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Impact of individual resilience and safety climate on safety performance and psychological stress of construction workers: A case study of the Ontario construction industry

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ABSTRACT

Introduction: The construction industry has hit a plateau in terms of safety performance. Safety climate is regarded as a leading indicator of safety performance; however, relatively little safety climate research has been done in the Canadian construction industry. Safety climate may be geographically sensitive, thus it is necessary to examine how the construct of safety climate is defined and used to improve safety performance in different regions. On the other hand, more and more attention has been paid to job related stress in the construction industry. Previous research proposed that individual resilience may be associated with a better safety performance and may help employees manage stress. Unfortunately, few empirical research studies have examined this hypothesis. This paper aims to examine the role of safety climate and individual resilience in safety performance and job stress in the Canadian construction industry. *Method:* The research was based on 837 surveys collected in Ontario between June 2015 and June 2016. Structural equation modeling (SEM) techniques were used to explore the impact of individual resilience and safety climate on physical safety outcomes and on psychological stress among construction workers. *Results:* The results show that safety climate not only affected construction workers' safety performance but also indirectly affected their psychological stress. In addition, it was found that individual resilience had a direct negative impact on psychological stress but had no impact on physical safety outcomes. *Conclusions:* These findings highlight the roles of both organizational and individual factors in individual safety performance and in psychological well-being. *Practical applications:* Construction organizations need to not only monitor employees' safety performance, but also to assess their employees' psychological well-being. Promoting a positive safety climate together with developing training programs focusing on improving employees' psychological health — especially post-trauma psychological health — can improve the safety performance of an organization.

1. Introduction

The construction industry plays an important role in Ontario's economic growth and employment. Since 2003, the Ontario government invested nearly $3 billion in the residential sector, which created 60,000 jobs (Ontario, 2014). However, safety remains one of the biggest challenges in construction (Becerik-Gerber & Siddiqui, 2014). Over the 10 year period from 2004 to 2013, the construction sector accounted for 26.6% of all workplace traumatic fatalities in Ontario, the highest percentage of any industry (WSIB, 2013). Meanwhile, the fatality rate in the Ontario construction has shown little improvement since the 1990s, as shown in Fig. 1.

Between 1965 and 1995, there was a steady decrease in the fatality rate. The decrease was due in part to the enforcement of an increasingly more comprehensive construction safety act that brought about greater safety awareness. After 1995, however, the industry continued to experience approximately 5 fatalities per 100,000 construction workers per year. The plateau phenomenon in safety performance can be observed in other jurisdictions as well, such as New Zealand (Guo, Yiu, & González, 2016) and Australia (Lingard, Cooke, & Blismas, 2010). Similarly, the rate of safety improvement in other countries, such as the United States, has been slowing (Bureau of Labor Statistics (BLS), 2014; Mendeloff & Staetsky, 2014; National Institute for Occupational Safety and Health (NIOSH), 2001).

In addition to the physical safety outcomes, herein safety outcomes refer to unsafe outcomes (e.g., eye injuries and pinch), job related stress

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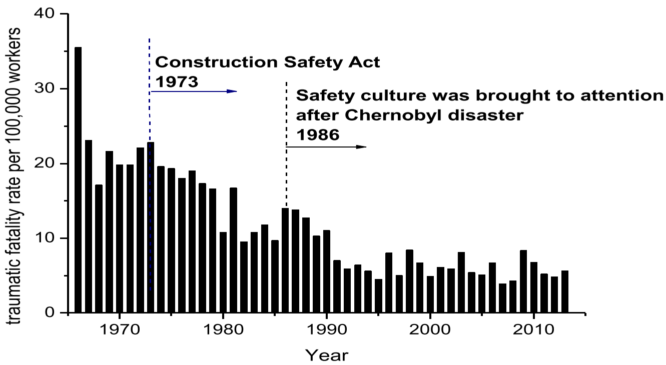

Fig. 1. Traumatic fatality rate in Ontario Construction (1965–2013)[1,2,3].
[1] IHSA, (2008)
[2] AWCBC, (2013)
[3] Statistics Canada, (2015a)

in the construction industry is attracting more and more attention. The relatively dangerous work environment, intense job demand, group work style, and interpersonal relationships, etc., increase construction workers' risk for adverse psychological outcomes (Goldenhar, Williams, & Swanson, 2003). Stress, if not properly managed, affects both employees' performance and their health (Cattell, Bowen, & Edwards, 2016). The geographical distribution of 46 papers published between 1989 and 2013 about work related stress in the construction industry (Leung, Chan, & Cooper, 2015) indicated that half of the work on work related stress was from Hong Kong (50%), with the remaining research distributed between Europe (22%), Australia (15%), Africa (11%), and United States (2%). More research on job stress in North America may identify local factors that are associated with psychological stress of workers, and thus may uncover ways to escape the safety plateau.

Safety culture has been shown to improve safety performance. Safety culture is a set of beliefs, norms, attitudes, roles, and social and technical practices focused on minimizing the exposure of employees to dangerous conditions (Pidgeon, 1991; Turner, Pidgeon, Blockley, & Toft, 1989). It is an abstract phenomenon and therefore challenging to measure. One indicator of safety culture is safety climate, which refers to the shared perception of people toward safety in their work environment (Dov Zohar, 1980). Measuring safety climate gives insight into safety culture in its current state (Cox & Cheyne, 2000; Glendon & Stanton, 2000). In addition, individual resilience is associated with higher coping abilities (Wanberg & Banas, 2000); thus, it is believed that individual resilience is associated with lower job stress and better safety performance. The remainder of Section 1 discusses the dimensions of construction safety climate, defines individual resilience, and proposes four hypotheses.

1.1. Safety climate dimensions

Safety climate has been widely recognized as a leading indicator of safety performance, in contrast to lagging indicators, such as lost time injury rates (Flin, Mearns, O'Connor, & Bryden, 2000). Although there is no agreement on the dimensions of safety climate, management commitment to safety is a widely acknowledged organizational level safety climate factor that applies to most industries. For example, perceived management attitudes toward safety was originally proposed as a leading safety climate factor based on surveys from 20 industrial organizations (Zohar, 1980). More recent work used four factors to measure safety climate: management commitment to safety, return to work policies, post-injury administration, and safety training (Huang, Ho, Smith, & Chen, 2006). In addition to management commitment to safety (Cigularov, Lancaster, Chen, Gittleman, & Haile, 2013; Dedobbeleer & Béland, 1991; Gillen, Baltz, Gassel, Kirsch, & Vaccaro, 2002; Guo et al., 2016; Hon, Chan, & Yam, 2014; Tholén, Pousette, & Törner, 2013), a set of dimensions have been proposed for construction, mainly including work pressure focusing on the balance between production and safety (Cigularov et al., 2013; Glendon & Litherland, 2001; Guo et al., 2016), support from supervisors and/or coworkers (Cigularov et al., 2013; Guo et al., 2016; Kines et al., 2010), and, safety equipment or knowledge needed to have control over safety (Cigularov et al., 2013; Gillen et al., 2002; Glendon & Litherland, 2001; Guo et al., 2016). Categorization of these factors is challenging as two scales with the same name may use different statements to define them and the same statement may be used toward different factors. For instance, statements reflecting safety communications may be included under the scale of management commitment to occupational health and safety (OHS) and employee involvement (Hon et al., 2014), while other researchers may use a separate scale of safety communication (Tholén et al., 2013).

1.2. Safety climate and physical safety outcomes

The relationship between safety climate and physical safety outcomes in construction safety research is evident worldwide. Safety climate was negatively related to near misses and injuries in the Hong Kong construction industry (Fang, Chen, & Wong, 2006; Hon et al., 2014) and positively related to safety behavior in Queensland (Mohamed, 2002). Safety climate was also found to be inversely related to underreporting of workplace injuries and illnesses in the United States (Probst, Brubaker, & Barsotti, 2008). Moreover, safety climate may be affected by a country culture (Ali, 2006), and decisions on safety management may be influenced by cultural norms. From this point of view, aspects of safety climate may vary geographically and there is a clear value in assessing the safety climate in different regions. Here, the authors investigate the Canadian construction safety climate and explore its relationship with physical safety outcomes.

H1. safety climate is negatively related to physical safety outcomes.

1.3. Individual resilience, physical safety outcomes, and psychological stress

Individual resilience (IR) is "the capacity of individuals to cope successfully in the face of significant change, adversity, or risk. This capacity changes over time and is enhanced by protective factors in the individual and environment" (Stewart, Reid, & Mangham, 1997). It is regarded as one type of positive psychological capacity for performance improvement (Luthans, 2002; Youssef & Luthans, 2007). To extend an individual's physical and psychological resources, IR may help individuals deal with stressors that are inherent in the work environment but cannot be changed (e.g., work pressure; Cooper & Cartwright, 1997). Thus, it may improve employees' performance by reducing counter-productive behaviors and help manage their work related stress (Avey, Reichard, Luthans, & Mhatre, 2011). Several studies found evidence to support its positive role. For example, IR was found to be directly related to job satisfaction, work happiness, and organizational commitment (Youssef & Luthans, 2007). It was associated with less work irritation, and weaker intentions to quit given that IR is associated with higher change acceptance (Wanberg & Banas, 2000). IR was also negatively related to depressive symptoms of frontline correctional officers (Liu, Hu, Wang, Sui, & Ma, 2013). It is further believed that positive psychological resource capacities may facilitate safety focused behaviors (Eid, Mearns, Larsson, Laberg, & Johnsen, 2012). However, the authors were unable to find any empirical studies that have examined if IR is associated with better safety performance and lower job stress in the construction industry.

H2. IR is negatively related to physical safety outcomes.

H3. IR is negatively related to psychological stress.

1.4. Injuries and psychological stress

Serious injuries, exposure to actual or threatened death, and other traumatic experiences may result in post-traumatic stress disorder

(PTSD) (Ontario Centre for Suicide Prevention, 2015). A study of 41 male construction workers in China found that workers exposed to a fatal accident had significantly higher symptoms of depression, such as insomnia and decreased interest in work and other activities (Hu, Liang, Hu, Long, & Ge, 2000). In turn, individuals under high psychological stress tend to have higher accident rates (Siu, Phillips, & Leung, 2004) and unsafe behaviors (Leung, Liang, & Olomolaiye, 2016). This is a vicious spiral. Finding ways to help employees manage job related stress may help prevent this downward spiral of disintegrating performance. It is reasonable to expect that injuries and job stress are positively correlated.

H4. Physical safety outcomes are positively associated with job stress.

2. Methods

2.1. Data collection procedures

2.1.1. Survey instrument

This research used a self-administered questionnaire adapted from previous research (McCabe, Loughlin, Munteanu, Tucker, & Lam, 2008). Modifications to the survey questions were made, such as adding individual resilience questions. The self-administered questionnaires comprised three sections: demographics, attitude statements, and incident reporting. The demographics section included questions, such as age and job tenure with the current employer of a participant. In the attitudinal section, respondents indicated the degree to which they agree with the statements using a Likert scale between 1 (strongly disagree) and 5 (strongly agree). In the incident reporting part, the respondents were asked how frequently they experienced incidents on the job in the 3 months previous to the survey. There are three categories of incidents: physical symptoms, unsafe events, and psychological stress symptoms. Physical symptoms and unsafe events are regarded as physical safety outcomes. Psychological stress symptoms describe job related stresses. Physical symptoms, such as respiratory injuries, may be associated with certain jobs in the construction industry. Safety events comprise events that respondents may have experienced without necessarily resulting in an injury, such as "slip/trip/fall on same level." One example of psychological stress symptoms is "lost sleep due to work-related worries."

2.1.2. Data collection

A multi-site data collection strategy was employed. In total, 837 surveys were collected from 112 construction sites between July 2015 and July 2016. For each site, at least two research assistants were available to distribute surveys to workers on site. They provided immediate responses to any questions from the participants, which improved the reliability and completeness of the data. No follow-up was undertaken and the questionnaires were strictly anonymous. The number of surveys collected from each site ranged from 1 to 42, with an average of about 8. Each survey required approximately 4 person-hours of research effort to find sites, communicate with corporate employees and site superintendents, travel to site, and collect the data. This is consistent with previous findings (Chen, Alderman, & McCabe, 2015).

2.1.3. Demographics of the respondents

The respondents were from the high-rise residential, low-rise residential, heavy civil, institutional, and commercial sectors of the construction industry. Among the respondents, 69.3% were from construction sites in the Greater Toronto Area (GTA) with the remainder from areas outside the GTA but inside Ontario (safety is regulated provincially in Canada), extending from Ottawa to Thunder Bay. Table 1 shows demographic information of the respondents. The mean age of the respondents was 37 years (SD = 12) and 98% were male; 69% of workers were journeymen or apprentices. The respondents had been working for their current employers for just over 6 years on average, but half of them had worked for their employers less than 4 years. Respondents reported relatively high mobility between projects, as expected in construction. The weekly working hours of the respondents were approximately 44 h, and 37.8% worked more than 44 h, which is considered overtime (Ontario Ministry of Labour, 2015). The respondents also reported a very high safety training percentage (97.7%) and 38.1% reported that they had the experience of being a safety committee member. Approximately 61% of the respondents were union members.

Table 1
Demographics of respondents.

Demographic factors	Response range	Mean or percent	Median
Gender	Male/female	98% male	–
Age	16 to 67	37.11	36.00
Years in construction	0.01 to 46	14.30	11.00
Years with the current employer	0.01 to 45	6.30	3.70
Number of construction employers in previous 3 yrs	1 to 100	2.33	1.00
Number of projects worked in previous 3 yrs	1 to 300	9.85	5.00
Average hours worked per week in previous month	9 to 100	44.24	42.00
Did respondent have any job-related safety training	Yes or no	97.7% yes	–
Was respondent ever a safety committee member	Yes or no	38.1% yes	–
Was respondent a member of a union	Yes or no	60.7% yes	–
Job position	Supervisor	31.3%	–
	Journeyman	50.5%	–
	Apprentice	18.2%	–

Our data were compared to Statistics Canada's Ontario construction workforce data on gender, age, and employee distribution by company size from 2011 to 2015, as shown in Table 2. Age distribution is reasonably similar, while our data had a lower percentage of female workers and a lower percentage of workers from micro-sized companies. One possible reason for fewer female respondents is that our data are site focused while the government data may include administration employees in site offices. It is very challenging to capture the employees of micro-sized companies as they are typically less motivated to participate in any activities that distract them from their work, including research.

2.1.4. Incidents

Incident reporting responses were discrete choices of 'never,' 'once,' 'two to three times,' 'four to five times,' and 'more than 5 times' in the previous 3 months. For each of the incident questions, these were transcribed as 0, 1, 2, 4, and 5 respectively. As such, incident counts reported

Table 2
Data representativeness.

Category	Our sample	Verification data[a,b] 2011–2015
Gender distribution		
Male	98.0%	88.9%
Female	2.0%	11.1%
Age distribution		
15–24 years	14.7%	11.9%
25–54 years	75.8%	71.6%
55 years & over	9.4%	16.5%
Employee distribution by employer size		
Micro (1–4 employees)	5.1%	16.6%
Small (5–99 employees)	55.7%	57.4%
Medium (100–499 employees)	25.7%	13.8%
Large (500 + employees)	13.5%	12.3%

[a] Statistics Canada (2015c).
[b] Statistics Canada (2015b).

Table 3
Frequency of physical safety outcomes.

	Report at least one occurrence in previous 3 months (%)
Physical symptoms	80.6
Cut/puncture	53.4
Headache/dizziness	52.8
Strains/sprains	50.8
Persistent fatigue	47.7
Skin rash/burn	24.7
Eye injury	11.8
Respiratory injuries	10.7
Temporary loss of hearing	8.9
Electrical shock	6.7
Dislocated/fractured bone	4.3
Hernia	4.0
Unsafe events	66.7
Overexertion while handling/lifting/carrying	41.9
Slip/trip/fall on same level	34.5
Pinch	34.3
Exposure to chemicals	33.6
Struck against something stationary	8.8
Struck by falling/flying objects	8.4
Fall from height	5.5
Contact with moving machinery	3.1
Struck by moving vehicle	2.9
Trapped by something collapsing/caving/overturning	2.3

herein are conservative. Then, for each of the three incident categories, namely, physical symptoms, unsafe events, and psychological stress symptoms, the incident counts were summed for each respondent.

Table 3 shows the frequency of physical safety outcomes. In total, 80.6% and 66.7% of the respondents reported at least one occurrence of physical symptoms and unsafe events in the previous 3 months. This number is not surprising, because the aggregated value of physical symptoms and unsafe events included incidents like cuts that are not severe but have very high occurrences. Cut or puncture, headache/dizziness, strains or sprains, and persistent fatigue are the most frequently experienced physical symptoms and approximately 50% of the participants experienced at least one of these four symptoms in the previous 3 months. In terms of unsafe events, 42% of the respondents experienced overexertion, and approximately 34% experienced slip/trip/fall on the same level, pinch, and exposure to chemicals at least once in the previous 3 months. With regard to the more severe incidents, such as dislocated or fractured bone and fall from height, it is very surprising that 30 to 40 respondents experienced these incidents recently.

Table 4 shows the frequency of stress symptoms. More than a half of the respondents reported at least one occurrence of stress symptoms, and 29% to 37% of the respondents reported that they were unable to enjoy daily activities, unable to concentrate on work tasks, felt constantly under strain, and lost sleep because of the work related worries. Relatively fewer incidents of feeling incapable of making decisions and losing confidence were reported (16% and 15%, respectively).

Table 4
Frequency of job stress symptoms.

	Report at least one occurrence in previous 3 months (%)
Job stress symptoms	55.2
Lost sleep due to work-related worries	36.7
Felt constantly under strain	30.1
Unable to concentrate on work tasks	28.8
Unable to enjoy day-to-day activities	28.6
Felt incapable of making decisions	16.1
losing confidence in self	15.0

2.2. Measures

2.2.1. Individual resilience

Six statements were used to measure IR. Three statements were adapted from a self-efficacy scale (Schwarzer & Jerusalem, 1995); an example statement is "I am confident that I could deal efficiently with unexpected events." The remaining three statements (Connor & Davidson, 2003) focus on a person's tolerance of negative impacts, and positive acceptance of change. An example statement from this category is "I am able to adapt to changes." The coefficient alpha of the scale is 0.84.

2.2.2. Safety climate

Management commitment to safety examines the priority that management puts on safety, especially when it conflicts with production. Six statements were used. Three were adapted from the previous research (Hayes, Perander, Smecko, & Trask, 1998). An example is "our management provides enough safety training programs." Two statements were adapted from Zohar & Luria (2005); an example is "our management is strict about safety when we are behind schedule." The final statement is "after an accident, our management focuses on how to solve problems and improve safety rather than pinning blame on specific individuals" (Carthey, de Leval, & Reason, 2001). The coefficient alpha of the scale is 0.87.

Supervisor safety perception is the workers' perception about whether their supervisors commit to safety. Six statements were used (Hayes et al., 1998). An example statement is: "my supervisor behaves in a way that displays a commitment to a safe workplace." The coefficient alpha of the scale is 0.86.

Coworker safety perception is one's perceptions about whether their coworkers have good safety behaviors. Four statements were used (Hayes et al., 1998). One example is: "my coworker ignores safety rules." The coefficient alpha of the scale is 0.72.

Role overload examines whether a worker feels that there is more work than can be accomplished in the time frame available in one's job. Two statements were adapted to measure role overload (Barling, Loughlin, & Kelloway, 2002). One example statement is: "I am so busy one the job that I cannot take normal breaks." The coefficient alpha of the scale is 0.62.

Work pressure is one's perceptions of whether there is excessive pressure to complete work faster, thereby reducing the amount of time available to plan and carry out work. Two statements were adapted from Glendon and Litherland (2001) to measure it. One example statement is: "there are enough workers to carry out the required work." These two statements were reversed to have a consistent direction with the meaning of the factor. The coefficient alpha of the scale is 0.65.

Safety knowledge is about whether workers know what to do confronted with unexpected events. Five statements were extracted from the safety consciousness factor (Barling et al., 2002). One example statement is "I know what to do if an emergency occurred on my shift." The coefficient alpha of the scale is 0.79.

The suggested alpha values range from 0.70 to 0.90 (Tavakol & Dennick, 2011). Although the alpha values of work pressure and role overload are less than 0.70, lower alpha values can be accepted (Loewenthal, 2001).

2.3. Data analysis

2.3.1. Data screening

Before performing any analysis, some data management was undertaken. Fifty-four cases were removed because a high proportion of data were missing (>10%). Thus, 783 cases were used for the analysis (672 surveys complete and 111 with on average 5% missing information). Four statement responses were reversed to have the same perception direction as other statements in the same scale. For example, "My coworkers ignore safety rules" was reversed to be directionally consistent with "My coworkers encourage others to be safe." Finally, missing values of one variable were replaced with the mean value of that variable across all subjects.

Regarding the univariate normality of all the variables, none of the observed variables were significantly skewed or highly kurtotic. The absolute values of the skewness of the variables were less than or equal to 2 and the kurtosis was less than or equal to 7 (Kim, 2013). However, the original data had multivariate non-normality and outlier issues, hence, variable transformations using log10 function were attempted based on their distributions (Tabachnick & Fidell, 2007). For example, one variable "I always wear the protective equipment or clothing required on my job" was transformed using log10 function because it had substantial negative skewness. Although there was a slight improvement after variable transformations, multivariate non-normality and outliers still existed. One hundred cases with extreme values were reported via Mahalanobis distance detection. Thus, data transformations were not considered for the following analysis. After examination, it is believed that the outliers are the natural variation of the data, thus, the cases with extreme values were kept.

2.3.2. Analysis procedure

The statistical analyses were performed using IBM SPSS Statistics and Amos (Windows version 23). The first step was to determine whether the proposed six dimensions of safety climate were conceptually distinct. Considering that the measures used in the present study were adapted from the research completed 10 years ago (McCabe et al., 2008), a set of confirmatory factor analyses were used to assess the adequacy of the previously mentioned scales. Robust maximum likelihood estimation technique was used to handle the multivariate non-normality (Brown, 2015; Byrne, 2001a). In Amos, the robust estimation was achieved by a bootstrapping procedure (10,000 bootstrap samples and 95% confidence intervals). The key idea underlying bootstrapping is that it creates multiple subsamples from an original data set and the bootstrapping sampling distribution is rendered free from normality assumptions (Byrne, 2001b). Internal-consistency reliability tests were conducted to show how well the individual scale statements reflected a common, underlying construct. Then descriptive statistics and correlations of the studied variables were analyzed. Finally, structural equation modeling (SEM) techniques were used to examine IR and the six hypothesized safety climate factors in relation to physical safety outcomes and job stress.

2.3.3. Model fit indices

There is no consensus about which indices to use, but reporting a variety of indices reflects different aspects of model fit (Hooper, Couglan, & Mullen, 2008). The fit indices used for SEM included an overall fit statistic χ^2, the relative χ^2 (i.e. χ^2/degrees of freedom), root mean square error of approximate (RMSEA), standardized root mean square residual (SRMR), comparative fit index (CFI), and the parsimonious normed fit Index (PNFI).

Although χ^2 value is very sensitive to sample size, it should be reported along with its degree of freedom and associated p value (Kline, 2005). The relative χ^2 (i.e. χ^2/degrees of freedom) (Wheaton, Muthén, Alwin, & Summers, 1977) can address the sample size limitation, and thus it was used. A suggested range for this statistic is between 2 (Tabachnick & Fidell, 2007) and 5 (Wheaton et al., 1977). RMSEA is regarded as one of the most informative fit indices (Byrne, 2001b; Diamantopoulos & Siguaw, 2000). In a well-fitting model, its range is suggested to be from 0 to 0.08 (Browne & Cudeck, 1992; Hooper et al., 2008). The maximum acceptable upper bound of SRMR is 0.08 (Hu & Bentler, 1999). CFI values greater than 0.95 have been suggested (Hooper et al., 2008), but CFI values greater than 0.90 are deemed acceptable. Higher values of PNFI are better, but there is no agreement about how high PNFI should be. When comparing two models, differences of 0.06 to 0.09 indicate substantial differences (Ho, 2006; Williams & Holahan, 1994).

3. Results

3.1. Measurement model

A hypothesized six-factor model was examined, composed of management commitment to safety, supervisor safety perception, coworker safety perception, work pressure, role overload, and safety knowledge. Five alternative competing models were also assessed (Table 5), including a one-factor model, two-factor model, three-factor model, four-factor model, and five-factor model.

All of the alternative models are nested in the proposed six-factor model, so we compared the hypothesized six-factor model with each of the competing models based on the Chi-square difference (χ^2 diff) associated with the models. The χ^2 difference also follows a χ^2 distribution. For instance, the χ^2 value of the hypnotized six-factor model is 778.37 with a degree of freedom is 252 and the χ^2 value of the alternative one-factor model is 2119.35 with a degree of freedom is 267. The χ^2 difference between these two models is 1340.98 with a degree of freedom of 15, which is significant. This suggests that the six-factor model is superior to the one-factor model. The results in Table 5 suggest that the hypothesized six-factor model performs better than all the alternative models. The findings also show that the six scales are conceptually different.

Following these steps, individual resilience in relation to the six proposed factors of safety climate were further examined. In the final measurement model (a total of seven factors, MC, SS, CS, WP, RO, SK, and IR), $\chi^2 (405) = 1124.68$, $p < 0.01$. The fit indices have the following values: χ^2/d.f. = 2.78, RMSEA = 0.048, SRMR = 0.06, CFI = 0.93, PNFI = 0.78. Overall, the fit indices suggest that the final measurement model fits the data well.

Table 6 shows the factor loadings and squared multiple correlation (SMC) of each scale statement. Table 10 shows the detailed scale questions. All the estimates in Table 6 are significant ($p < 0.001$). The factor loadings are the standardized regression weights, ranging from 0.42 to 0.82. In Amos, SMC of a statement variable is the proportion of its variance that is accounted for by its predictors (Arbuckle, 2012), which is also known as R^2. For example, SMC of statement MC1 is 0.47, i.e. 47% variance of MC1 was explained by the factor "management commitment to safety." Lower and upper bound of SMC estimates were also given based on 10,000 bootstrap samples with 95% confidence intervals.

Table 5
Comparisons of the hypothesized six-factor model of safety climate with selected alternative models.

Model	χ^2	d.f.	χ^2 diff	d.f. diff	χ^2/d.f.	RMSEA	SRMR	CFI	PNFI
Hypothesized six factor model of safety climate	778.37	252			3.09	0.05	0.07	0.94	0.76
Alternative model 1: One factor (MC + SS + CS + WP + RO + SK)	2119.35	267	1340.98	15	7.94	0.09	0.08	0.77	0.66
Alternative model 2: two-factors (MC + SS + CS + WP + RO, SK)	1818.07	266	1039.7	14	6.84	0.09	0.07	0.81	0.69
Alternative model 3: three-factors (MC, SS + CS + WP + RO, SK)	1451.58	264	673.21	12	5.50	0.08	0.06	0.85	0.73
Alternative model 4: four-factors (MC, WP + RO, SS + CS, SK)	1241.55	261	463.18	9	4.76	0.07	0.06	0.88	0.74
Alternative model 5: five-factors (MC, SS, CS, WP + RO, SK)	939.41	257	161.04	5	3.66	0.06	0.07	0.92	0.76

MC: management commitment to safety; SS: supervisor safety perception; CS: coworker safety perception; WP: work pressure; RO: role overload; SK: safety knowledge.

Table 6
Measurement model: squared multiple correlations (SMCs) and factor loadings.

Scale statements	SMCs		Management commitment to safety	Supervisor safety perception	Coworker safety perception	Work pressure	Role overload	Safety knowledge	Individual resilience
	Estimate	10,000 bootstrapping 95% C.I.							
MC1	0.47	[.39,.56]	0.69						
MC2	0.55	[.46,.63]	0.75						
MC3	0.58	[.49,.65]	0.76						
MC4	0.49	[.39,.58]	0.70						
MC5	0.58	[.49,.66]	0.76						
MC6	0.48	[.40,.56]	0.69						
SS1	0.46	[.38,.54]		0.68					
SS2	0.59	[.50,.66]		0.77					
SS3	0.68	[.61,.73]		0.82					
SS4	0.38	[.31,.44]		0.61					
SS5	0.56	[.47,.63]		0.75					
SS6	0.48	[.38,.56]		0.69					
CS1	0.67	[.58,.76]			0.82				
CS2	0.18	[.11,.26]			0.42				
CS3	0.56	[.46,.66]			0.75				
CS4	0.19	[.12,.27]			0.43				
WP1	0.44	[.34,.54]				0.66			
WP2	0.52	[.40,.64]				0.72			
RO1	0.39	[.28,.51]					0.62		
RO2	0.50	[.36,.67]					0.71		
SK1	0.29	[.19,.40]						0.54	
SK2	0.29	[.18,.42]						0.54	
SK3	0.59	[.48,.70]						0.77	
SK4	0.47	[.37,.56]						0.68	
SK5	0.43	[.34,.53]						0.66	
IR1	0.36	[.27,.46]							0.73
IR2	0.53	[.45,.61]							0.72
IR3	0.52	[.43,.61]							0.59
IR4	0.35	[.26,.44]							0.72
IR5	0.52	[.44,.59]							0.69
IR6	0.48	[.38,.57]							0.73

All the factor loadings are significant ($p < 0.01$).

On the whole, SMCs ranged from 0.18 to 0.68. Accordingly, the adequacy of the measurement model was supported.

3.2. Correlations among the variables

Table 7 displays descriptive statistics and the correlations between the studied variables. In general, management commitment to safety, supervisor safety perception, coworker safety perception, safety knowledge, and individual resilience had significantly negative correlations with physical symptoms, unsafe events, and psychological stress symptoms. Work pressure and role overload were positively related to physical symptoms, unsafe events, and psychological stress symptoms. In addition, management commitment to safety, supervisor safety perception, coworker safety perception, safety knowledge, and individual resilience were positively correlated with each other. Work pressure was positively related to role overload. Physical symptoms, unsafe events, and psychological stress were positively correlated with each other. Finally, management commitment to safety and supervisor safety perception had the strongest negative correlations with physical symptoms and unsafe events; and coworker safety perception had the strongest negative correlation with psychological stress symptoms. Work pressure had the strongest positive correlations with physical symptoms, unsafe events, and psychological stress.

3.3. Structural model

To examine the impact of safety climate and individual resilience on physical safety outcomes and psychological stress symptoms, a structural model was built (model 1 in Fig. 2). The latent construct of safety climate was indicated by six dimensions: management commitment to safety, supervisor safety perception, coworker safety perception, work pressure, role overload, and safety knowledge. The overall model

Table 7
Descriptive statistics and correlations.

	Number of statements in each scale	M	S.D.	1	2	3	4	5	6	7	8	9	10
1. Physical symptoms	–	6.01	6.12	–	0.59	0.46	−0.29	−0.29	−0.24	0.35	0.16	−0.18	−0.18
2. Unsafe events	–	3.59	5.19		–	0.41	−0.23	−0.23	−0.22	0.26	0.14	−0.17	−0.15
3. Psychological stress symptoms	–	3.62	4.56			–	−0.19	−0.20	−0.25	0.30	0.26	−0.15	−0.20
4. Management commitment to safety	6	3.48	0.54	–			0.87	0.69	0.41	−0.68	−0.25	0.55	0.48
5. Supervisor safety perception	6	2.99	0.51					0.86	0.42	−0.57	−0.24	0.48	0.44
6. Coworker safety perception	4	3.41	0.74						0.72	−0.40	−0.47	0.27	0.23
7. Work pressure	2	0.57	0.52							0.65	0.48	−0.34	−0.51
8. Role overload	2	0.70	0.54								0.62	−0.22	−0.32
9. Safety knowledge	5	3.19	0.42									0.79	0.53
10. Individual resilience	6	3.14	0.37										0.84

All the correlations are significant ($p < 0.01$), two tailed; numbers underlined in the diagonal of the matrix are the Cronbach's alpha of the scales.

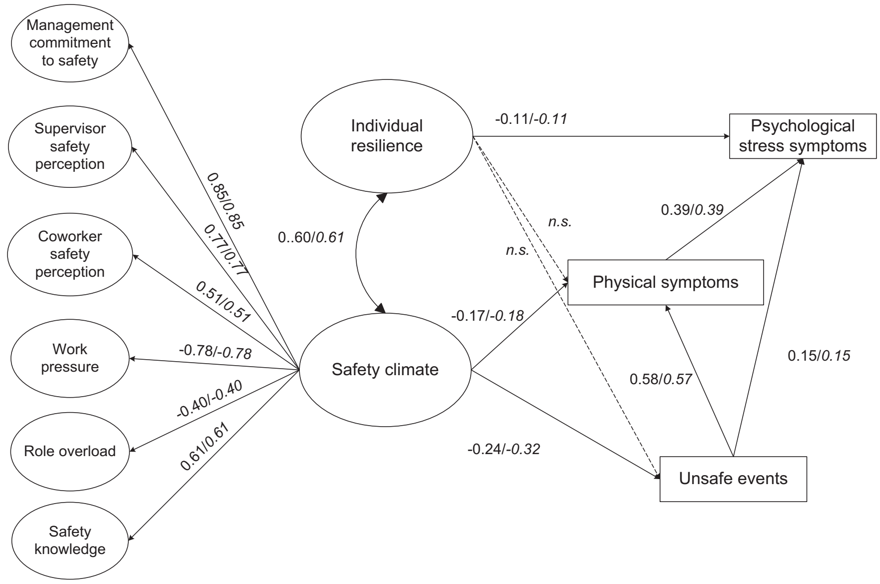

Fig. 2. Structural equation model. Model 1: without non-significant coefficients from individual resilience to physical symptoms and unsafe events. Model 2 shown by dashed line and by italic numbers: with non-significant coefficients from individual resilience to physical symptoms and unsafe events.

fit of model 1 was assessed by χ^2 (509) = 1459.80, $p < 0.01$. Because χ^2 tends to be affected by sample size, it is advisable to use other fit indices. In our model, χ^2/d.f. = 2.87, RMSEA = 0.049, SRMR = 0.07, CFI = 0.91, PNFI = 0.79. These fit measures all indicate that the hypothesized model fits the data well. Further, all structural coefficients were significant ($p < 0.01$).

We also compared the model to one with the non-significant paths from individual resilience to physical symptoms and unsafe events, i.e. Model 2 in Fig. 2. The fit indices of model 2 together with those of model 1 are listed in Table 8. The χ^2 difference of model 1 and model 2 is 4.34 with 2° of freedom, which was not significant. It suggested that the parsimonious model (i.e. model 1) is the better choice. It is also worth mentioning that other models, such as a model with direct path from safety climate to psychological stress symptoms, were also compared. All the findings showed that model 1 has the best-fit.

Path analysis of model 1 was conducted to determine whether safety climate has indirect effects on stress symptoms. As shown in Table 9, besides the direct effects displayed in Fig. 2, safety climate had significantly indirect negative effects on physical symptoms via unsafe events; and unsafe events had significantly indirect positive effects on stress symptoms via physical symptoms. More interestingly is that safety climate had a significant indirect negative impact (i.e. −0.16) on stress symptoms via both physical symptoms and unsafe events. This indirect effect was achieved through three paths: SC → physical symptoms → stress symptoms; SC → unsafe events → stress symptoms; SC → unsafe events → physical symptoms → stress symptoms. Thus, the indirect effect was decomposed into three parts, −0.07, −0.04, and −0.05, respectively. Because AMOS only reported the total indirect effect from one variable to another variable, the decomposition of the indirect effect was conducted manually by the authors; therefore, the corresponding bootstrapping results were not available here.

Table 8
Comparisons of model 1 and model 2.

Model	χ^2	d.f.	χ^2 diff	d.f. diff	χ^2/d.f.	RMSEA	SRMR	CFI	PNFI
Model 1	1459.80	509			2.87	0.05	0.07	0.91	0.79
Model 2	1455.46	507	4.34	2	2.87	0.05	0.07	0.91	0.79

Table 9
Direct and indirect effect testing of the hypothesized model relationships.

Path	R^2 contribution	Direct effects	Indirect effects	10,000 bootstrapping 95% C.I.
Direct effects				
SC → physical symptoms	0.07	−0.17		
SC → unsafe events	0.06	−0.24		
IR → stress symptoms	0.03	−0.11		
Unsafe events → physical symptoms	0.34	0.58		
Unsafe events → stress symptoms	0.09	0.15		
Physical symptoms → stress symptoms	0.17	0.39		
Indirect effects				
SC → unsafe events → physical symptoms			−0.14	[−0.19, −0.09]
SC → (physical symptoms and unsafe events) → stress symptoms			−0.16	[−0.21, −0.11]
SC → physical symptoms → stress symptoms			−0.07	–
SC → unsafe events → stress symptoms			−0.04	–
SC → unsafe events → physical symptoms → stress symptoms			−0.05	–
Unsafe events- > physical symptoms → stress symptoms			0.23	[0.17, 0.29]

Direct effects, indirect effects, and 95% bootstrapped confidence intervals denoting indirect effects are significant ($p < 0.01$).

Table 10
Scale statements.

Management commitment to safety	
MC1	Our management provides enough safety training programs
MC2	Our management conducts frequent safety inspections
MC3	Our management provides safe equipment
MC4	Our management is strict about working safely when work falls behind schedule
MC5	Our management gives safety personnel the power they need to do their job
MC6	After an unsafety event, our management focuses on how to solve problems and improve safety, rather than seeking to pin blame on specific individuals
Supervisor safety perception	
SS1	My supervisor spends time showing me the safest way to do things at work
SS2	My supervisor expresses satisfaction when I perform my job safely
SS3	My supervisor talks about values and beliefs in the importance of safety
SS4	My supervisor makes sure that we receive appropriate rewards for achieving safety targets on the job
SS5	My supervisor behaves in a way that displays a commitment to a safe workplace
SS6	My supervisor keeps workers informed of safety rules
Coworker safety perception	
CS1	My coworkers ignore safety rules (R)
CS2	My coworkers encourage others to be safe
CS3	My coworkers take chances with safety (R)
CS4	My coworkers keep work area clean
Work pressure	
WP1	There are enough workers to carry out the required work (R)
WP2	There is sufficient "thinking time" to enable workers to plan and carry out the required work (R)
Role overload	
RO1	I am so busy on the job that I can't take normal breaks.
RO2	There is too much work to do in my job for it all to be done well
Safety knowledge	
SK1	I always wear the protective equipment or clothing required on my job
SK2	I do not use equipment that I feel is unsafe
SK3	I inform management of any potential hazards I notice on the job
SK4	I know what procedures to follow if a worker is injured on my shift
SK5	I would know what to do if an emergency occurred on my shift
Individual resilience	
IR1	It is so easy for me to stay focused and accomplish my goals
IR2	I am confident that I could deal efficiently with unexpected events
IR3	I remain calm when facing difficulties because I can rely on my coping abilities
IR4	When confronted with a problem, I can usually find several solutions
IR5	I can cope with stress
IR6	I can focus and think clearly when I am under pressure

R: reverse.

Moreover, R^2 of unsafe events, physical symptoms, and psychological stress symptoms were 0.06, 0.41, and 0.29, respectively. Although it has been argued that it is difficult to decompose the R^2 contribution of correlated predictors, Dominance Analysis (DA) is a well-known approach to determining the relative importance of each predictor (Budescu & V, 1993). The novelty of DA is that "predictors are compared in a pairwise fashion across all subset models, and a hierarchy of levels of dominance can be established" (Azen & Budescu, 2006). Table 9 gives the estimates of the R^2 contribution from each predictor based on DA. Matlab R2015b was used and the code employed was from Broomell, Lorenz, & Helwig (2010). As displayed, safety climate explained 7% and 6% variance of physical symptoms and unsafe events, respectively. IR explained 3% variance of stress symptoms, physical symptoms contributed 17%, and unsafe events contributed 9%.

4. Discussion

The objective of this study was to examine the impacts of safety climate and individual resilience on physical safety outcomes and job stress of construction workers. Six dimensions of safety climate were adapted from previous research. Each of these dimensions was found to be significant, and to be important components of the latent construct of safety climate including management commitment to safety climate, supervisor safety perception, coworker safety perception, work pressure, role overload, and safety knowledge. Our findings validated H1 and confirmed that safety climate is a critical factor predicting the occurrence of physical safety outcomes in the construction industry (Fang et al., 2006; Hon et al., 2014; Mohamed, 2002). Among the six factors of safety climate, management commitment to safety, and supervisor safety perception had the strongest positive correlations with safety climate; work pressure had the strongest negative correlation with safety climate. This validated that management commitment to safety and the balance between safety and production are essential aspects of workplace safety climate (Flin et al., 2000; Glendon & Litherland, 2001; Huang et al., 2006; Zohar, 2000; Zohar & Luria, 2005).

The current study showed that job related stress is a common phenomenon in the Ontario construction industry. Approximately one third of the respondents reported experiencing at least four of the six stress symptoms. The strong correlations between job stress and physical safety outcomes indicate that more attention needs to be paid to the job related stress in the construction industry. Moreover, we found that safety climate has the potential to decrease workers' job stress. This suggests that safety climate can affect not only employees' physical health but also their psychological health.

Individual resilience had a significantly negative impact on psychological stress, which validated H3. It explained 3% of the variance of stress. Individual resilience improvement can be taken as a secondary preventer of job stress (Cooper & Cartwright, 1997). Hence, organizations may consider developing training programs, such as awareness activities (Cooper & Cartwright, 1997), to improve workers' relaxation techniques, cognitive coping skills, and work/lifestyle modification skills. Failing our expectation, H2 was not confirmed (i.e., we did not find that individual resilience was associated with physical safety outcomes). More research is needed to validate this.

There are several limitations of the current study. First, the study was based on a cross-sectional design, which prevented us from making definitive causal conclusions. Second, work pressure and role overload had relatively low internal consistency alpha values, which needs to be enhanced in the future. Finally, our data were skewed to larger-size companies, which also needs to be addressed in the future.

5. Conclusions

This study demonstrated that, in addition to injuries and unsafe events, job related stress is very common in the construction industry. Safety climate was confirmed to be associated with fewer physical safety outcomes and with fewer job related stresses. Results also suggest that individual resilience affects one's ability to manage job-related stress. These findings highlight the role of organizational factors as well as individual factors in affecting individual safety performance and psychological well-being. Given these findings, construction organizations need to not only monitor employees' safety performance but also their psychological well-being. Promoting a positive safety climate together with developing training programs focusing on improving employees' psychological health, especially post-trauma psychological health, can improve the organizations' safety performance.

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References

Ali, T. H. (2006). *Influence of national culture on construction safety climate in Pakistan.* Griffith University.

Arbuckle, J. L. (2012). IBM® SPSS® Amos™ 21 User's guide. Retrieved May 1, 2016, from ftp://public.dhe.ibm.com/software/analytics/spss/documentation/amos/21.0/en/Manuals/IBM_SPSS_Amos_Users_Guide.pdf

Avey, J. B., Reichard, R. J., Luthans, F., & Mhatre, K. H. (2011). Meta-analysis of the impact of positive psychological capital on employee attitudes, behaviors, and performance. *Human Resource Development Quarterly*, *22*(2), 127–152. http://dx.doi.org/10.1002/hrdq.20070.

Azen, R., & Budescu, D. V. (2006). Comparing predictors in multivariate regression models: an extension of dominance analysis. *Journal of Educational and Behavioral Statistics*, *31*(2), 157–180. http://dx.doi.org/10.3102/10769986031002157.

Barling, J., Loughlin, C., & Kelloway, E. K. (2002). Development and test of a model linking safety-specific transformational leadership and occupational safety. *Journal of Applied Psychology*, *87*(3), 488–496. http://dx.doi.org/10.1037/0021-9010.87.3.488.

Becerik-Gerber, B., & Siddiqui, M. (2014). Civil engineering grand challenges: opportunities for data sensing, information analysis, and knowledge discovery. *Journal of Computing in Civil Engineering*, *28*(4), 1–13. http://dx.doi.org/10.1061/(ASCE)CP.1943-5487.0000290.

Broomell, S., Lorenz, F., & Helwig, N. E. (2010). Dominance function in Matlab. Retrieved October 1, 2016, from http://www.andrew.cmu.edu/user/sbb59/code.html

Brown, T. A. (2015). *Confirmatory factor analysis for applied research.* New York: The Guilford Press.

Browne, M. W., & Cudeck, R. (1992). Alternative ways of Assesing model fit. *Sociological Methods & Research*, *21*(2), 230–258. http://dx.doi.org/10.1177/0049124192021002005.

Budescu, D. V., & V, D. (1993). Dominance analysis: A new approach to the problem of relative importance of predictors in multiple regression. *Psychological Bulletin*, *114*(3), 542–551. http://dx.doi.org/10.1037/0033-2909.114.3.542.

Bureau of Labor Statistics (BLS) (2014). Number, percent, and rate of fatal occupational injuries by selected worker characteristics, industry, and occupation, 1996–2014. Retrieved October 10, 2016, from http://www.bls.gov/iif/

Byrne, B. M. (2001a). Structural equation modeling with AMOS, EQS, and LISREL: comparative approaches to testing for the factorial validity of a measuring instrument. *International Journal of Testing*, *1*(1), 55–86. http://dx.doi.org/10.1207/S15327574IJT0101_4.

Byrne, B. M. (2001b). *Structural equation modeling with AMOS: basic concepts, applications, and programming.* Mahwah, NJ: Lawrence Erlbaum Associations, Inc.

Carthey, J., de Leval, M. R., & Reason, J. T. (2001). Institutional resilience in healthcare systems. *Quality in Health Care: QHC*, *10*(1), 29–32. http://dx.doi.org/10.1136/qhc.10.1.29.

Cattell, K., Bowen, P., & Edwards, P. (2016). Stress among South African construction professionals: A job demand-control-support survey. *Construction Management and Economics*, *34*(10), 700–723. http://dx.doi.org/10.1080/01446193.2016.1203967.

Chen, Y., Alderman, E., & McCabe, B. (2015). Data collection framework for construction safety. *ICSC15 – The Canadian Society for Civil Engineering's 5th international/11th construction specialty conference. Vancouver, Canada.*

Cigularov, K. P., Lancaster, P. G., Chen, P. Y., Gittleman, J., & Haile, E. (2013). Measurement equivalence of a safety climate measure among Hispanic and white non-Hispanic construction workers. *Safety Science*, *54*, 58–68. http://dx.doi.org/10.1016/j.ssci.2012.11.006.

Connor, K. M., & Davidson, J. R. T. (2003). Development of a new resilience scale: the Connor-Davidson resilience scale (CD-RISC). *Depression and Anxiety*, *18*(2), 76–82. http://dx.doi.org/10.1002/da.10113.

Cooper, C. L., & Cartwright, S. (1997). An intervention strategy for workplace stress. *Journal of Psychosomatic Research*, *43*(1), 7–16. http://dx.doi.org/10.1016/S0022-3999(96)00392-3.

Cox, S. J., & Cheyne, A. J. T. (2000). Assessing safety culture in offshore environments. *Safety Science*, *34*(1–3), 111–129. http://dx.doi.org/10.1016/S0925-7535(00)00009-6.

Dedobbeleer, N., & Béland, F. (1991). A safety climate measure for construction sites. *Journal of Safety Research*, *22*(2), 97–103. http://dx.doi.org/10.1016/0022-4375(91)90017-P.

Diamantopoulos, A., & Siguaw, J. A. (2000). *Introducing LISREL.* London: SAGE Publications.

Eid, J., Mearns, K., Larsson, G., Laberg, J. C., & Johnsen, B. H. (2012). Leadership, psychological capital and safety research: conceptual issues and future research questions. *Safety Science*, *50*(1), 55–61. http://dx.doi.org/10.1016/j.ssci.2011.07.001.

Fang, D., Chen, Y., & Wong, L. (2006). Safety climate in construction industry: a case study in Hong Kong. *Journal of Construction Engineering and Management*, *132*(6), 573–584. http://dx.doi.org/10.1061/(ASCE)0733-9364(2006)132:6(573).

Flin, R., Mearns, K., O'Connor, P., & Bryden, R. (2000). Measuring safety climate: identifying the common features. *Safety Science*, *34*(1–3), 177–192. http://dx.doi.org/10.1016/S0925-7535(00)00012-6.

Gillen, M., Baltz, D., Gassel, M., Kirsch, L., & Vaccaro, D. (2002). Perceived safety climate, job demands, and coworker support among union and nonunion injured construction workers. *Journal of Safety Research*, *33*(1), 33–51. http://dx.doi.org/10.1016/S0022-4375(02)00002-6.

Glendon, A. I., & Litherland, D. K. (2001). Safety climate factors, group differences and safety behaviour in road construction. *Safety Science*, *39*(3), 157–188. http://dx.doi.org/10.1016/S0925-7535(01)00006-6.

Glendon, A., & Stanton, N. (2000). Perspectives on safety culture. *Safety Science*, *34*(1–3), 193–214. http://dx.doi.org/10.1016/S0925-7535(00)00013-8.

Goldenhar, L. M., Williams, L. J., & Swanson, N. G. (2003). Modelling relationships between job stressors and injury and near-miss outcomes for construction labourers. *Work & Stress*, *17*(3), 218–240. http://dx.doi.org/10.1080/02678370310001616144.

Guo, B., Yiu, T., & González, V. (2016). Predicting safety behavior in the construction industry: development and test of an integrative model. *Safety Science*, *84*, 1–11. http://dx.doi.org/10.1016/j.ssci.2015.11.020.

Hayes, B. E., Perander, J., Smecko, T., & Trask, J. (1998). Measuring perceptions of workplace safety: development and validation of the work safety scale. *Journal of Safety Research*, *29*(3), 145–161. http://dx.doi.org/10.1016/S0022-4375(98)00011-5.

Ho, R. (2006). *Handbook of univariate and multivariate data analysis and interpretation with SPSS.* New York: CRC Press.

Hon, C. K. H., Chan, A. P. C., & Yam, M. C. H. (2014). Relationships between safety climate and safety performance of building repair, maintenance, minor alteration, and addition (RMAA) works. *Safety Science*, *65*, 10–19. http://dx.doi.org/10.1016/j.ssci.2013.12.012.

Hooper, D., Couglan, J., & Mullen, M. R. (2008). Structural equation modelling: guidelines for determining model fit. *Electronic Journal of Business Research Methods*, *6*(1), 53–60.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. http://dx.doi.org/10.1080/10705519909540118.

Hu, B. S., Liang, Y. X., Hu, X. Y., Long, Y. F., & Ge, L. N. (2000). Posttraumatic stress disorder in co-workers following exposure to a fatal construction accident in China. *International Journal of Occupational and Environmental Health*, *6*(3), 203–207. http://dx.doi.org/10.1179/oeh.2000.6.3.203.

Huang, Y. -H., Ho, M., Smith, G. S., & Chen, P. Y. (2006). Safety climate and self-reported injury: Assessing the mediating role of employee safety control. *Accident Analysis & Prevention*, *38*(3), 425–433. http://dx.doi.org/10.1016/j.aap.2005.07.002.

Kim, H. -Y. (2013). Statistical notes for clinical researchers: Assessing normal distribution (2) using skewness and kurtosis. *Restorative Dentistry & Endodontics*, *38*(1), 52–54. http://dx.doi.org/10.5395/rde.2013.38.1.52.

Kines, P., Andersen, L. P. S., Spangenberg, S., Mikkelsen, K. L., Dyreborg, J., & Zohar, D. (2010). Improving construction site safety through leader-based verbal safety communication. *Journal of Safety Research*, *41*(5), 399–406. http://dx.doi.org/10.1016/j.jsr.2010.06.005.

Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York: The Guilford Press.

Leung, M., Chan, I. Y. S., & Cooper, C. L. (2015). *Stress management in the construction industry.* Chichester, West Sussex, UK: John Wiley & Sons, Ltd.

Leung, M. -Y., Liang, Q., & Olomolaiye, P. (2016). Impact of job stressors and stress on the safety behavior and accidents of construction workers. *Journal of Management in Engineering*, *32*(1), 1943–5479. http://dx.doi.org/10.1061/(ASCE)ME.1943-5479.0000373.

Lingard, H. C., Cooke, T., & Blismas, N. (2010). Safety climate in conditions of construction subcontracting: a multi-level analysis. *Construction Management and Economics*, *28*(8), 813–825. http://dx.doi.org/10.1080/01446190903480035.

Liu, L., Hu, S., Wang, L., Sui, G., & Ma, L. (2013). Positive resources for combating depressive symptoms among Chinese male correctional officers: perceived organizational support and psychological capital. *BMC Psychiatry*, *13*(1), 89. http://dx.doi.org/10.1186/1471-244X-13-89.

Loewenthal, K. M. (2001). *An introduction to psychological tests and scales* (2nd ed.). Hove, UK: Psychology Press.

Luthans, F. (2002). The need for and meaning of positive organizational behavior. *Journal of Organizational Behavior*, *23*(6), 695–706. http://dx.doi.org/10.1002/job.165.

McCabe, B., Loughlin, C., Munteanu, R., Tucker, S., & Lam, A. (2008). Individual safety and health outcomes in the construction industry. *Canadian Journal of Civil Engineering*, *35*(12), 1455–1467. http://dx.doi.org/10.1139/L08-091.

Mendeloff, J., & Staetsky, L. (2014). Occupational fatality risks in the United States and the United Kingdom. *American Journal of Industrial Medicine*, *57*(1), 4–14. http://dx.doi.org/10.1002/ajim.22258.

Mohamed, S. (2002). Safety climate in construction site environments. *Journal of Construction Engineering and Management*, *128*(5), 375–384. http://dx.doi.org/10.1061/(ASCE)0733-9364(2002)128:5(375).

National Institute for Occupational Safety and Health (NIOSH) (2001). Fatal injuries to civilian workers in the United States, 1980–1995. Retrieved October 10, 2016, from http://www.cdc.gov/niosh/docs/2001-129/pdfs/2001-129.pdf

Ontario (2014). Progress report: jobs and economy. Retrieved December 12, 2015, from https://www.ontario.ca/government/progress-report-2014-jobs-and-economy

Ontario Centre for Suicide Prevention (2015). First Responders & trauma intervention and suicide prevention. Retrieved October 10, 2016, from https://www.suicideinfo.ca/wp-content/uploads/2015/05/First-Responders-Toolkit-WEB.pdf

Ontario Infrastructure Health & Safety Association (IHSA) (2008). Fatalities, injuries, and disease. Retrieved June 14, 2015, from http://ihsa.ca/pdfs/research_docs/Injury_Statistics_2008.pdf

Ontario Ministry of Labour (2015). Overtime pay. Retrieved May 15, 2016, from https://www.labour.gov.on.ca/english/es/pubs/guide/overtime.php

Ontario Workplace Safety and Insurance Board (WSIB) (2013). By the numbers: 2012 WSIB statistical report table of contents. Retrieved March 20, 2015, from http://www.wsibstatistics.ca/wp-content/uploads/2015/05/WSIB_BTN_SCHED1.pdf

Pidgeon, N. F. (1991). Safety culture and risk management in organizations. *Journal of Cross-Cultural Psychology*, *22*(1), 129–140. http://dx.doi.org/10.1177/0022022191221009.

Probst, T. M., Brubaker, T. L., & Barsotti, A. (2008). Organizational injury rate underreporting: the moderating effect of organizational safety climate. *Journal of Applied Psychology*, *93*(5), 1147–1154. http://dx.doi.org/10.1037/0021-9010.93.5.1147.

Schwarzer, R., & Jerusalem, M. (1995). Generalized self-efficacy scale. In J. Weinman, S. Wright, & M. Johnston (Eds.), *Measures in health psychology: A user's portfolio* (pp. 35–37). Windsor, UK: NFER-NELSON.

Siu, O., Phillips, D. R., & Leung, T. (2004). Safety climate and safety performance among construction workers in Hong Kong. The role of psychological strains as mediators. *Accident; Analysis and Prevention*, *36*(3), 359–366. http://dx.doi.org/10.1016/S0001-4575(03)00016-2.

Statistics Canada (2015a). Labour force survey estimates (LFS), by North American Industry Classification System (NAICS), sex and age group. Retrieved June 14, 2015, from http://www.statcan.gc.ca/

Statistics Canada (2015b). Table 282-0008, Labour force survey estimates (LFS), by North American Industry Classification System (NAICS), sex and age group annual (persons x 1,000). Retrieved June 14, 2015, from http://www.statcan.gc.ca/

Statistics Canada (2015c). Table 281-0042 - Survey of Employment, Payrolls and Hours (SEPH), employment for all employees, by enterprise size and North American Industry Classification System (NAICS), annual (persons). Retrieved June 14, 2015, from http://www.statcan.gc.ca/

Stewart, M., Reid, G., & Mangham, C. (1997). Fostering children's resilience. *Journal of Pediatric Nursing*, *12*(1), 21–31. http://dx.doi.org/10.1016/S0882-5963(97)80018-8.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (5th ed.). Boston, MA: Pearson Education, Inc.

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, *2*, 53–55. http://dx.doi.org/10.5116/ijme.4dfb.8dfd.

The Association of Workers' Compensation Boards of Canada (AWCBC) (2013). Number of Fatalities, by Industry and Jurisdiction, 2011-2013. Retrieved June 14, 2015, from http://awcbc.org/

Tholén, S. L., Pousette, A., & Törner, M. (2013). Causal relations between psychosocial conditions, safety climate and safety behaviour — A multi-level investigation. *Safety Science*, *55*, 62–69. http://dx.doi.org/10.1016/j.ssci.2012.12.013.

Turner, B., Pidgeon, N., Blockley, D., & Toft, B. (1989). Safety culture: its importance in future risk management. *Second World Bank workshop on safety control and risk management. Karlstad, Sweden*.

Wanberg, C. R., & Banas, J. T. (2000). Predictors and outcomes of openness to changes in a reorganizing workplace. *Journal of Applied Psychology*, *85*(1), 132–142. http://dx.doi.org/10.1037/0021-9010.85.1.132.

Wheaton, B., Muthén, B., Alwin, D. F., & Summers, G. F. (1977). Assessing reliability and stability in panel models. *Sociological Methodology*, *8*, 84–136.

Williams, L. J., & Holahan, P. J. (1994). Parsimony-based fit indices for multiple-indicator models: do they work? *Structural Equation Modeling: A Multidisciplinary Journal*, *1*(2), 161–189. http://dx.doi.org/10.1080/10705519409539970.

Youssef, C. M., & Luthans, F. (2007). Positive organizational behavior in the workplace: the impact of hope, optimism, and resilience. *Journal of Management*, *33*(5), 774–800. http://dx.doi.org/10.1177/0149206307305562.

Zohar, D. (1980). Safety climate in industrial organizations: theoretical and applied implications. *The Journal of Applied Psychology*, *65*(1), 96–102. http://dx.doi.org/10.1037/0021-9010.65.1.96.

Zohar, D. (2000). A group-level model of safety climate: testing the effect of group climate on microaccidents in manufacturing jobs. *The Journal of Applied Psychology*, *85*(4), 587–596. http://dx.doi.org/10.1037/0021-9010.85.4.587.

Zohar, D., & Luria, G. (2005). A multilevel model of safety climate: cross-level relationships between organization and group-level climates. *The Journal of Applied Psychology*, *90*(4), 616–628. http://dx.doi.org/10.1037/0021-9010.90.4.616.

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