performed electrical (19%), carpentry (17%), pipefitting (7%) or drywall (10%) tasks, covering 18 tasks overall. Many subcontractors (n=16) had fairly comprehensive safety programs incorporating 90% of the checklist of safety items in their program. Safety programs with 90% or more of the safety items were strongly associated with higher safety climate scores for the subcontractor safety climate (5.15 point difference on a 100 point scale, p=0.05) and coworkers safety climate (6.69 points, p=0.01) as well as crew safety behaviors (5.34 points, p=0.02) and their own behavior scores (5.14 points, p=0.02) compared to safety programs with fewer than 90% of safety items.

Discussion: Workers employed by subcontractors with more comprehensive safety programs perceived their projects to be safer than employees of subcontractors with fewer safety program items. Similarly, workers from subcontractors with more comprehensive safety programs report their coworkers and their own behaviors were safer. Most of the stronger safety programs incorporated activities from all four domains including organizational management, worker participation, hazard identification, and training. Additional data collected from this ongoing study will provide the ability to explore the influence of the specific domains within the safety programs as well as comparing the safety program against other leading indicators.

G1.2
Title: Safety Climate and its Relationship with Construction Company Safety Management Systems and Programs

Authors: Luz Stella Marin, Jack Dennerlein, Michael Grant

Background: Organizational models of safety climate suggest it is influenced by organizational policies, programs and practices such as safety management systems. However, evidence of these influences is still limited, particularly in construction. Often, construction companies report both low implementation of SMS and poor safety climate. Therefore, our three exploratory studies determined relationships between organization and workplace indicators of safety management systems and workers' perceptions of safety climate.

Methods: First, we completed a cross-sectional study of 401 workers from 26 construction sites from 58 companies registered with ConstructSecure Inc. (Lexington, MA), a safety pre-qualification database. The database generates a score on a 100-point scale for each company, which is based on measurements of the company's SMS as well as other safety programs and worker policies. Worker surveys assessed safety climate based on the 9 questions in a measure for construction. Spearman rank correlations evaluated the association between the CSAP score and the safety climate score. Second, we utilized weekly safety inspection scores from safety managers' walkthroughs and weekly safety climate scores from worker surveys collected at six commercial construction sites (20,000 sq ft to 485,000 sq ft) over a four to five-month period per site. Linear mixed effects models estimated weekly safety climate scores from the concurrent and the previous weekly work site safety inspections scores. Third, using a sample of 25 commercial construction companies in Colombia, we examined the relationship between workers' safety climate perceptions and SMS. Implementation of SMS was evaluated using 86 desirable practices, and the Nordic Safety Climate Questionnaire (NOSACQ-50) was used to assess workers' perceptions of safety climate. Injury rates were calculated from a database of claims provided by the 25 companies. Generalized linear models were used to test associations.

Results: For our first study, there were, at best, weak correlations between workers' safety climate scores and the measurements of the company's safety management systems scores, with marginal statistical significance with two groupings of the data. However, for the second study, concurrent weekly safety inspections were significant predictors of safety climate in our unadjusted and adjusted analysis ($p < 0.0001$). Safety inspections were not significant ($p=0.9426$) predictors of safety climate measured one week after the inspection. Finally in the third study, workers' perceptions of safety climate were independent of their own company's implementation of SMS, and its injury rates. However, injury rates were negatively related to the implementation of SMSs.

Discussion: Our goal was to examine the relationship between safety climate and SMS for construction companies. We saw weak correlations between our metrics of safety management systems and safety climate in these construction companies. We examined associations between physical working conditions and safety climate measures that appeared to be somewhat temporal in nature. Given the dynamic aspects of construction worksites, traditional theories surrounding safety

climate suggest that a worker who is on site for a short period of time may not be able to perceive a company's safety management system. However, since the ultimate goal of a strong, positive SMS is to reduce risk, working conditions in a construction site may be a better measure of the effectiveness of the SMS articulated through the working condition rather than through verbal and policy communications.

G1.3
Title: The Safety Climate Assessment Tool: Rubric-Based Approach to Measuring Construction Safety Climate

Authors: Linda Goldenhar, Tahira Probst, Jesse Byrd, Eileen Betit

Background: Safety climate - employee's shared perceptions of the degree to which their organization values safety - has been linked to numerous health and safety outcomes. A recent review article showed that a plethora of organizational safety climate and culture surveys have been developed over the last 20 years. The majority ask respondents to record their safety climate perceptions using 5-point Likert response scales ranging from strongly agree to strongly disagree which are then combined to create a summary score. Although empirical research has demonstrated that safety climate scores are significantly related to important safe work practices, the scores alone do not provide guidance on what an organization can do to improve their own safety management systems and thus safety climate. Many consulting companies charge a fee to conduct an assessment of an organization's safety climate. This can be cost-prohibitive for many construction companies, which data show have 10 or fewer employees. Thus, the practical application of 2 decades of safety climate research remains largely out of reach for the vast majority of construction firms. Further, the translational "research-to-practice" activities that could enable companies of any size to assess their own safety climate and produce actionable ideas for improving their safety management systems, has been limited. The project goal was to develop and validate a new rubric-based tool - the Safety Climate Assessment tool or S-CAT. This tool gives any sized company the opportunity to not only self-assess their level of safety climate maturity, but the rubric descriptors give respondents a concrete idea of specific practices that can lead to a more or less mature safety climate. While the rubric-based approach to measuring safety climate may be an innovative shift from more traditional assessment methodology, it still must be empirically tested to determine factor structure and reliability. Its criterion-related validity must also be assessed by examining the degree to which the scores correlate with key lagging indicators such as organizational recordable injury rates (RIR).

Methods: Nine hundred eighty-five respondents from the construction industry completed the S-CAT scale, which contains 37 indicators designed to measure the safety climate maturity for 8 leading safety climate factors identified by construction stakeholders at a 2013 workshop. Each factor uses between 3-6 rubric-based response scales (one for each factor's indicators) that contain specific descriptors for each level of safety climate maturity ranging from 1 (inattentive) to 5 (exemplary). We used company recordable incident rate (RIR) to assess the S-CAT's criterion validity.

Results: Cronbach alpha reliabilities ranged from .77 (Empowering and Involving Employees) to .90 (Owner/Client Involvement) and the confirmatory factor analysis supported the hypothesized 8 factor structure with a higher-order safety climate factor. Moreover, 7 of 8 factor scores and the overall S-CAT score were negatively correlated with RIR values supporting the S-CATs criterion validity. A regression analysis indicated that a company's total S-CAT score accounted for 9% of the variability in organizational recordable injury rates.

Discussion: These findings provide evidence that the S-CAT, a new rubric-based assessment tool, is both reliable and valid. Qualitative data also show that the S-CAT has provided companies not only with safety climate scores but they've also used the rubric descriptors to strengthen their safety management systems and move up the safety climate maturity scale.

G1.4
Title: Evaluation of Safety Leadership Training to Enhance Construction Jobsite Safety Climate: The Foundations for Safety Leadership (FSL)

Authors: Natalie Schwatka, Linda Goldenhar, Stefanie Johnson, Marissa Beldon, Jamie Tessler, Jack Dennerlein, Mark Fullen, Dan Weinstein, Hao Trieu

Background: Recent research has shown a positive

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