SAFETY CLIMATE: RECENT DEVELOPMENTS AND FUTURE IMPLICATIONS

Hon, Carol, Dept of Building and Real Estate, The Hong Kong Polytechnic University, HKSAR
Chan, Albert, Dept of Building and Real Estate, The Hong Kong Polytechnic University, HKSAR

ABSTRACT
Safety climate is of current interest to construction practitioners and researchers. The concept of safety climate has been actively explored in the field of industrial and organizational (I/O) psychology but is just gaining popularity in the construction industry. This paper aims to review the literature of safety climate in a systematic manner and highlight future directions for safety research and development of safety practices in the construction industry. The value of safety climate lies in its ability to predict safety behaviour. Safety climate, as a mediator, unfolds the relationship between organizational variables and safety behaviour. It, as a moderator, affects the effectiveness of any safety initiatives to improve safety performance. Future research directions would be likely to look at relationship between organizational factors and safety climate using a multi-level analysis. To the construction industry, safety climate measurement is a good indicator to assess safety performance. Empirical studies show that frontline supervisor would be the best conduit to create a positive safety climate at workgroup level. This paper is beneficial to researchers interested in behavioural aspects of construction safety and industry practitioners striving for achieving better safe behaviour on site.

Keywords: Safety climate, Repair maintenance alteration and addition works, Construction industry of Hong Kong

INTRODUCTION
Safety has been one of the chronic problems of the Hong Kong construction industry. The Hong Kong Construction Industry Review Report (HKCIRC, 2001) advocates safety to be one of the six major areas for improvement. A pressing need to improve construction safety is also evidenced by the latest statistics. Accident rate per 1000 workers of all industries in Hong Kong were 29.3 in 2007 whereas accident rate per 1000 of the construction industry in 2007 was 60.6, a figure that was surpassingly high (Labour Department, 2008). Accidents of repair, maintenance, alteration and addition works (RMAA) are particularly alarming. Fatal rate of RMAA works accounted for 55.6% of the whole construction industry in 2006 (Labour Department, 2008). Safety legislation and policies can effectively drive down accident rate to a certain point; however, continuous safety improvement can only be done through promoting a positive safety culture in the construction industry.

The Occupational Safety and Health Council (OSHC) has been actively promoting safety culture to the Hong Kong construction industry. Safety Climate Index (SCI) recently developed by the OSHC has been promoted to the industry for measuring construction safety climate as an indicator of safety performance. Industry practitioners have practical reasons to know more about safety climate so as to make better use of safety climate scores. For example, meaning of high/low level of safety climate, implications to organization policies and management, the way to further improve safety and etc. Safety climate is a prevalent issue that interests practitioners in the construction industry.

Safety climate has been used to predict organizational safety performance for more than two decades. Industrial and organizational psychology (I/O) researchers have attempted to use safety
climate to deal with unsafe behavior in industries and organizations. The notion of safety climate has been applied in different industries such as manufacturing (Brown and Holmes, 1986; Clarke, 2006), chemical processing (Hofmann and Stretzer, 1998), nuclear processing and also construction (Dedobbeleer and Béland 1991; Mohamed, 2002; Siu et al., 2004; O’Toole, 2002; Fang et al., 2006; Zhou et al., 2008; Teo and Feng, 2009). Safety climate is relatively new to the construction industry as compared to other industries such as manufacturing. As research proliferates, safety climate has emerged to be a promising construct to affect people’s safety behaviour and in turn safety outcome. Seen in this light, it is high time to review the recent research development of safety climate and see how new research initiatives could be extrapolated to the construction industry.

This paper aims to develop a fuller understanding of safety climate through a systematic review of published literature, find out implications to future research and safety practices of RMAA works. As safety climate evolves to be a mature construct, it often appears in the form of a moderator or mediator, or contextual variable in models of more general interest (Reichers and Schneider, 1990). Reviews and discussions are thus more focused on the latest development of safety climate as a moderator or mediator. This paper is believed to be useful to researchers interested in construction safety and industry practitioners using safety climate as a safety performance indicator for their projects.

CONCEPT OF SAFETY CLIMATE
Safety climate and culture are considered to be subsets of organizational climate and culture (Coyle et al., 1995). Safety culture forms the context within which individual safety attitudes develop and persist and safety behavior are promoted. Safety climate is regarded as ‘the manifestation of safety culture in the behavior and attitude of employees’ (Cox and Flin, 1998). Zohar (1980) defines safety climate as ‘a summary of molar perceptions that employees share about their work environments… a frame of reference for guiding appropriate and adaptive task behaviors’ (p.96). Griffin and Neal (2000) advocate that perceptions of employees towards policies, procedures, and practices relating to safety comprise safety climate. As stated by Zohar (2003 a), safety climate reflects the true perceived priority of safety in an organization. Safety climate is a current-state reflection of the underlying safety culture (Mearns et al., 2003).

Safety climate is a social-cognitive construct. People make sense of organizational safety priority from procedures-as-pattern rather than discrete procedures (Zohar and Luria, 2004). With this in mind, unsafe behavior can be explained. Safety system and polices do not automatically generate safety; it is the true priority of safety that are consensually perceived by people that affect their safety behaviour. Safety climate influences one’s behavior through behavior-outcome expectancies (Zohar, 2003 a). Low safety climate implies that people assign lower weight to safety but greater value to short-term gains; for example, finish the work faster. In low safety climate, people also underestimate the likelihood of possible injury. It is believed that expectancies influence prevalence of safety behaviour which in turn influences company safety records. Climate strength may be the moderator variable for this climate-behavior relationship because the less homogeneity of climate perceptions, the weaker the climate-behavior relationship (Zohar and Luria, 2004).

According to Clarke and Cooper (2004), the definition of safety climate suggests that it might be regarded as a mediating variable between organizational characteristics and workers’ safe/ unsafe behaviours. Empirical studies have supported a mediation role for safety climate (Neal et al., 2000; Barling et al., 2002; Zohar, 2002 a, b). Safety climate has been found to mediate the relationship between organizational climate (Neal et al., 2000), leadership style (Zohar, 2002 a, b) on measures of safety performance.
METHODS AND RESULTS
A systematic literature search was done through books, conference proceedings and electronic database *ISI web of knowledge* which contains a wide coverage of academic journals with scientific citation index (SCI). Another electronic database *Scopus* was also searched for cross reference and to capture those articles, if any, not published in journals with SCI. Article titles with keywords “safety climate”, “safety culture” and “safety performance” were searched for up to 2009. 78 articles were identified in *ISI Web of Knowledge* and 38 articles were identified in *Scopus*, confirming results of each other. Another keyword search of “safety climate” was done in construction field related journals. By scanning through their abstracts, articles were mainly categorized into three different themes for review. They are measurement of safety climate, role of safety climate as a mediator and its role as a moderator.

MEASUREMENT OF SAFETY CLIMATE
Safety climate is agreed to be a multi-dimensional construct. However, there is yet any consensus to number of dimensions and items to form the measurement scale of safety climate. Zohar (1980) initially identifies eight dimensions of safety climate, namely: perceived importance of safety training programs, perceived management attitudes toward safety, perceived effects of safe conduct on promotion, perceived level of risk at the workplace, perceived effects of workplace on safety, perceived status of the safety officer, perceived effects of safe conduct on social status, and perceived status of safety committee. Similar studies have been conducted subsequently (Brown and Holmes, 1986; Dedobeleeer and Béland, 1991; Coyle et al., 1995) hoping to clearly identify the dimensions of safety climate. However, results are not replicable. Number of dimensions identified range from two to seven.

Factor structure of safety climate seems to unstable (Coyle et al., 1995) and tends to be industry specific (Cox and Flin, 1998). Items developed in one industry cannot generalize to other industries. Lin et al. (2008) attribute the safety climate factor structure difference to a combination of reasons, such as different populations in different industries or cultures, and the researchers’ discretion to determine the structure by different procedures of factor analysis. Usage of non-interval data in the factor analysis, type of rotation applied, and unipolar dimensions also affect the factor structure of safety climate (Guldenmund, 2000). Shannon and Norman (2008) critically point out that variation in safety climate scales are, at least partly, due to the incorrect application of factor analysis. Data input for factor analysis are usually individual workers’ perception on safety management system, practices etc. The object of measurement in safety climate scale items are, however, the work group or the company, making the scale items multi-level. Individual workers’ perceptions are often added together without considering their within group homogeneity. In that case, multi-level statistical analysis, such as multi-level confirmatory factor analysis, should be more appropriately employed to derive factor structure of safety climate.

The measurement of safety climate has evolved from a single level construct to multi-level. Thus, Zohar (2000) put forward a group-level model of safety climate. Zohar’s study is an echo to Hofmann and Stetzer’s study (1996) which adopts a cross-level approach of safety climate investigation. It is meaningful to analyse group level safety climate because there are variations between different groups. Since safety practices, policies are carried out at work group level by different supervisors, some work group may have higher level and strength of safety climate while some do not even within the same organization.

---

1 Mediator is defined as any variable that ‘accounts for the relation between the predictor [independent variable] and the criterion [dependent variable]’ (Barron and Kenny 1986).

2 Baron and Kenny (1986) define moderator as ‘qualitative (e.g. sex, race, class) or quantitative (e.g. level of reward) variable that affects the direction and/or strength of the relation between an independent or predictor variable and a dependent or criterion variable’.

---

3
ROLE OF SAFETY CLIMATE AS A MEDIATOR

Organizational factors play an important role to safety performance improvement. Recent research has attempted to link safety climate to organizational climate. Safety climate plays an intervening role between organizational factors and safety-related outcomes. ‘Safety climate becomes a potentially useful intermediate indicator of safety performance within the organization’ (DeJoy et al., 2004).

One example of safety climate as a mediator goes together with high performance work systems (HPWS). HPWS are high commitment and high involvement-oriented organizational strategies. Work practices generating high levels of commitment are believed to enhance safety behaviour. As show in Figure 1, Zacharatos et al. (2005) investigate the relationship between high performance work systems and occupational safety. Safety climate is found to be a mediator between high performance work systems and safety incidents.

Another example is found between leadership and safety behavior. Zohar (2002 a) examines the mediation effect of safety climate on different styles of leadership. Results indicate that there are full mediation effects of safety climate on transformational leadership whereas there is only partial mediation effect on corrective leadership. Findings of Barling et al. (2002) show that leadership quality predicts safety climates both directly and indirectly subject to the group members’ level of safety consciousness. Safety climate then predicts safety-related events (i.e. safety behavior) (Figure 2).

Transformational leadership is characterized by four dimensions: individualized consideration; intellectual stimulation; inspirational motivation and idealised influence. Empirical evidence shows that these dimensions have indirect effect on occupation safety (Barling et al., 2002; Yule et al., 2007; Zohar, 2002 a). Transformational leadership shows greater concern for subordinates’ welfare and develops closer individualized relationships, which promotes supervisory practices and in turn affects safety behavior. Transformational leadership works particularly well to improve work group safety behavior when job nature is not routine and safety procedures are not formalized. Transformational leadership allows people in the work group to make discretion decision following general pattern of safety procedures. On the other hand, transactional leadership characterized by non-individualized and hierarchical exchanges is found to be associated with higher accident rates (Barling et al., 2002).

Figure 1: Simplified model of effects of a high-performance work system on occupational safety at the employee level (Adopted from Zacharatos et al. 2005).
Besides these, there are other examples which model safety climate as a mediator, for example, organizational climate (Neal et al., 2000; Wallace et al., 2006), job satisfaction, job involvement and organizational commitment.

**ROLE OF SAFETY CLIMATE AS A MODERATOR**

An example of safety climate acts as a moderator is found in the relationship between leader member exchange (LMX) and safety citizen behavior (Hofmann et al., 2003). LMX is the relationship between supervisor and subordinate. Reciprocity, a basic tenet of social exchange theory (Gouldner, 1960), suggests that subordinates reciprocate high-quality supervision by extending their role beyond normal role requirements. They will perform citizenships behaviors (i.e. extra-role behavior) to benefit their supervisor and the organization. When safety climate is high, safety is perceived as the avenue to reciprocate high-quality LMX.

Referring to Figure 3, safety climate acts as a moderator to leader-member exchange and safety citizenship role definition. With the presence of high-quality LMX and positive safety climate, employees will likely to expand their role definition and perform safety behavior but such role expansion will not exist when safety climate is less positive (Hofmann et al., 2003).
One may notice that the leadership study of Hofmann et al. (2003) investigates the moderation property of safety climate by modeling safety climate as a higher order context variable. By contrast, Barling et al. (2002) and Zohar (2002 a) examine the mediation property of safety climate by modeling safety climate at the same level with leadership. Leadership style seems to exert both direct and indirect effect on safety behavior. Safety climate can be a mediator or a moderator on the relationship between leadership and safety behavior.

Job insecurity is commonly found to be associated with more injuries; however, researches with contrasting results (Parker et al. 2001) emerge as well. The study of Probst (2004) sheds light on the relationship between job insecurity and safety performance by incorporating safety climate as the moderator (Figure 4). Their study reveals that job insecurity, in fact, has low effect on safety behavior. Rather, it is the moderating effect of safety climate that affects safety behavior. When safety climate is positive, employees would perceive that acting safe is the way to retain their jobs but not productivity. In contrast, when safety climate is negative, employees tend to neglect safety because they would perceive that productivity rather than safety is important to job retention.

![Safety Climate Diagram](image)

Figure 4: Safety climate as a moderator of job insecurity and safety behavior.

**FUTURE IMPLICATIONS: RESEARCH**

Future research directions may turn to antecedents of safety climate; what are they and how they affect safety climate. The value of studying safety climate lies on its ability to predict and explain safety behavior. Safety climate researches in the construction industry have tried to identify key dimensions of safety climate (Mohamed, 2002) and establish the relationship with safety performance (Fang et al., 2006). Despite these research efforts, there is still a lack of specific guidelines for improving safety climate and in turn improve safety performance. More research could be conducted to determine the role of safety climate as a mediator and an intermediate indicator of safety performance (DeJoy et al., 2004).

To establish a causal relationship between safety climate and safety performance, longitudinal study or quasi-experimental study would be needed. Most of the safety climate researches have been cross-sectional survey designs. Without temporal difference, casual relationship could not be plausibly established.

Appropriate data analysis methods should be employed in future safety climate research. As statistical data or self-reported accidents/ injuries may not follow the requirement of normal distribution, they would be more appropriately analysed by logistic regression (Fang et al, 2006) or probit regression which are designed for categorical and limited dependent variables. Rather than multiple linear regressions, hierarchically nested data drawn from safety climate measurement may be more appropriately analysed by Hierarchical Linear modelling (HLM) which is designed for multi-level analysis (Hofmann and Stretzer, 1996).
A mixed methodology, which includes both quantitative and qualitative methods, is recommended. Safety climate research has been overwhelmingly on quantitative side; there may be a need for qualitative research as well for theory building. Safety climate research is popular because it allows, to certain extent, quantitative measurement of safety culture. However, safety culture, which is still not theoretically well-defined, is the ultimate target for change. For further research progression, future studies may need to incorporate the research merits of safety climate and safety culture.

FUTURE IMPLICATIONS: PRACTICE
Positive safety climate needs to be established on site. Construction works, no matter new works or repair and maintenance, are located away from head office of contracting companies. Despite safety policies and management system are in place, true priority of safety cannot be easily conveyed to workers situated on site. To successfully establish a positive safety climate, it is very important that project managers, resident engineers, safety supervisors/officers and subcontractors on site consistently demonstrate that safety always overrides.

Safety supervisor plays an important role to uphold safety. Safety training to workers only temporarily changes their behavior expectancies but does not last long. Frontline supervisors, however, can create positive project-level safety climate by consistently rewarding those perform safety while punishing those do not. This may infer that unsafe behavior could be more effectively controlled with the help of frontline supervisors. Efforts to raise safety awareness of group leaders or supervisors would be much needed.

Employment of casual workers may not necessarily lead to more injuries (Parker et al. 2001). Most of the construction workers are not direct labour, that is, they do not have job security. They may not have received enough safety training as those direct labour and they are more prone to accident. As Probst et al. (2008) reveal, safety shortcomings of employing indirect labour could be lessened by frontline supervisors promoting positive safety climate on site.

Appropriate leadership style helps to improve safety performance. Although repair, maintenance, alteration and addition (RMAA) works are perceived to be routine, they account for equally high or even higher accident rates than new works in Hong Kong. Research shows that it is more difficult to promote workers’ safety behavior in routine tasks because people tend to underestimate the potential risks. Immediate and frequent personal reward is the most effective action taken to change one’s expectancy value in routine tasks (Zohar and Erev, 2007). Leadership and supervision has important effect on safety behavior of workers. Zohar (2003 b) proclaims that in highly routine jobs, transactional leadership style could enforce workers’ safety compliance; whereas in less routine jobs, transformational leadership could motivate workers’ safety participation. As for RMAA work, transactional leadership may be more effective to enforce safety compliance by adhering to practice guidelines issued by the OSHC or the Labour Department.

CONCLUSIONS
To conclude, although safety climate has been studied widely in recent years, more research is needed especially in the construction industry. Discussions in this study are not exhaustive but may enlighten researchers and practitioners how to improve safety. Vast majority of safety accidents in the construction industry stems from unsafe behavior. However, Heinrich, et al. (1980) claims that unsafe behavior is one of the symptoms of failure (Seo, 2005). Underlying causes are usually traceable to poor management policies and decisions, personal and environmental factors. Only when antecedents and intervening variables leading to unsafe behaviour are identified can effective safety measures be made. Safety climate, as a mediator, predominantly offer a way to unfold the relationship between organizational factors and safety performance. Safety climate, as a moderator, can intensify or attenuate the effectiveness of safety policies and safety management.
system to improve safety performance. Having established its value, more safety climate research is worthy to be done in the construction industry.

REFERENCES


