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Individual safety performance in the construction industry: Development and validation of two short scales

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ABSTRACT

In the current research a short measure of safety performance is developed for use in the construction industry and the relationships between different components of safety performance and safety outcomes (e.g., occupational injuries and work-related pain) are explored within the construction context. This research consists of two field studies. In the first, comprehensive measures of safety compliance and safety participation were shortened and modified to be appropriate for use in construction. Evidence of reliability and validity is provided. Both safety compliance and safety participation were negatively related to occupational injuries, yet these two correlations were not statistically different. In the second study, we investigated the relationships between these two components of safety performance and work-related pain frequency, in addition to replicating Study 1. Safety compliance had a stronger negative relationship with pain than safety participation. Implications for research are discussed.

1. Introduction

In 2008 the largest number of workplace fatalities in the United States (US) took place in the construction industry. The construction industry alone accounted for roughly 19% of the total fatalities recorded. Further, the construction industry's rate of nonfatal occupational injuries and illnesses is greater than the average rate for all US industries (i.e., all industries including state and local government) at 4.7 cases compared to 4.2 cases per 100 full-time equivalent workers respectively. Strides have been made to reduce occupational injuries and illnesses (BLS, 2010) in construction. However, additional work must be done to continue to control and further reduce the safety concerns in this industry.

A critical step in trying to understand how and why occupational injuries occur is to examine what workplace behaviors might be linked to these injuries. These workplace behaviors can be collectively referred to as safety performance (Christian et al., 2009). It is well recognized that there are a number of problems plaguing the safety performance research literature (Christian et al., 2009). One significant shortcoming is the lack of practical, yet reliable and valid measure of safety performance, which are designed with the construction context in mind. In the current research, we attempt to address this shortcoming.

1.1. Safety performance

Researchers in the occupational safety domain have investigated safety performance or the safety-related components of general job performance for the last quarter century. Many of the early studies in this area focused on following safety regulations. For instance, Komaki et al. (1980) trained public utilities workers on proper use of equipment and tools (such as using screwdrivers for the intended purpose rather than as pry tools), proper use of personal protective equipment (such as properly wearing fall harnesses and work gloves), housekeeping (such as cleaning up or marking spills), and general safety procedures. In this study, safety performance was conceptualized as supervisors' observations of the incidence of engaging in trained safety behaviors. Cohen and Jensen (1984) and Reber et al. (1990) conducted similar studies where safety performance was defined as behavioral compliance with company safety procedures.

In more recent years, there has been a trend toward conceptualizing safety performance as multi-dimensional in the occupational safety research literature. For example, Griffin and Neal (2000) differentiated between safety compliance and safety participation. Safety compliance was defined as the core safety activities that need

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to be carried out by individuals to maintain workplace safety, such as wearing personal protective equipment. Safety participation was conceptualized as behaviors that may not directly contribute to workplace safety, but do help to develop an environment that promotes safety (e.g. attending voluntary safety meetings and training). It has been suggested that safety compliance refers to behaviors that are required and safety participation refers to behaviors that are voluntary in nature (Neal et al., 2000).

1.2. Safety compliance vs. safety participation

Griffin and Neal (2000) helped to lay the groundwork for a distinction between safety compliance and safety participation. These researchers found relatively modest relationships (Study 1: $r = .30$ and Study 2: $r = .38$) between safety compliance and safety participation, and differences in the relationships between these variables and safety knowledge and motivation. However, the quality of the measures of safety participation and compliance that were used by Griffin and Neal is questionable. The internal consistency reliabilities were as low as $\alpha = .56$ for compliance and $\alpha = .66$ for participation. Further, the authors did not provide a great deal of information on measure development, which leaves room to question whether safety compliance and safety participation were really adequately being assessed.

Since Griffin and Neal's (2000) work, two other groups of researchers have developed more comprehensive measures of the required and discretionary aspects of safety performance. In 2002, Burke, Sarpy, Tesluk, and Smith-Crowe completed a content oriented measurement development study which provided support for a four-factor model of safety compliance or what they call general safety performance: using personal protective equipment, engaging in work practices to reduce risk, communicating health and safety information, and exercising employee rights and responsibilities. In 2003, Hofmann, Morgeson, and Gerras developed a measure of safety citizenship behaviors or safety participation. They based the measure on theoretical and empirical work done by Van Dyne et al. (1994, 1995), Van Dyne and LePine (1998), Podsakoff et al. (1990) and Morrison and Phelps (1999). Their measure had six dimensions: helping (e.g. volunteering for safety committees and helping to teach safety procedures to new employees), voice (i.e. making safety-related recommendations and speaking up and encouraging others to get involved), stewardship (protecting fellow crew members from safety hazards and going out of one's way to look out for the safety of other crew members), whistle-blowing (telling other crew members to follow safe working procedures and reporting crew members who violate safety procedures), maintaining up-to-date knowledge of safety issues (attending non-mandatory safety-related meetings), and initiating safety-related workplace change (trying to improve safety procedures and making suggestions to improve the safety of a mission). Hofmann et al. provided some evidence of construct validity. They found that the safety citizenship behaviors included in their measure were viewed less as being required by study participants than behaviors from a modified version of the Burke et al. measure.

Since the development of these two comprehensive measures, there have been two meta-analyses, which have explored the distinction between safety compliance and safety participation. First, Clarke (2006) conducted a meta-analysis, which examined the relationships between safety climate and the two dimensions of safety performance and between the two dimensions of safety performance and occupational accidents and injuries. Clarke's (2006) results suggested that there was a need to distinguish between safety participation and safety compliance. Safety climate was more strongly related to safety participation ($\rho = .50$) than to safety compliance ($\rho = .43$), and safety participation had a stronger relationship with occupational accidents and injuries ($\rho = .14$) than safety compliance ($\rho = .09$). It should be noted that all of the correlations in Clarke's study were transposed so that higher scores on safety climate for instance are associated with more positive safety performance or outcomes (i.e., safety compliance, safety participation, accidents and injuries).

In another meta-analysis, Christian et al. (2009) explored the person- and situation-related antecedents of workplace safety. The authors found support for a moderate relationship between safety compliance and safety participation ($\rho = .46$). Both types of performance, were only weakly related to occupational accidents and injuries (compliance $\rho = -.14$, and participation $\rho = -.15$). Safety climate and leadership tended to be more highly related to safety participation than safety compliance.

The studies used in both of these meta-analyses were reviewed, and many made use of safety performance measures which were created for the individual studies themselves, and in most cases the samples utilized were not construction workers (i.e., in most cases the samples consisted of healthcare and manufacturing workers). Most of the studies did not provide information about how the measures were created. For instance, they did not address whether the measures adequately assessed the specific safety performance component it was intended to assess (e.g., Goldenhar et al., 2003; Probst and Brubaker, 2001). There were a couple of studies which made use of the same or nearly the same measures used by Griffin and Neal (2000) (e.g., Wallace and Chen, 2005; Probst, 2004), and the limitations of these measures have been noted earlier. Comprehensive measures such as those developed by Burke et al. (2002) and Hofmann et al. (2003) were rarely used. This may be due to a practical concern, length of these measures, which has been noted as a problem in previous studies (e.g., Turner et al., 2005).

Something, which is particularly concerning for those interested in measuring safety performance in the context of construction is the lack of measures developed for construction workers. Griffin and Neal's (2000) measure was developed in manufacturing and mining. Burke et al.'s (2002) measure was developed among hazardous waste workers at a nuclear facility, and the Hofmann et al. (2003) measure was developed in the military. It has been suggested in previous research that safety performance measures need to be created respecting the idiosyncrasies of the particular work context in which they will be used (Marchand et al., 1998).

1.3. Current research

Construction is apt to be different than manufacturing, mining, healthcare, work in nuclear facilities and the military. Researchers have noted that safety in construction is complex due to the industry's unique work hazards, rapidly changing conditions and the characteristics of construction organizations (Choudhry and Fang, 2008; NORA Construction Sector Council, 2008). Therefore, in the current research we develop a short measure of safety performance, which assesses both safety compliance and safety participation, which is appropriate for use in the construction industry. We also add to existing research by exploring the relationships that these two components of safety performance have with occupational safety outcomes including injuries and work-related pain.

2. Study 1

2.1. Method

2.1.1. Participants and procedure

The participants in this study were pipefitters working primarily in the construction industry. The sample came from a union Local in the Western United States. A representative from the Local sent the surveys to the pipefitters with a letter encouraging them to participate in the survey. Prepaid envelopes were provided in effort to ease survey return. It took less than 10 min to complete the survey. Approximately 1056 active journeymen were mailed surveys. Of the surveys mailed, 150 (14.3%) participants returned usable surveys. The mean age of respondents was 48.12 years (SD = 8.88). On average the participants had worked in their trade for an average of 23.11 years and belonged to the union for an average of 18.82 years. The majority of respondents were Caucasian (89.30%); however, the sample also consisted of Native Americans (1.30%), Hispanics (5.30%). Approximately 2.70% of the sample did not report their ethnicity. Gender was not included on the questionnaire, as the female membership for the Local was below 1%.

2.1.2. Safety performance measure

Focus groups were employed in order to ensure the measure of safety performance was applicable to the population. The focus group participants were pipefitter apprentices (who did not participate in the final survey) who were in their 4th or 5th year of a 5-year apprentice program. The more senior apprentices were selected because they would have the most work experience. Apprentices work in the field starting with their first year of training. They participated in 2-h focus group sessions and discussed whether the 54 items of Burke et al.'s (2002) general safety scale (measuring safety compliance) and the Hofmann et al. (2003) safety citizenship role definitions scale were required behaviors or considered to be extra-role behaviors. In addition, focus group participants also provided comments on the relevance and clarity of the items. Twenty-six safety compliance and twenty-six safety participation items developed and used by Burke et al. (2002) and Hofmann et al. (2003) respectively, were retained based on focus group recommendations with slight alterations to a few items. For example, Burke et al.'s "dons all personal protective equipment correctly" was changed to "puts on personal protective equipment correctly." One item from the general safety scale dimension "engaging in work practices to reduce risk" (i.e., inspects engineering controls as dictated by conditions) and one item from the safety citizenship role definitions dimension "helping" (i.e., volunteers for safety committees) were deleted from the measures, because they were deemed inapplicable to the study's population. The focus group participants found the measures to be comprehensive and, therefore, did not suggest the addition of any items to the performance scales. Survey participants responded to the 52 safety performance items using a 6-point Likert-type scale (1, Never; 2, Once in a While; 3, Sometimes; 4, Quite Often; 5, Frequently; 6, Always).

2.1.3. Occupational injuries

Participants were asked about their experiences with occupational injuries in the past four weeks. A four-week time period was selected based on the recommendations of Landen and Hendricks (1995), Massey and Gonzales (1976) and Warner et al. (2005). Massey and Gonzalez and Warner et al. have compared the accuracy of injury memories over different recall periods. Their research finding lead them to suggest recall periods of 2–4 or 3–6 weeks as the best balance of concerns related to having a sufficient recall period to allow for injuries to have occurred yet not long enough that respondents would have forgotten the injuries. Respondents were asked to indicate the extent to which they had experienced any of the following injuries: strain, sprain, cut or laceration, blisters, back or muscle pain, puncture, burn, bruise or contusion, fractured bone, dislocated joint, electric shock, eye injury, asbestos exposure, welding flash, carpal tunnel, chemical exposure, concussion, hearing loss, radiation exposure, frostbite or sun positioning. They responded "yes" or "no." Example injuries included "strain/sprain/torn ligament" and "burn/blister/scald/welding flash". To come up with an overall injury score for each participant, we calculated the total number of injuries each participant had experienced.

2.2. Results and discussion

The length of the measures was reduced based on the guidelines for measure reduction outlined by Stanton et al. (2002). These authors outlined three categories for evaluating items when reducing a measure. Specifically, internal item qualities refer to "properties of items that can be assessed in reference to other items on the scale" (Stanton et al., 2002, p. 169). To assess internal item qualities one can examine item-total correlations, mean, variance, skewness, or factor analysis results. External item qualities refer to "connections between the individual items and other constructs," and judgmental item qualities refer to "those issues that require subjective judgment" such as an item's face validity (Stanton et al., 2002, p. 169). External item qualities can be assessed by looking at the relationships that individual items have with other constructs, which should be related to the construct of interest. When assessing judgmental item qualities clarity of expression, relevance to the population, semantic redundancy, and invasiveness are taken into account. Stanton et al. suggested that when reducing a scale researchers should (1) generate item level indices of external item quality, (2) use corrected item-total correlations to assess internal item quality, and (3) assess the face validity of each item. These recommendations were followed.

The measure reduction process resulted in a ten item safety performance measure with four safety compliance items and six safety participation items. One item was selected from each subdimension of the safety compliance and safety participation scales. Selection decisions were made based on item correlations with the occupational injury measure, corrected item-total correlations, and subjective ratings of item quality completed by two occupational safety researchers who had done field work (including field work with construction workers). Items with the high correlations with the occupational injury measure and item-total correlations were given preference. However, when there were multiple items, which had positive external and internal items qualities, preference was given to the items which were judged to have the highest degree of face-validity. A listing of the 10 items selected for the shortened measure can be found in Appendix A. Cronbach's alpha was .79 for the shortened safety compliance scale. Cronbach's alpha was .85 for the shortened safety participation scale.

To assess the dimensionality of the overall safety performance measure, we evaluated the fit of competing models (i.e., a one factor and two-factor model). Fit statistics for the models are shown in Table 1. The analysis suggests that a two-factor model provides a better fit to the data than a one-factor model. Chi-square acts as a "badness of fit" measure. A significant value would suggest that the model is not a good fit for the data. However, a non-significant value is rarely found. This statistic was significant for both the one-factor and two-factor model. Traditionally a chi-square difference test is used to assess the relative fit between two models when one of the models is nested within the other. Table 1 also displays a chi-square difference value, $\Delta\chi^2(1) = 17.3$, $p < .05$. The significant result suggests that the two-factor model is a better fit for the data than the one-factor model.

A variety of fit indices are reported in Table 1 including the goodness of fit index (GFI), the standardized root mean square residual (SRMR), the comparative fit index (CFI), the non-normed fit index (NNFI), the parsimony normed fit index (PNFI), and the root-mean-square error of approximation (RMSEA). Fit indices were chosen based on common practice (McDonald and Ho, 2002) and the recommendations of Kelloway (1998) and Kline (2005). GFI values greater than .90 indicate acceptable fit (Schermelleh-Engel et al., 2003). SRMR values less than .05 indicate a good fit (Byrne, 1998)

Table 1
Study 1 CFA results for the safety performance measure.

Model	χ^2	*df*	χ^2_{diff}	df_{diff}	GFI	SRMR	CFI	RMSEA	NNFI	PNFI
One factor	63.17*	35			.92	.05	.95	.08 (.05–.11)	.94	.70
Two factor	48.47*	34	17.3*	1	.93	.04	.98	.06 (.00–.09)	.97	.70

* $p < .05$.

Table 2
Study 1 Descriptive statistics and intercorrelations.

	M	SD	1	2	3
1. Safety compliance	19.00	4.00			
2. Safety participation	25.93	6.13	.74*		
3. Injuries	4.54	3.95	−.36*,a	−.35*,a	

Note: $N = 132$.
* $p < .05$.
[a] These correlations are calculated as r_{RI} with the associated *z*-test ($z = r_{RI}(n-1)^{1/2}$) of the null hypothesis. This is to be consistent with suggestions in Chen and Popovich (2002) for correlations between continuous and ordinal variables.

but values as high as .08 are acceptable (Hu and Bentler, 1999). Values of CFI and NNFI between .90 and .95 indicate acceptable fit and values above .95 indicate good fit. Values of PNFI are generally lower than those for other fit indices. It is not uncommon to find values around .50 (Mulaik et al., 1989). Higher values indicate better fit. An RMSEA of zero indicates perfect fit. It has been argued that values greater than .10 indicate poor fit, between .08 and .10 indicate mediocre fit, between .05 and .08 indicate reasonable fit, and values lower than .05 indicate good fit.

Taken collectively the fit indices seem to also indicate that the two-factor solution fits the data better than the one-factor solution. The GFI, CFI, and RMSEA values are acceptable for the two-factor model. The SRMR and NNFI for the two-factor model are not in the preferred range for either the one-factor or the two-factor solution; however the values for the two-factor solution are better than those for the one-factor solution. The PNFI values for both models are equal. Both safety compliance and safety participation were significantly negatively correlated with occupational injuries ($r = -.36$ and $r = -.35$ respectively), as seen in Table 2. However, a William's (1959) dependent *t*-test suggests there seems to be little difference between the strength of the two relationships. Overall, the above results support previous research (Christian et al., 2009; Clarke, 2006), which suggests safety compliance and safety participation have a strong relationship ($r = .74$) but are empirically distinct.[1]

3. Study 2

Stanton et al. (2002) suggested that once a measure has been shortened, that the reliability and validity of the scale should be assessed and ideally this should be done in more than one sample. The second study aims to do this. Further, the study investigates whether safety compliance and safety participation have different relationships with safety outcomes/results and whether they explain unique variance in these outcomes/results.

3.1. Method

3.1.1. Participants

The participants in this study were plumbers, steamfitters, marine pipefitters in the construction industry who were sampled from a union Local in the Northwest United States. As was the case in Study 1, a representative from the Local sent the surveys to the pipefitters with a letter encouraging them to participate in the survey. Again, prepaid envelopes were provided in effort to ease survey return. It took less than 10 min to complete the survey. Of the 615 surveys mailed to active journeymen, 182 (29.6%) respondents returned usable surveys. The mean age of respondents was 45.26 years (SD = 9.87) and 97% were male. (This Local indicated that they had relatively more female pipefitters than the Local from Study 1, thus gender was assessed in the present study.) The average respondent had worked in his/her trade for an average of 22.15 years and had belonged to the union for an average of 15.7 years. The self-reported ethnicity of the participants was as follows: Caucasian (96.2%), Native American (.5%), and Hispanic (.5%). Approximately 1.6% of the sample did not report their ethnicity.

3.1.2. Measures

The same 10-item measure of safety performance used in Study 1 was again used in Study 2. Cronbach's alpha for the safety compliance and safety participation measures were .70 and .88 respectively.

The occupational injury measure consisted of a list of occupational injuries. The injuries were selected using workers' compensation data from a large workers' compensation insurance provider in the western United States. An injury was selected for the final scale if it had been experienced by at least 20% of the pipefitter population. A total of nine injuries met this criterion. The participants in this study were asked whether they had experienced each of the nine injuries listed in the prior four months. They responded "yes" or "no." Example injuries included "strain/sprain/torn ligament" and "burn/blister/scald/welding flash". To come up with an overall injury score for each participant, we calculated the total number of injuries each participant had experienced.

Work-related pain was measured by a scale consisting of nine items developed by Rosecrance et al. (2006) based on the Standardized Nordic Questionnaires (Kuorinka et al., 1987). Participants were asked to indicate whether they had experienced pain in any of the areas listed in the prior four months, and to respond "yes" or "no". Example areas include "head/skull/face" and "lower back". This was then an assessment of pain frequency rather than pain severity. To come up with an overall pain score for each participant we calculated the total number of body areas in which each participant had experienced pain.

3.2. Results and discussion

A confirmatory factor analysis was conducted to replicate the findings in Study 1. We compared the two-factor model to a parsimonious one-factor solution. As summarized in Table 3, a better fit was obtained for the two-factor solution. The significant chi-square difference supports this conclusion ($\Delta\chi^2(1) = 79.97$, $p < .05$). Further, fit indices were improved from the one-factor to two-factor model. The GFI value of .87 was close to the .90 guideline. The SRMR value of .07 was not in the preferred range (less than .05), however, it was acceptable (less than .08) where as the SRMR for the one-factor model was not acceptable. The CFI value of .90 for the two-factor model indicates acceptable fit. The NNFI value does not fall within the acceptable range; however, the value is higher for the two-factor model than the one-factor model. Unlike the first study

[1] To control a single source of method bias, we followed Podsakoff et al.'s (2003) procedure by allowing all items to load on a latent common method factor in the previously described two-factor structure. This approach was not successful because the hypothesized model did not converge.

Table 3
Study 2 CFA results for the safety performance measure.

Model	χ^2	*df*	χ^2_{diff}	df_{diff}	GFI	SRMR	CFI	RMSEA	NNFI	PNFI
One factor	202.15*	35			.78	.09	.82	.17 (.15–.19)	.76	.61
Two factor	122.18*	34	79.97*	1	.87	.07	.90	.12 (.10–.15)	.87	.66
Third factor	52.07*	24	70.11*	10	.94	.03	.97	.08 (.05–.11)	.94	.50

* $p < .05$.

Table 4
Descriptive statistics and intercorrelations.

	M	SD	1	2	3	4
1. Safety compliance	20.64	3.32				
2. Safety participation	26.18	6.85	.61*			
3. Injuries	1.68	1.58	−.37*,a	−.26*,a		
4. Pain	1.44	1.71	−.37*,a	−.18*,a	.44*,b	

Note: $N = 177$.
a These correlations are calculated as r_{RI} with the associated *z*-test ($z = r_{\text{RI}}(n-1)^{1/2}$) of the null hypothesis. This is to be consistent with suggestions in Chen and Popovich (2002) for correlations between continuous and ordinal variables.
b This correlation is calculated as Spearman's rho.
* $p < .05$.

there is a difference between the PNFI values for the one-factor and two-factor model. The value is greater for the two-factor model indicating better fit. RMSEA indexes of .17 and .12 were obtained for the one-factor, and two-factor solution, respectively. By looking at these fit indices together, the two-factor structure provides a more acceptable fit to the data than the one-factor structure.[2]

The relationships between safety compliance, safety participation, injuries, and work-related pain are displayed in the Table 4. Similar to the results of Study 1, there is a fairly strong relationship (.61) between safety compliance and safety participation. Overall, both safety compliance and safety participation were related to occupational injuries and work-related pain. However, there were stronger correlations between safety compliance and injuries and pain than safety participation. A William's (1959) *t*-test was conducted to test the difference between these correlations. The results suggest that there is a significant difference between the correlations with work-related pain ($t(174) = -3.05$, $p < .05$, two-tailed) but not between the correlations with occupational injuries ($t(174) = -1.94$, $p > .05$, two tailed). These results run counter to those of Clarke (2006).

4. General discussion

There is a tendency in organizational research to focus less time on trying to understand criteria and more time on understanding predictors (Austin and Villanova, 1992). The occupational safety research domain is no exception. It is well recognized that there are a number of problems plaguing the safety performance literature (Christian et al., 2009) and significant occupational safety issues which make stalled progress in this domain particularly concerning (BLS, 2010). The current study adds to existing research by providing short measures of safety compliance and participation appropriate for use amongst pipefitters working in construction. The measure was derived from comprehensive measures of both safety compliance and safety participation developed by Burke et al. (2002) and Hofmann et al. (2003) respectively. Both measures when modified for the construction work context and shortened proved adequately reliable and distinct. Further, both studies provide criterion-related validity evidence for these shortened measures.

This research also adds to existing research, which explores the relationships between different types of safety performance and safety outcomes. In the first study the relationships between the two components of safety performance and occupational injuries were not significantly different. In the second study, there was a stronger relationship between safety compliance and work-related pain than between safety participation and work-related pain. Despite there being no statistical difference between the correlations between safety compliance and injuries and safety participation and injuries, the patterns of relationships observed in both studies are the same. The relationship between safety compliance and injuries is slightly stronger in both.

These findings run counter to the results of Clarke's (2006) and Christian et al.'s (2009) exploratory meta-analyses. First, the correlations between the different aspects of safety performance and safety outcomes seem to be stronger than those in either meta-analysis. Further, safety participation did not have stronger relationships with safety outcomes than safety compliance. There are a number of possible explanations for the discrepancies between the current findings and Clarke's findings. One possibility is that this study makes use of a scale capturing broad aspects of safety performance, which may be somewhat different than some other short measures of safety performance. The discrepancy could also be due to moderators of the relationships between the different components of safety performance and safety outcomes. These moderators may include occupation, unionization of workers, content of measures (i.e., different subsets of safety performance), or type of injury. Future research is needed to examine potential moderators of these relationships, as well as to replicate the current findings in different samples.

4.1. Limitations

Although this research makes important contributions to the safety performance literature it is not without limitations. First, these two studies made use of self-report data collected at one point in time. This raises a concern that the observed relationships could have been affected by common method variance. Common method variance refers to variance shared by variables due to the common method, which was used to collect data. While most behavioral scientists agree that common method variance can be a problem (Podsakoff et al., 2003), some researchers have suggested that the common method variance problem is not as serious as it has been made out to be (e.g., Spector, 2006; Lindell and Whitney, 2001). We made an attempt in both studies to control for a latent method factor by following Podsakoff et al.'s approach. However, in the first study the model including this factor did not converge and in the second study the model contained many nonsignificant path coefficients. Future research should use other sources of data (e.g., official injury records, supervisory ratings of safety performance, etc.) to address these concerns.

Another limitation is that the samples utilized in both studies consisted of unionized construction workers. This might limit the generalizability of our results. Unions are known for their emphasis

[2] Similar to Study 1, we applied Podsakoff et al.'s (2003) approach to control potential single source method bias. The results which appear in Table 3, show a better fit than the two-factor model. However, eight of ten factor loadings with safety compliance and safety participation, the variance estimate of safety participation, and covariance between the two factors were non-significant. Thus, this model could not be interpreted meaningfully.

Table A.1
Items used to measure safety compliance and safety participation.

Item	C/P[a]	Dimension[b]
Apply the appropriate work practices to reduce exposures to hazards including applicable standard operating procedures relating to operations and construction	C	Reducing risk
Use appropriate personal protective equipment as indicated by the site health and safety plan	C	PPE use
Take the appropriate steps if prevented from or punished for exercising your rights under OSHA policies and procedures	C	Exercising rights
Appropriately report injuries, accidents, or illnesses	C	Safety communication
Assist others to make sure they perform their work safely	P	Helping
Explain to other workers that you will report safety violations	P	Whistle blowing
Try to change the way the job is done to make it safer	P	Initiating change
Speak up and encourage others to get involved in safety issues	P	Voice
Take action to stop safety violations in order to protect the well-being of other crew members	P	Stewardship
Attend non-mandatory safety orientated training	P	Civic virtue

[a] C = safety compliance, P = safety participation; all safety compliance items were taken from Burke et al. (2002) and all safety participation items were taken from Hofmann et al. (2003).
[b] Indicates from which dimension of the Burke et al. or Hofmann et al. measure this item came.

on safety both in training and contract negotiations. At the onset of this research, we thought that there might be less variability in safety compliance and safety participation. Therefore, we speculated that the correlations between these two components of safety performance and safety outcomes might be weak. However, our results did not support our speculation.

Further, the response rates for the two studies were 14.3% and 29.6%. This may be in part due to the fact it was a mailed survey. Mailed surveys tend to have lower response rates (Roth and BeVier, 1998). Those individuals who responded could have been meaningfully different than those who did not respond to the survey. For instance, the sample might have consisted of more highly conscientious people. Conscientiousness has been found to be related to safety performance and safety outcomes (e.g., accidents and injuries) (Christian et al., 2009; Clarke and Robertson, 2008). Therefore, the observed relationships between safety performance and safety outcomes may be inflated due to this third variable. It is noted that in comparison with mean uncorrected correlations from Christian et al.'s meta-analysis our observed correlations between safety compliance and safety participation and occupational injuries are higher. Additional research should be done to further explore the validity of this measure.

4.2. Conclusion

The current research adds to the existing safety performance research literature. These studies have helped to make future research easier by providing a short measure of safety performance appropriate for use in the construction context, which is both reliable and valid. With this type of measure available, research in construction can advance to help reduce injuries and accidents in this dangerous industry.

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Appendix A.

See Table A.1.

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