAT feedback. Individual respondents receive a shorter feedback report that simply compares their responses to the overall benchmarking norms contained in the S-CAT database. Visit www.safetyclimateassessment.com to view the full S-CAT tool, as well as the supplemental resources provided to improve climate within each factor.

2.4. Analyses

SPSS 24 was used to calculate item-level descriptive statistics, compute scale and factor reliabilities, as well as assess the relationship between S-CAT scores and the RIRs. Confirmatory factor analyses were conducted in MPlus 6.1 to test the factor structure of the S-CAT (Muthén & Muthén, 2010), allowing us evaluate whether the S-CAT data fit the hypothesized eight factor conceptualization of construction safety climate developed by the subject matter experts in the 2013 CPWR workshop. Finally, to assess the criterion-related validity of the eight factor scores and total variance explained, a relative weights analysis (Johnson, 2000) was conducted using RWA-web (Tonidandel & LeBreton, 2015).

3. Results

3.1. Item-level descriptive statistics

Table 1 provides item level descriptive statistics for the 37 S-CAT items as well as confirmatory factor loadings (discussed below). As can be seen, respondents used the full range of the Inattentive to Exemplary scale for all items. However, all items were negatively skewed suggesting these respondents tended to report their organization had a relatively high level of safety climate maturity. Additionally, more than 20% of respondents failed to respond to one item (#4 on the encouraging owner/client involvement factor). This item used an abbreviation (PtD) for the term Prevention through Design; however, not all respondents may have been familiar with the abbreviation or concept.

3.2. Scale and sub-scale reliability and intercorrelations

Table 2 presents the Cronbach's alpha reliability coefficients for the overall S-CAT and each factor, as well as their intercorrelations. As can be seen, the scale reliability was 0.97 for the 37-item scale. Moreover, factor reliabilities were generally excellent, ranging

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[3] If an individual did not know the answer to a specific demographic or organizational item, they were instructed to leave it blank.

[4] One organizational RIR of 17.8 was identified as an extreme outlier ($z = 4.51$; Studentized deleted residual of 9.15; and Cook's D of 0.35). Therefore, this RIR was omitted from further analyses utilizing the RIR.

Table 1
Item-level descriptive statistics and Confirmatory factor (CFA) loadings.

Items	N	Min	Max	Mean	SD	Skewness	Kurtosis	Factor Loading
Demonstrating management commitment								
Item 1	956	1	5	3.89	1.05	−1.02	0.87	0.64
Item 2	952	1	5	3.76	0.95	−0.75	0.65	0.73
Item 3	949	1	5	3.70	1.05	−0.76	0.31	0.67
Item 4	958	1	5	3.93	0.86	−0.75	0.73	0.70
Item 5	941	1	5	4.27	0.85	−1.16	1.18	0.69
Item 6	943	1	5	3.88	1.01	−0.82	0.47	0.72
Aligning and integrating safety as a value								
Item 1	970	1	5	4.14	0.80	−0.95	1.12	0.75
Item 2	963	1	5	4.41	0.84	−1.27	1.00	0.69
Item 3	974	1	5	4.04	0.88	−0.88	0.63	0.77
Item 4	973	1	5	4.26	0.81	−1.15	1.51	0.81
Item 5	952	1	5	4.16	0.94	−1.32	1.83	0.76
Item 6	969	1	5	4.08	0.89	−0.92	0.61	0.76
Ensuring accountability at all levels								
Item 1	940	1	5	3.70	0.94	−0.53	−0.11	0.81
Item 2	937	1	5	3.79	1.05	−0.93	0.64	0.78
Item 3	966	1	5	4.13	0.85	−1.20	2.05	0.80
Item 4	950	1	5	3.37	1.30	−0.80	−0.55	0.72
Improving supervisor leadership								
Item 1	965	1	5	3.77	0.90	−0.58	0.34	0.82
Item 2	945	1	5	3.80	1.04	−0.69	−0.06	0.72
Item 3	959	1	5	3.92	0.82	−0.70	0.91	0.83
Empowering and involving employees								
Item 1	973	1	5	3.72	0.91	−0.36	0.03	0.79
Item 2	968	1	5	3.80	0.96	−0.83	0.80	0.80
Item 3	944	1	5	3.65	1.20	−1.01	0.25	0.63
Improving communication								
Item 1	970	1	5	3.94	0.83	−1.15	1.93	0.79
Item 2	939	1	5	4.06	0.95	−0.86	0.29	0.77
Item 3	966	1	5	4.12	0.89	−0.92	0.51	0.80
Training at all levels								
Item 1	958	1	5	3.89	0.91	−0.74	0.69	0.79
Item 2	929	1	5	3.62	1.19	−0.85	−0.19	0.59
Item 3	940	1	5	3.72	0.95	−0.79	0.74	0.79
Item 4	953	1	5	3.73	0.90	−0.82	1.05	0.80
Item 5	942	1	5	3.78	0.94	−0.70	0.60	0.77
Item 6	936	1	5	3.83	0.99	−0.58	−0.18	0.74
Encouraging owner/client involvement								
Item 1	923	1	5	3.54	1.07	−0.82	0.27	0.79
Item 2	912	1	5	3.60	0.97	−0.38	−0.11	0.81
Item 3	870	1	5	3.75	1.07	−0.85	0.26	0.76
Item 4	776	1	5	3.28	1.28	−0.69	−0.63	0.63
Item 5	906	1	5	3.66	0.95	−0.63	0.33	0.81
Item 6	918	1	5	3.57	1.02	−0.58	0.21	0.78

from 0.77 (Empowering and Involving Employees) to 0.90 (Encouraging Owner/Client Involvement).

Correlations among the different factors ranged from 0.49 to 0.90, with an average correlation of 0.71. In general, Encouraging Owner/Client Involvement exhibited the lowest correlations with the other factors (ranging from 0.49 to 0.61). Given these correlations, our next step was to determine whether a single-factor model provided an adequate fit to

the data or if the hypothesized 8-factor model provided a significantly better fit.

3.3. S-CAT factor structure

To test the hypothesized factor structure of the S-CAT, nested confirmatory factor analyses were conducted in MPlus 6.1 (Muthén & Muthén, 2010) using robust maximum likelihood estimation. Based on recommendations in the literature (Byrne, 2006; Meade, Johnson, & Braddy, 2008), we used a number of goodness-of-fit indices to assess model fit: comparative fit index (CFI), Tucker-Lewis Index (TLI), root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). The CFI and TLI are both considered incremental fit indices that compare the model of interest with a null or independence model (Bentler, 1990), with values of 0.90–0.95 indicating acceptable fit and values above 0.95 indicating good fit (Hu & Bentler, 1999). The RMSEA and SRMR are both indices of absolute fit estimating the lack of model fit between the observed and predicted correlations; the RMSEA has the additional advantage of compensating for model complexity. In general, values of 0.05 or lower indicate a good-fitting model (Browne & Cudeck, 1993). Additionally, we report traditional chi-square statistics. However, because chi-squares are highly sensitive to sample size (Cheung & Rensvold, 2002), to evaluate and compare the fit of the nested models, we examined the difference in CFI (ΔCFI). As noted by Cheung and Rensvold (2002), a CFI difference larger than 0.01 would indicate a meaningful change in model fit.

The first model we estimated was a 1-factor model with all S-CAT items loading on a single safety climate factor. The fit indices for this model suggested a poor to moderate fit to the data, $\chi^2(629) = 3098.65$; CFI = 0.86; TLI = 0.85; RMSEA = 0.060; and SRMR = 0.052. We next tested the hypothesized 8-factor model; $\chi^2(601) = 1234.63$; CFI = 0.96; TLI = 0.96; RMSEA = 0.033; and SRMR = 0.031. A comparison of these fit indices indicates that the predicted 8-factor model fits considerably better than the single factor model, supporting Hypothesis 1. Moreover, the ΔCFI was 0.10, which greatly exceeds the Cheung and Rensvold (2002) criterion for a meaningful change in model fit. Thus, Hypothesis 1 was supported in that an 8-factor model fit the observed data better than a single-factor model.

To test Hypothesis 2, a third nested model was assessed to determine whether the eight safety climate factors loaded onto a higher-order safety climate factor. The fit indices of this more restrictive model remained nearly identical to those reported above, $\chi^2(621) = 1298.85$; CFI = 0.96; TLI = 0.96; RMSEA = 0.033; and SRMR = 0.033. Moreover, the ΔCFI was 0.00, indicating equivalent fit to the less parsimonious 8-factor model. Therefore, in support of Hypothesis 2, this third model was accepted as the final model due to its excellent fit and greater parsimony.

Standardized factor loadings from the final model for the S-CAT items can be found in Table 1. Factor loadings can be interpreted as the correlation coefficient between observed variables (e.g., items) and their purported latent factor (e.g., "demonstrating management commitment"). As can be seen, factor loadings for items within each

Table 2
S-CAT scale and sub-scale reliabilities, intercorrelations, and validity coefficients.

Variable	# Items	1	2	3	4	5	6	7	8	9
1. Total S-CAT	37	*0.97*								
2. Demonstrating management commitment	6	0.89	*0.85*							
3. Aligning and integrating safety as a value	6	0.93	0.83	*0.89*						
4. Ensuring accountability at all levels	4	0.92	0.88	0.90	*0.85*					
5. Improving supervisor leadership	3	0.84	0.67	0.74	0.77	*0.82*				
6. Empowering and involving employees	3	0.88	0.76	0.78	0.82	0.79	*0.77*			
7. Improving communication	3	0.91	0.84	0.86	0.86	0.74	0.83	*0.83*		
8. Training at all levels	6	0.82	0.59	0.69	0.66	0.69	0.69	0.70	*0.88*	
9. Encouraging owner/client involvement	6	0.68	0.51	0.51	0.50	0.49	0.53	0.49	0.61	*0.90*
10. Organizational RIR	1	−0.30	−0.30	−0.37	−0.28	−0.32	−0.33	−0.24	−0.13	−0.07

Note: Listwise organizational n = 46. Cronbach's reliability coefficients are placed on the diagonal. Correlations greater than |0.29| are significant at $p < .05$.

factor ranged from 0.59 to 0.83. Moreover, the lower-order factor loadings onto the higher-order safety climate factor (i.e., the correlations between each safety climate factor and the overall safety climate) ranged from 0.72 (Encouraging owner/client involvement) to 0.95 (Ensuring accountability at all levels; Empowering and involving employees).

3.4. Validity of the S-CAT

To evaluate Hypothesis 3, we tested the validity of the S-CAT and its factors by computing the average safety climate score among respondents within each unique organization and correlating these scores with the organization's RIR as provided by the company's representative. Respondents who were not part of company-wide safety climate assessments (i.e., individual respondents for whom we could not verify the company's RIR) were excluded from this analysis. Thus, the resulting organizational-level sample size for this analysis was smaller (n = 46).

As shown in Table 2, organizational-level safety climate was significantly and negatively correlated with organizational RIR scores, $r = -0.30$, $p < .05$. Moreover, all factors were also negatively correlated with an organization's RIR ranging from $r = -0.07$ (ns) for Owner/Client Involvement to -0.37 (p < .05) for Aligning and Integrating Safety as a Value. Thus, the results show support for the criterion validity of S-CAT.

To further assess the relative predictive validity of the factor scores and total variance explained, a follow-up relative weights analysis (Johnson, 2000) was conducted using RWA-web (Tonidandel & LeBreton, 2015). As noted by Tonidandel, LeBreton, and Johnson (2009), relative weights analysis is particularly useful when there is collinearity among predictors which may result in traditional regression approaches not detecting significant incremental variance. As presented earlier in Table 2, the S-CAT factor correlations ranged from 0.49 to 0.90, indicating substantial potential collinearity. Moreover, relative weights analysis provides bias corrected confidence intervals based on bootstrapping with 10,000 replications.

Table 3 provides a summary of the relative weights analysis (RWA) results. The raw relative weights indicate the incremental variance in RIR explained by each predictor. The RWA results indicate that a weighted combination of our eight safety climate factors explained 27% of the variance in organizational RIR with Aligning and Integrating Safety as a Value accounting for the most variance (6.88%) and Encouraging Owner/Client Involvement accounting for the least (1%).

To facilitate interpretation of which factors accounted for proportionally more variance, rescaled relative weights indicate the percentage of total variance explained by each factor. In other words, of the total variance explained, Aligning and Integrating Safety as a Value provided the most variance explained relative to the other predictors (25.53% of the total explained variance). Improving Supervisor Leadership accounted for an additional 4.54% of the RIR variance (or 16.84% of the total variance explained by all the predictors).

Table 3
Summary of Relative Weights Analysis.

Predictor	RW	CI-L	CI-U	RS-RW
Demonstrating management commitment	0.0348	0.008	0.096	12.91%
Aligning and integrating safety as a value	0.0688	0.016	0.152	25.53%
Ensuring accountability at all levels	0.0286	0.005	0.048	10.62%
Improving supervisor leadership	0.0454	0.011	0.118	16.84%
Empowering and involving employees	0.0392	0.010	0.076	14.57%
Improving communication	0.0231	0.005	0.038	8.57%
Training at all levels	0.0195	0.004	0.030	7.23%
Encouraging owner/client involvement	0.0100	0.002	0.019	3.71%

Note: * p < .05 **p < .01.
RW = Raw Relative Weights; CI-L = Lower Confidence Interval; CI-U: Upper Confidence Interval; RS-RW = Rescaled Relative Weights.

4. Discussion

In 2016 alone, over 200,000 construction workers experienced a work-related injury or illness within the United States (BLS, 2017). Over the course of their career, a construction worker has a 78% chance of getting injured at work (Dong, Ringen, Welch, & Dement, 2014). Such events carry significant direct and indirect costs for employers, affected workers and their families, as well as society as a whole. The cost of construction-related injuries to workers, contractors, and the industry totals over $11 billion per year or about $27,000 per injured construction worker (Waehrer, Dong, Miller, Haile, & Men, 2007). According to a recent analysis of all industry sectors (Leigh, 2011), companies pay nearly $1 billion per week in workers' compensation costs alone; yet, workers' compensation represents less than one-quarter of the total economic burden associated with work-related injuries. Including indirect costs associated with retraining, productivity losses, uninsured costs, and repairs to damaged property or equipment, the total estimated costs approach $250 billion annually. To put this into context, these total costs of job-related injuries and illnesses are on par with the total cost of cancer ($219 billion) and exceed that of coronary artery disease ($152 billion; Leigh, 2011). These dollar amounts do not reflect the non-monetary costs imposed on affected workers and their families in terms of quality of life and pain or suffering.

As a result, there are compelling economic and social incentives driving companies to identify strategies to reduce job-related incidents and to improve overall workplace safety. However, focusing on lagging indicator statistics alone cannot inform how organizations can best achieve these goals. Therefore, it is not surprising that the past several decades has witnessed a shift away from reliance on lagging retrospective indicators toward a focus on leading indicators whose measurement can enable companies to proactively monitor and continually improve their safety environment.

One such leading indicator that has been shown to reliably and consistently predict a variety of safety-related outcomes is organizational safety climate. Despite a plethora of empirical evidence demonstrating the importance of building a positive and robust safety climate (Beus et al., 2010; Christian et al., 2009; Clarke, 2006, 2010; Jiang et al., 2019; Nahrgang et al., 2011), these scientific results have been difficult to translate into practice for organizations due to the lack of easy-to-use and freely available safety climate assessment tools that provide actionable information companies can use to improve their safety climate and ultimately safety-related adverse outcomes.

Therefore, the purpose of our research was to develop and validate a rubric-based safety climate assessment tool (S-CAT) that would meet both psychometric and practical goals. Indeed, our results indicate that the S-CAT appears to exhibit excellent psychometric properties. The total scale and its factors are highly reliable. Additionally, the importance of the unique eight factors originally identified by construction industry subject matter experts was confirmed via factor analysis that demonstrated that the S-CAT items loaded onto the hypothesized eight factors which themselves loaded onto a single higher-order safety climate factor. Equally important, company S-CAT scores are significantly related to the organizational recordable incidence rate – accounting for 27% of the variance in this important lagging indicator of safety.

4.1. Contributions to science and practice

Our research makes several important contributions to academic researchers as well as applied practitioners within the construction industry. First, to our knowledge, the S-CAT represents the first rubric-based safety climate measure designed for the construction industry. This is particularly significant given recent empirical evidence attesting to the importance of developing valid industry-specific measures of safety climate (e.g., Jiang et al., 2019). From a practical perspective, the S-CAT provides construction companies of any size the opportunity to assess their organizational and job

site safety climate all at no cost. As noted earlier, after completing the S-CAT, companies receive a tailored report providing detailed feedback on how their organization scores on each safety climate factor, as well as how their scores compare to industry benchmarking norms based on all scores contained in the S-CAT database. Companies are also provided guidance and ideas for how to improve in each area. As a result, they can use the S-CAT scores to longitudinally track and evaluate the effectiveness of any company-wide safety-related interventions implemented as a result of the S-CAT feedback.

Another advantage of the S-CAT is that early on industry stakeholders provided input into helping to define safety climate in construction, its leading indicators, and improvement ideas. This subject matter expert approach resulted in a tool that reflects the realities of the construction industry, increasing the likelihood of its acceptance and use by the target audiences – construction employers, safety and health professionals, and workers. As noted earlier, the tool's standardized process for collecting and compiling industry data creates a unique and dynamic way to track the industry's safety climate norms overtime. To date, information on industry-specific safety climate norms has not been readily available to construction employers. The S-CAT gives construction employers an easy and uniform way to assess their company's safety climate, and the reports generated allow them to compare and track their progress against these industry norms over time.

The S-CAT also provides a new platform for detecting areas ripe for safety climate related research by identifying specific indicators that need to be strengthened in order for a company to successfully move along the path to achieving an 'exemplary' safety climate. For example, CPWR – The Center for Construction Research and Training along with academic and industry subject matter experts developed the 2.5 h Foundations for Safety Leadership (FSL) training module to specifically target the factor "Improving Supervisory Leadership." Indeed, since its official rollout on January 1, 2017 many companies have started their safety climate improvement journey by first taking the S-CAT and then implementing the FSL as a safety management intervention to target a low scoring Improving Supervisory Leadership factor. The FSL has also been incorporated into the OSHA 30-h and companies can download all the training and support materials for free at https://www.cpwr.com/foundations-safety-leadership-fsl. To date, over 10,000 individuals have participated in the FSL training.

4.2. Directions for future research and application

Despite the positive initial evidence supporting the use of the S-CAT, there remain several avenues for continued improvement. As noted, employee responses to the S-CAT items tended to be negatively skewed; moreover, the average organizational RIR of participating companies was slightly lower than the industry average. Together, these suggest that the employees and organizations who have used the S-CAT to date might represent construction firms that already have more positive safety climates and/or have safer than average working environments. Therefore, future work on validating the S-CAT should make a concerted effort to attract companies and participants that represent the broad array of construction firms, not only those already highly focused on safety. This could be done by recruiting and working with OSHA Consultation offices from across the country and asking them if they would use the S-CAT with the smaller companies with whom they work.

Additionally, while we were able to demonstrate that organizational safety climate scores derived from S-CAT responses were significantly associated with self-reported organizational RIR, our data cannot strictly make inferences of causality. Therefore, a more rigorous test of this association would be to gather RIR data over time that would allow us to longitudinally assess the relationship. Moreover, as our database grows larger with a more diverse sample of companies, the benchmarking industry norms will become more reliable and stable and allow

for more nuanced benchmarking norms (e.g., broken down by contractor type, company size, etc.).

In response to numerous requests from the industry we have created additional S-CAT tools. For example, using the recommended translation/back-translation process (Brislin, 1970) we created a Spanish version of the S-CAT that can be accessed and completed online at the S-CAT website (https://www.safetyclimateassessment.com) for free, as is the case with all of the S-CAT materials. With the collection of Spanish S-CAT responses over time, eventually we will be able to empirically assess the measurement equivalence of the English language and Spanish language versions.

We also created the S-CAT^{sc} designed specifically for small contracting firms. Our stakeholders told us that while very small companies may not be interested in measuring their level of safety maturity using the S-CAT's rubric-based scale, they may want the opportunity to assess the types of safety-climate activities they are currently doing or could do in the future. To that end, the S-CAT^{sc} lists all the same indicator-specific activities presented in the S-CAT. The wording was modified slightly based on feedback from small employers and their representatives to ensure the terminology was understandable and relevant to employers with the equivalent of 50 or fewer full-time employees and respondents answer by indicating whether they are: (a) Already doing it, (b) Could do it in the future, (c) Would need help doing it, (d) Aren't able to do it, or (e) They don't know. The report they receive after completing the S-CAT^{sc} provides them with a summary score for each factor based on their responses. For scores that indicate specific factors they said they "could do it in the future" or "would need help doing it," they are provided with links to feasible interventions they could implement that can help move them toward an improved safety climate. Despite positive anecdotal feedback regarding the usefulness of this tool, future research should empirically evaluate whether this newly developed S-CAT^{sc} provides a reliable and valid assessment of safety climate for small contractors.

5. Conclusion

In summary, our research demonstrates that the rubric-based S-CAT is a reliable and valid instrument that companies can easily use not just at the beginning of their journey but also to check their progress as they move toward the goal of having an exemplary organizational and job site safety climate. To date, the S-CAT has not been used in any academic intervention research studies or tested against safety outcomes other than the RIR. However, construction companies have been using the S-CAT before and after implementing safety management interventions to assess their safety climate. Therefore, a next step is to use the S-CAT as an assessment tool in conjunction with such construction safety intervention projects to evaluate intervention effectiveness related to improved safety outcomes.

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