Leadership in Sustainable Infrastructure
Leadership en Infrastructures Durables

Vancouver, Canada
May 31 – June 3, 2017/ *Mai 31 – Juin 3, 2017*

DIMENSIONS OF CONSTRUCTION SAFETY CLIMATE

Alruqi, Wael[1, 3], Hallowell, Matthew [2]
[1, 2] University of Colorado at Boulder, United States
[3] Wael.alruqi@colorado.edu

Abstract: Safety climate has been recognized as a proactive safety metric that can be used to predict safety performance. In recent years, researchers have measured dimensions of organizational safety climate across a variety of sectors and work types. However, at present there is no consensus about the dimensions that define safety climate. Additionally, despite the volume of literature, there is limited analysis of the various dimensions modeled across studies. The paper addresses this limitation by reviewing the research on construction's safety climate in an effort to: (1) identify the salient dimensions of safety climate; (2) establish a consistent definition of each safety climate dimension; (3) review the questionnaires used to measure safety climate dimensions; and (4) model the trends of safety climate research in the last 16 years. All of the 114 construction safety climate studies published in peer-reviewed journals since the year 2000 were reviewed and analyzed. The results indicate that the rate of construction safety climate papers has increased rapidly. In fact, 60% of the identified studies were published after 2012. Fifteen percent of these studies modeled the relationship between safety climate dimensions and safety performance. When measuring safety climate, researchers most often use Likert-scale questionnaires; however, there is very little commonality in the dimensions of climate used across studies. Of the dimensions, management commitment, supervisory safety response, safety procedures and rule, and 15 other dimensions were the most common. The findings from this review can be used to direct future work, establish a unified method of measuring safety climate, and act as a catalyst for the first meta-analysis of the relationship between safety climate and performance.

1 INTRODUCTION

The construction industry has adopted and implemented various safety performance measures to improve safety performance. Safety climate is a safety measure that has been found to correlate to safety performance. Safety climate is the shared perception among employees regarding safety in the work environment (Zohar 1980). Numerous studies have examined the validity of safety climate and its effect on construction safety. Safety climate has been perceived as a valid metric that has a positive effect on the project safety performance. For example, Siu et al. (2004) surveyed 374 construction workers in different jobsites to examine the relationship between safety climate and self-reported accidents with psychological strains, and found that safety climate is a proactive measure that could predict injuries. Additionally, various authors have reported a positive relationship between safety climate and safety performance, and an inverse relationship between safety climate and on-the-job injury rates (Panuwatwanich et al. 2016; McCabe et al. 2016; Hon et al. 2014; Chen et al. 2013; Lingard et al. 2012).

Safety climate has been analyzed using two levels: organization level and group level. Zohar (2000) suggested that safety climate can be measured at the organization level as top management typically sets organizational policies, practices, and procedures. In addition, safety climate can be measured at the

group-level because work groups execute these organizational policies and procedures (Zohar 2000). Zohar (2000) collected data from 534 metal-processing plant workers and found that work group members across the organization shared similar views of their supervisory roles during the implementation of work policies. Several studies have analyzed construction safety climate at the organization level (Panuwatwanich et al. 2016; McCabe et al. 2016; Soraperra et al. 2015). However, others examine construction safety climate at the group level (Lingard, et al. 2012) . Despite these differences in perspective, the questions and dimensions of safety climate and questions used to assess them remain relatively consistent.

Safety climate questionnaires consist of different sets of questions commonly known in literature as safety climate dimensions, such as management commitment to safety, safety rules and procedures, and communication. These dimensions are thought to be independent but collectively shape the overall safety climate in a group or organization. In recent years, researchers have measured construction safety climate with different questionnaires developed specifically for the industry or a particular sector. Often, questionnaires were adapted from other industries. In a recent review of safety climate studies, Schwatka et al. (2016) found that the construction industry still lacks a common definition of safety climate, specifically the core dimensions of safety climate. This gap indicated the need for an in-depth investigation and analysis of the climate dimensions that define construction safety climate.

The purpose of this study was to: (1) model the trends of safety climate research since the year 2000; (2) identify the salient dimensions of safety climate; (3) establish a consistent definition of each safety climate dimension; and (4) review the questionnaires used to measure safety climate dimensions.

2 SAFETY CLIMATE QUESTIONNAIRES

In recent years, researchers have measured safety climate through the use of inconsistent and non-standardized set of questionnaires. The questionnaires in general were designed to reflect the definition of safety climate (Mohamed 2002). Commonly, the outputs of these questionnaires are aggregated scores of workers' perception of the safety environment in which they work. In an early study by Zohar (1980), eight safety climate dimensions were introduced: (1) management commitment to safety; (2) the importance of safety training; (3) level of work risk; (4) status of safety officer; (5) the requirement of work pace on safety; (6) status of safety committee; (7) effects of safe conduct on promotion; and (8) effects of safe conduct on social status. The final product was a questionnaire with 40 items addressing the eight dimensions. The questionnaire was tested with a sample from the industrial organization, and was shown to be a valid tool for quantifying worker perceptions of safety. Later, the Zohar questionnaire was tested for replicability by Brown and Holmes (1986) who found that three of the eight dimensions (commitment of management to safety; management act to worker concerns; and risk level) were the strongest predictors of performance in the work place.

Since the early work of Zohar, numerous studies have been conducted to create or refine a safety climate questionnaire specific to the construction industry. A few researchers have created their own safety climate surveys. For example, Mohamed (2002) created a questionnaire with ten dimensions: (1) management commitment to safety; (2) communication; (3) safety role and procedure; (4) supportive environment; (5) supervisory environment; (6) worker involvement; (7) risk tacking behaviour; (8) appraisal of work hazard; (9) work pressure; and (10) competence. Similarly, Kines et al. (2011) developed the "Nordic Safety Climate Questionnaire," which has seven dimensions: (1) management safety priority; commitment and competence; (2) management safety empowerment; (3) management safety justice; (4) workers' safety commitment; (5) workers' safety priority and risk non-acceptance; (6) safety communication, learning, and trust in co-workers' safety competence; (7) workers' trust in the efficacy of safety systems. Recently, Li et al. (2016) constructed a safety climate questionnaire with six dimensions: workers' self-perception of safety, workers' involvement in safety, co-workers' interaction, safety environment, safety management involvement, and safety personnel support. However, most researchers have adopted or modified existing safety climate questionnaires to meet the needs of the stakeholders (Gillen et al. 2002; Siu et al. 2004;

Pousette et al. 2008; Lingard et al. 2009). Interestingly, the literature is inconsistent when it comes to safety climate dimensions and there is no accepted standard across the construction industry.

3 RESEARCH METHOD

The objectives of this paper were met by conducting a comprehensive search and codification of the relevant literature. Specifically, these steps were followed: search, selection, coding, and analysis. The first step involved searching most recognized science-indexing tools includes Engineering Village, and Google Scholar using a wide variety of individual or combined keywords such as “safety climate”, “safety culture”, “safety attitude”, “safety performance” and “construction safety” The second step involved selecting studies using at least one or more of the following criteria: (1) the study used a developed or adopted safety climate questionnaire; (2) the study was reported in English and published after the year 2000; and (3) the study was specific to the construction industry (e.g. study samples were taken from the construction industry). The third step was coding individual studies using the following characteristics: author’s name, year of publication, whether the questionnaire was original or adopted, and the Likert scale type (Table 1). The final step was analyzing the coded information.

Table 1: Partial example of studies coding

Authors	Year	Original or Adopted	Climate Dimensions	Likert-scale
(Gao et al.)	2016	Adopted	Management commitment Supervisor safety response Co-worker safety response	5-point
(Arcury et al.)	2015	Adopted	Management commitment Employee risk perception	4-point
(Lingard, Cooke, and Blismas)	2012	Adopted	Management safety commitment Supervisor safety response Co-worker safety response	5-point
(Mohamed)	2002	Original	Management commitment Communication Plus other eight dimensions	5-point

4 RESULTS

4.1 Literature search result

Of all studies reviewed, 114 met the previously mentioned inclusion criteria. The literature review revealed that interest in safety climate has grown in the construction industry in the last 16 years. Approximately 60% of the identified studies were published after the year of 2012. The majority of these studies were published between the years of 2015-2016 (35%). Furthermore, 15% of the studies modeled relationships between safety climate dimensions and safety performance. However, the majority of the identified studies adopted safety climate questionnaires containing a variety of climate dimensions. In addition, only 10% of the identified studies developed new climate questionnaires for the construction industry, and the rest were adopted or adapted from other studies.

4.2 Safety climate questionnaires

There are three leading climate surveys that have been adapted or adopted by other researchers. The first is the Climate Survey Tool (CST) developed by the UK Health and Safety Executive (HSE, 2002). The first draft of CST included 71 items that measured 10 safety climate dimensions, such as organizational commitment and communication, line management commitment, supervisors’ role, and workmate’s influence. Later, Zhou et.al. (2008) adopted the CST tool to address the relationship between safety climate and safety behavior in the Chinese construction industry. Many other researchers used part of the CST

tools along with other adopted safety climate tools (e.g. Lingard et al. 2012; Choudhry et al. 2009). The second tool was developed by Dedobbeleer and Béland (1991), which contains 10 dimensions including a self-reported injury rate. Different studies adopted and used the Dedobbeleer questionnaire as the only instrument for their study (Gillen et al. 2002) or as a part of their study questionnaire (Sparer et al. 2016; Sunindijo and Zou 2011). Finally, the third was the Safety Climate Index Survey (SCI) of the Occupational Safety and Health Council of Hong Kong (OSHC, 2008). The SCI includes` 38 questions related to different safety dimensions (Hon et al. 2014). Different authors across a variety of sectors and work types tested the SCI (He et al. 2016; Hon and Liu 2016, Hon et al. 2014). Only 10% of the studies developed new safety climate questionnaires (Mohamed 2002; Kines et al. 2011; Li et al. 2016; Zhang et al. 2015). When measuring safety climate, researchers most often used Likert-scale questionnaires. The five-point was the most common style used across studies (about 72%), followed by four-point (13%), and the less commonly used scale seven-point, six-point, and three-point (7%, 5%, and 3%, respectively).

4.3 Common safety climate dimensions

We identified 18 common safety climate dimensions measured across 114 studies as shown in Figure1. Seven of these 18 dimensions were used more often in the identified studies. Those dimensions are discussed below, including each dimension's common definition, the range of items used to measure each dimension, and the use percentage of each dimension across studies, as shown in Table 2. Besides these dimensions, other commonly measured safety climate dimensions included workload pressure (6%), co-worker safety response (6%), supportive environment (3%), workmate influence (2%), competence (2%), worker safety response (2%), and general safety climate (2%). Additionally, we identified other dimensions that the same authors repeated in other studies. These factors included individual responsibility for safety and health (1%), awareness (1%), accountability (1%), and acceptance (1%).

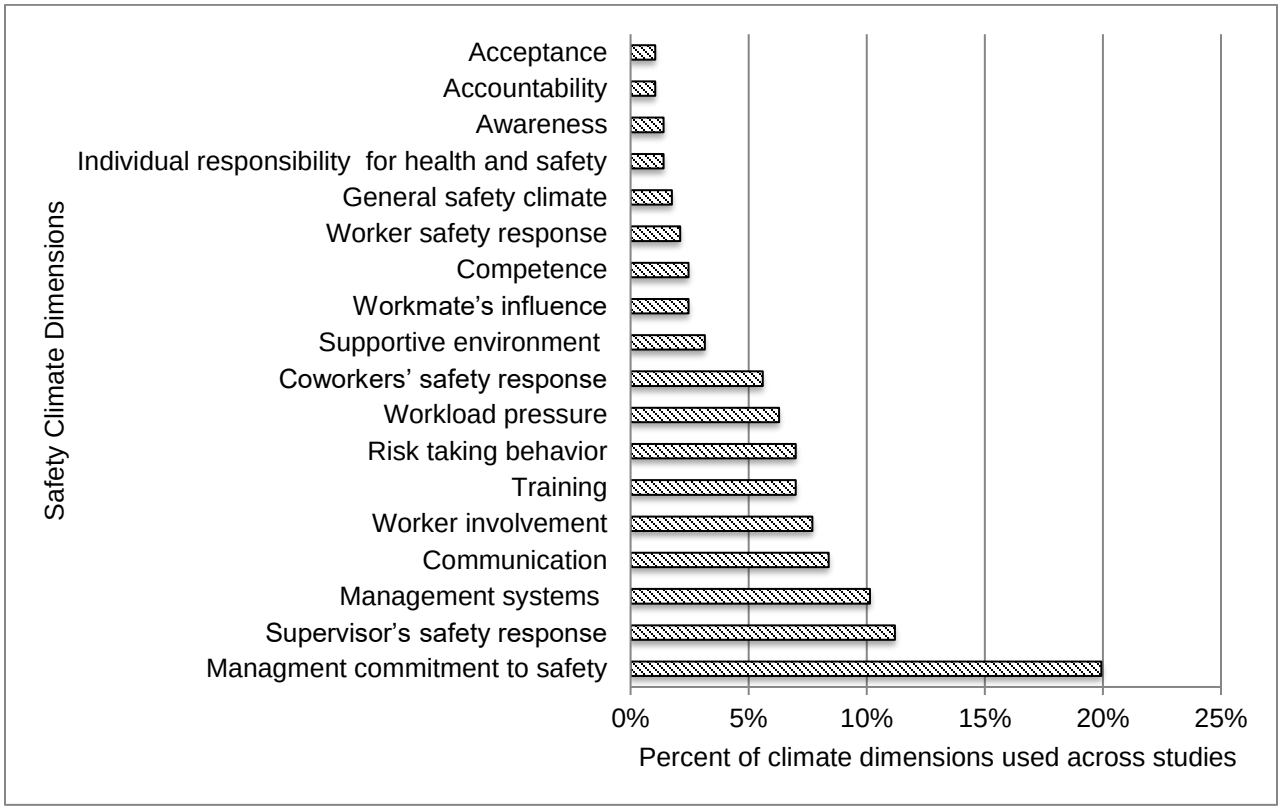

Figure 1: Percentage of safety climate dimensions used across studies

Table 2: Common safety climate dimensions used across studies

Dimension	Number of studies	Range of items in survey	Example items
Management commitment	57	6-16	"*Management clearly considers safety to be equally as important as production*" (Mohamed 2002)
Supervisory safety response	32	2-16	"*The supervisor in your company are good at dictating unsafe behavior*" (Fung et al. 2005)
Management system	29	3-7	"*Not all the health and safety procedures/instructions/rules are strictly followed here*". (Choudhry et al. 2009)
Communication	24	2-8	"*The upper management clearly communicates safety issues to all levels within the project*". (Wu et al. 2016)
Worker involvement	22	3-8	"*People at my site want to achieve the highest levels of safety performance*" (Hon et al. 2012)
Training	20	4-6	"*Safety issues are given a high priority in training programs*."(Shin et al. 2015)
Risk-taking behavior	20	4-7	"*How often do you feel you have to take risks to get the job done*"? (Sparer et al. 2016).

4.3.1 Management commitment to safety

Management commitment to safety was the most common safety climate dimension present in 57 studies (20%). This dimension refers to how effective the members of the top management are in ensuring that safety is a priority in their organization (Mohamed 2002; Cigularov et al. 2013; Stoilkovska et al. 2015; Patel and Jha 2016; and Kines et al. 2011). Such a priority can affect the decisions managers make in the areas of policy, procedures, and practice to ensure the safety and health of workers (Kines et al. 2011; Zohar 1980). The identified studies were consistent in the definition of management commitment to safety, but not consistent in regards the items used in measuring this dimension. This difference in the number of items ranged from six items (Sparer et al. 2013; Arcury et al. 2015) to 16 items (Gao et al. 2016). However, one explanation for the inconsistency of the number of items might relate to the definition of safety priority. Different studies show that such a priority might be related to one of the following aspects: "(1) *safety practice*, (2) *the first-line leader's response*, (3) *management activity* (e.g., *safety information*, and *safety meeting*), (4) *promotional campaigns, and* (5) *safety incentives*" (Dedobbeleer et al. 1991; Meliá et al. 2008; Zohar 1980).

4.3.2 Supervisory safety response

Supervisory safety response was used by 32 studies (11%). This dimension refers to how responsible the first-line leader is with regard to the implementation of his or her organization's supervisory safety role and procedures during day-to-day activities (Meliá et al. 2008; Patel and Jha 2016; Zhang et al. 2015). The definition of supervisory safety role was consistent among the identified studies. However, the items used to measure this dimension differed, and most of them reflected one of the following facets that directly impact worker health and safety: (1) controlling unsafe behavior, (2) the encouragement of safety behaviors, and (3) the priority of safety over productivity and time (Meliá et al. 2008; Zohar and Luria 2005). Fung et al. 2005 used only two items adapted from Health and Safety Executive (HSE, 2002) (e.g., "*The supervisors in your company are good at detecting unsafe behavior*;") that related to the two facets of controlling unsafe work behavior and ensuring the existence of a safety role in general at a worksite. On the other hand, Zhang et al. (2015) used 16 supervisory safety response items adopted from Zohar and Luria (2005).

4.3.3 Management system

Management system, also known as rules and procedures refers to the degree to which workers believe and follow their organization's safety rules and procedures to prevent accidents/incidents (Patel and Jha 2016; Fang and Wu 2013; Mohamed 2002). The management system dimension was used by 29 studies (10%). The identified studies were consistent in the definition of safety rules and procedures, but the items used to measure this dimension differed. Kante (2013), for example, used three items to measure this dimension's related aspects, including the effect on productivity of following safety rules and procedures, and the effect of the safety role on all work. Mohammed (2002), on the other hand, used seven items reflecting the above facets plus, for example, rules regarding the use of personal protective equipment, and the worker's understanding the benefits of following these rules and procedures.

4.3.4 Communication

The communication dimension refers to how members of the top management communicate health and safety issues with workers, and how openly managers receive feedback from workers about their safety and health concerns (Fang and Wu 2013; Patel and Jha 2016; Mohamed 2002). The communication dimension was used by 24 studies (8%). The common theme of the items used to define the communication dimension was related to the degree of trust between the management and workers (and among workers as well) when it comes to communicating and sharing their concerns and feedback related to health and safety (Kines et al. 2011). Additionally, Kines et al. (2011) indicated other facets related to the items used to define this dimension: "(1) *the management's openness to communicating with workers about safety*, (2) *the opportunity to learn from past experience*, and (3) *co-workers' openness to sharing and discussing safety-related issues during day-to-day activities*". An examination of the items used to measure this dimension showed that the items used varied in the above-mentioned facets. Wu et al. (2016), for example, used two items only to measure this dimension, and both related to the top management's openness to communicating with workers (e.g., "*The upper management clearly communicates safety issues to all levels within the project")*. On the other hand, Probst et al. (2008) used eight items adopted from Kines et al. (2011) considering all of the above aspects.

4.3.5 Worker involvement

Worker involvement refers to the degree to which workers receive encouragement from the upper management to participate in safety procedures and the extent to which they are invited to be a part of policy creation (Patel and Jha 2016; Fang and Wu 2013; Mohamed 2002). The worker involvement dimension was used by 22 studies (8%). Patel and Jha (2016) classified the degree of involvement into the following aspects: (1) the ability of the worker to report an injury; (2) the ability of the worker to be involved in making safety decisions; and (3) the ability of the worker to participate in hazard identification, safety inception, and accident investigations. In examining the items used to measure this dimension based on the above-mentioned aspects, we found the questions used to measure these items were not consistent.

Wu et al. (2016) identified three items that defined worker involvement based on the Chinese construction industry: (1) rewards for reporting injuries; (2) accident investigations; and (3) safety planning. However, Tholén et al. (2013) used eight items to measure this dimension, and those items related to the degree of involvement of workers, such as management's openness to involving workers in safety activities, and workers' confidence in reporting accidents and injuries.

4.3.6 Training

Safety training refers to the amount of safety education and instruction that workers receive during their work (Wu et al. 2015). The safety training dimension was measured across 20 studies (7%). The items used to measure safety training were shaped by facets such as the presence of safety representatives and safety training being held as a priority (Zohar 1980), training benefits (Kines et al. 2011), and safety instruction. However, the items used to measure this dimension differed from one study to another. Four items that Marin et al. (2015) used to measure the training dimension reflected facets such as the degree of understanding of safety instruction, a language barrier in safety instruction communication, the ability of workers to use protective equipment, and the adequacy of training on fall hazards. Meanwhile, Solís-Carca and Franco-Poot (2014) used six items related to safety management system efforts

4.3.7 Risk taking behaviour

Rsk-taking behavior refers to the degree of risk that workers are willing to take to complete tasks while violating safety regulations in the organization (Wu et al. 2015; Mohamed 2002). The risk-taking behavior dimension was included in 20 studies (7%). The facets of the items used to measure the dimension of risk-taking behavior were similar in the identified studies, including (1) worker responsibility for safety, (2) individual safety as a priority, and (3) the degree to which workers believe in the organization's rules to complete their work safely. However, the number of items differed. For example, Liao et al. (2013) used four items and Mohammed (2002) used seven items.

4.4 Contribution and differentiation from previous safety climate research

This study expanded on previous research conducted by Schwatka et al. (2016). Schwatka et al. (2016) conducted a literature review of 56 safety climate studies between 1983 and 2014 and developed a categorization scheme to group safety climate dimensions that shared common similarities and themes. Many of the safety climate dimensions found in their study are closely related to this literature review. However, differences do exist between studies and safety climate dimensions identified. Some of the dissimilarities stem from the categorization of dimensions. This study departs by eliminating the "categorizing" of common themes. Another primary difference lies in the volume of literature reviewed. Schwatka et al. (2016) included 56 publications compared to the 114 used in this study. This is primarily due to the large number of studies published after 2014 that were included in this study. This is important to the research community as there now exists no gap in safety climate dimension literature from 1983 to date. In addition, this research has identified common themes in safety climate dimensions. These similarities relate to safety rules and procedures, communication, and supervisory roles. All which have been found to be a critical aspect of safety performance.

5 DISCUSSION AND CONCLUSIONS

Despite over hundreds of studies conducted to date, there is still huge disagreement about the dimensions of safety climate in the construction industry. This study identified 18 common safety climate dimensions used in literature, including management commitment to safety, supervisory safety response, safety role, and safety procedures. These dimensions, although inconsistent among individual studies, are still consistent with previous literature reviews that found variation based on sample type, level of analysis (group or individual), and dimensions measured (Flin et al. 2000; Schwatka et al. 2016). For example, Lingard et al. (2009) used supervisory and co-worker safety response safety climate dimensions to measure employee group, while Soraperra et al. (2015) measured safety climate at the individual level using different

dimensions such as management commitment to safety. In addition to the lack of consensus about the core dimensions of safety climate, there is also inconsistency regarding the survey items used to measure these dimensions. This inconsistencies might be explained by the variety of elements the original surveys take into account when constructing the climate dimensions. The availability of many safety climate questionnaires may contribute to the wide variety of safety climate dimensions and survey items. The analysis revealed significant inconsistency in the use of safety climate questionnaires. The majority of the studies used existing surveys and combined different dimensions and items from different instruments. The level of measurement showed also a motivation for adopting safety climate dimensions and items. When the study measured the worker perceptions at group-level, the 10 items developed by Zohar (2000) were commonly included in the survey. Beside the level of measurement, the diversity and complicated activities of the construction industry may necessitate examination of the validity of dimensions for specific task. This is supported by Hon et al. (2012) who suggested that safety climate dimensions differ based on work type. Hon et al. (2012) identified three safety climate dimension specific for the repair and maintenance sector: (1) management commitment; (2) rule and procedure; and (3) individual responsibility for health and safety. The relationship between safety climate dimensions and safety performance are also important aspects.

This study demonstrates that the lack of consensus regarding safety climate dimensions in construction industry remains a challenge for the field and an area for potential improvement. Future research should expand on this study to investigate construction safety climate dimensions and their relation to injuries. Meta-analysis could be a particularly useful tool for this purpose. Meta-analysis can help validate the variation of the different significant effect levels of climate dimensions with injuries. In addition, expansion of this study can help standardize safety climate surveys so that researchers can collect consistent and reliable data.

References

Arcury, Thomas A., Phillip Summers, Julia Rushing, Joseph G. Grzywacz, Dana C. Mora, Sara A. Quandt, Wei Lang, and Thomas H. Mills. 2015. "Work safety climate, personal protection use, and injuries among Latino residential roofers." *American journal of industrial medicine* no. 58 (1):69-76.

Brown, R. L., and Harold Holmes. 1986. "The use of a factor-analytic procedure for assessing the validity of an employee safety climate model." *Accident Analysis & Prevention* no. 18 (6):455-470.

Chen, Q., R. Jin, and A. Soboyejo. (2013). "Understanding a Contractor's Regional Variations in Safety Performance." *Journal of Construction Engineering and Management* no.

Choudhry, Rafiq M., Dongping Fang, and Helen Lingard. 2009. "Measuring safety climate of a construction company." *Journal of construction Engineering and Management* no. 135 (9):890-899.

Cigularov, Konstantin P., Paige G. Lancaster, Peter Y. Chen, Janie Gittleman, and Elizabeth Haile. 2013. "Measurement equivalence of a safety climate measure among Hispanic and White Non-Hispanic construction workers." *Safety Science* no. 54:58-68.

Dedobbeleer, Nicole, and François Béland. 1991. "A safety climate measure for construction sites." *Journal of safety research* no. 22 (2):97-103.

Fang, Dongping, and Haojie Wu. 2013. "Development of a Safety Culture Interaction (SCI) model for construction projects." *Safety Science* no. 57:138-149.

Flin, Rhona, Kathryn Mearns, Paul O'Connor, and Robin Bryden. 2000. "Measuring safety climate: identifying the common features." *Safety science* 34, no. (1): 177-192.

Fung, Ivan W. H., C. M. Tam, Karen C. F. Tung, and Ada S. K. Man. 2005. "Safety cultural divergences among management, supervisory and worker groups in Hong Kong construction industry." *International Journal of Project Management* no. 23 (7):504-512.

Gao, Ran, P. Albert Chan, P. Wahyudi Utama, and Hafiz Zahoor. 2016. "Multilevel Safety Climate and Safety Performance in the Construction Industry: Development and Validation of a Top-Down Mechanism." *International Journal of Environmental Research and Public Health* no. 13 (11).

Gillen, Marion, Davis Baltz, Margy Gassel, Luz Kirsch, and Diane Vaccaro. 2002. "Perceived safety climate, job demands, and coworker support among union and nonunion injured construction workers." *Journal of Safety Research* no. 33 (1):33-51.

He, Qinghua, Shuang Dong, Timothy Rose, Heng Li, Qin Yin, and Dongping Cao. 2016. "Systematic impact of institutional pressures on safety climate in the construction industry." *Accident Analysis & Prevention* no. 93:230-239.
Hon, C., A. Chan, and M. Yam. 2012. "Determining Safety Climate Factors in the Repair, Maintenance, Minor Alteration, and Addition Sector of Hong Kong." *Journal of Construction Engineering and Management* no. 139 (5):519-528.
Hon, Carol K. H., Albert P. C. Chan, and Michael C. H. Yam. 2014. "Relationships between safety climate and safety performance of building repair, maintenance, minor alteration, and addition (RMAA) works." *Safety Science* no. 65:10-19.
Hon, K. Carol, and Yulin Liu. 2016. "Exploring Typical and Atypical Safety Climate Perceptions of Practitioners in the Repair, Maintenance, Minor Alteration and Addition (RMAA) Sector in Hong Kong." *International Journal of Environmental Research and Public Health* no. 13 (10).
Hon, Carol, Jimmie Hinze, and Albert Pc Chan. 2014. "Safety climate and injury occurrence of repair, maintenance, minor alteration and addition works: A comparison of workers, supervisors and managers." *Facilities* no. 32 (5/6):188-207.
HSE (2002) Evaluating the Effectiveness of the Health and Safety Executives Health and Safety Climate Survey Tool, HMSO, London.
Kines, Pete, Jorma Lappalainen, Kim Lyngby Mikkelsen, Espen Olsen, Anders Pousette, Jorunn Tharaldsen, Kristinn Tómasson, and Marianne Törner. 2011. "Nordic Safety Climate Questionnaire (NOSACQ-50): A new tool for diagnosing occupational safety climate." *International Journal of Industrial Ergonomics* no. 41 (6):634-646.
Li, Qiming, Chuang Ji, Jingfeng Yuan, and Ranran Han. 2016. "Developing dimensions and key indicators for the safety climate within China's construction teams: A questionnaire survey on construction sites in Nanjing." *Safety Science*.
Liao, Pin-Chao, Guangpu Lei, JiaWei Xue, and Dongping Fang. 2013. "Influence of person-organizational fit on construction safety climate." *Journal of Management in Engineering* 31, no. 4: 04014049.
Lingard, Helen Clare, Tracy Cooke, and Nick Blismas. 2009. "Group- level safety climate in the Australian construction industry: within- group homogeneity and between- group differences in road construction and maintenance." *Construction Management and Economics* no. 27 (4):419-432. doi: 10.1080/01446190902822971.
Lingard, Helen, Tracy Cooke, and Nick Blismas. 2012. "Do perceptions of supervisors' safety responses mediate the relationship between perceptions of the organizational safety climate and incident rates in the construction supply chain?" *Journal of Construction Engineering and Management* no. 138 (2):234-241.
Marin, Luz S., Manuel Cifuentes, and Cora Roelofs. 2015. Results of a community-based survey of construction safety climate for Hispanic workers." *International journal of occupational and environmental health* 21, no. (3): 223-231.
McCabe, B., E. Alderman, Y. Chen, D. Hyatt, and A. Shahi. 2016. "Safety Performance in the Construction Industry: Quasi-Longitudinal Study." *Journal of Construction Engineering and Management*:04016113.
Meliá, José L., Kathryn Mearns, Silvia A. Silva, and M. Luisa Lima. 2008. "Safety climate responses and the perceived risk of accidents in the construction industry." *Safety Science* no. 46 (6):949-958.
Mohamed, S. 2002. "Safety Climate in Construction Site Environments." *Journal of Construction Engineering and Management* no. 128 (5):375-384. doi: 10.1061/(ASCE)0733-9364(2002)128:5(375).
Occupational Safety and Health Council (OSHC). 2008. Construction Industry Safety Climate Index Software, OSHC, Hong Kong.
Panuwatwanich, Kriengsak, Saeed Al-Haadir, and Rodney A. Stewart. 2016. "Influence of safety motivation and climate on safety behaviour and outcomes: evidence from the Saudi Arabian construction industry." *International Journal of Occupational Safety and Ergonomics*:1-31. doi: 10.1080/10803548.2016.1235424.
Patel, D. A., and K. N. Jha. 2016. "Evaluation of construction projects based on the safe work behavior of co-employees through a neural network model." *Safety Science* no. 89:240-248.
Pousette, A., S. Larsson, and M. Törner. 2008. "Safety climate cross-validation, strength and prediction of safety behaviour." *Safety Science* no. 46 (3):398-404.

Probst, Tahira M., Ty L. Brubaker, and Anthony Barsotti. 2008. "Organizational injury rate underreporting: the moderating effect of organizational safety climate." *Journal of Applied Psychology* no. 93 (5):1147.

Schwatka, Natalie V., Steven Hecker, and Linda M. Goldenhar. 2016. "Defining and measuring safety climate: a review of the construction industry literature." *Annals of occupational hygiene* 60, no. 5 (2016): 537-550

Shin, Dong-Phil, Han-Seong Gwak, and Dong-Eun Lee. 2015. Modeling the predictors of safety behavior in construction workers." *International journal of occupational safety and ergonomics* 21, no. (3): 298-311.

Siu, Oi-ling, David R. Phillips, and Tat-wing Leung. 2004. "Safety climate and safety performance among construction workers in Hong Kong: The role of psychological strains as mediators." *Accident Analysis & Prevention* no. 36 (3):359-366.

Solís-Carca, Rómel G., and Ricardo J. Franco-Poot. 2014. "Construction workers' perceptions of safety practices: A case study in Mexico." *Journal of Building Construction and Planning Research* no. 2014.

Soraperra, Ivan, Lucia Savadori, Luigi Mittone, and Franco Fraccaroli. 2015. "Effects of Individual Risk Attitude, Safety Climate, and Affective Commitment on Safety Compliance." *Business and Economic Research* no. 5 (1):196-226.

Sparer, E. H., L. A. Murphy, K. M. Taylor, and Jt Dennerlein. 2013. "Correlation between safety climate and contractor safety assessment programs in construction." *American journal of industrial medicine* no. 56 (12):1463-1472.

Sparer, Emily H., Paul J. Catalano, Robert F. Herrick, and Jack T. Dennerlein. 2016. "Improving safety climate through a communication and recognition program for construction: a mixed methods study." *Scandinavian journal of work, environment & health*.

Stoilkovska, Biljana Blaževska, Valentina Žileska Pančovska, and Goran Mijoski. 2015. "Relationship of safety climate perceptions and job satisfaction among employees in the construction industry: the moderating role of age." *International journal of occupational safety and ergonomics* no. 21 (4):440-447.

Sunindijo, Riza Yosia, and P. X. Zou. 2011. Influence of technical skill on safety task implementation and safety climate development in construction. In *Procs 27th Annual ARCOM Conference*. Bristol, UK.

Tholén, Susanna Larsson, Anders Pousette, and Marianne Törner. 2013. "Causal relations between psychosocial conditions, safety climate and safety behaviour – A multi-level investigation." *Safety Science* no. 55:62-69.

Wu, C., X. Song, T. Wang, and D. Fang. 2015. "Core Dimensions of the Construction Safety Climate for a Standardized Safety-Climate Measurement." *Journal of Construction Engineering and Management* no. 141 (8):04015018.

Wu, Chunlin, Feng Wang, Patrick X. W. Zou, and Dongping Fang. 2016. "How safety leadership works among owners, contractors and subcontractors in construction projects." *International Journal of Project Management* no. 34 (5):789-805.

Zhang, Rita Peihua, Helen Lingard, and Steve Nevin. 2015. "Development and validation of a multilevel safety climate measurement tool in the construction industry." *Construction Management and Economics* no. 33 (10):818-839.

Zhou, Quan, Dongping Fang, and Xiaoming Wang. 2008. "A method to identify strategies for the improvement of human safety behavior by considering safety climate and personal experience." *Safety Science* no. 46 (10):1406-1419.

Zohar, Dov. 1980. "Safety climate in industrial organizations: theoretical and applied implications." *Journal of applied psychology* no. 65 (1):96.

Zohar, Dov. 2000. "A group-level model of safety climate: Testing the effect of group climate on microaccidents in manufacturing jobs." no. 85 (4):587-596.

Zohar, Dov, and Gil Luria.2005. "A multilevel model of safety climate: cross-level relationships between organization and group-level climates." *Journal of applied psychology* 90, no. 4 :616