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Towards a model for forming psychological safety climate in construction project management

Abstract

The nature of construction projects and their delivery exposes participants to accidents and dangers. Safety climate serves as a frame of reference for employees to make sense of safety measures in the workplace and adapt their behaviors. Though safety climate research abounds, fewer efforts are made to investigate the formation of a safety climate. An effort to explore forming psychological safety climate, an operationalization of safety climate at the individual level, is an appropriate starting point. Taking the view that projects are social processes, this paper develops a conceptual framework of forming the psychological safety climate, and provides a preliminary validation. The model suggests that management can create the desired psychological safety climate by efforts from structural, perceptual, interactive, and cultural perspectives. Future empirical research can be built on the model to provide a more comprehensive and coherent picture of the determinants of safety climate.

Key words:

Psychological safety climate, Conceptual model, Construction project, Safety management

1. Introduction

The nature of construction projects and their delivery poses immense challenges to the safety of construction practitioners. Historically, attempts to reduce accidents in project settings have gone through three overlapping stages, i.e. the technical age, the human error age, and lately the socio-technical age (Reason, 1993). In the technical age people adopted technical measures to mitigate or prevent hazards and risks in the project *environment*, while the human error age focused on

efforts to avoid malpractices of the *person* (i.e. project participants) in the project delivery process. However, “virtually all work injuries involve person-environment interactions” (DeJoy, 2005, p. 110). In the socio-technical age, great importance is therefore attached to both the *person* and *environment* and their interactions. The notion of safety climate, which is derived from the organizational climate theory and serves as a schema for employees to interpret the environment and adapt behaviors accordingly, is central to accident prevention in the socio-technical age.

The central tenet of organizational climate is that, faced with stimuli in the environment, individuals generate perceptions, attach meanings, develop expectations regarding behavior-outcome contingencies and ultimately adapt their behaviors (Moran and Volkwein, 1992; Zohar, 1980). An issue of concern with the organizational climate construct is that it is too general to be meaningful (Schneider and Reichers, 1983). Researchers therefore contend that the organizational climate should have a specific referent, and safety climate is the organizational climate of safety. Zohar (1980) described organizational climate as “coherent sets of organizational perceptions, when shared and summarized for individual employees” (p. 96 & 97), and safety climate as “common perceptions regarding safety” (p. 98), claiming that safety climate can supplement organizational climate. Later on, Zohar (2003) specifically related safety climate to “shared perceptions with regard to *safety* policies, procedures, and practices” (p. 125). Hence, both organizational climate and safety climate are traditionally conceptualized and operationalized at group or higher levels.

However, climate can be a property of both the individual and the organization (Johnston, 1976). Safety climate can therefore be conceived as a psychological, a psychosocial, or a socio-cultural construct, and perceptions can be aggregated at either group, organization or other

higher levels (Glendon, 2008). Psychological safety climate (PSC) is the conceptualization of safety climate at the individual level (Griffin and Neal, 2000; Morrow et al., 2010), and refers to the individual's perceptions of safety stimuli (including policies, procedures and practices) in the environment and serves as a frame of reference for guiding and directing appropriate and adaptive safety behavior in carrying out task activities. It forms the basis for safety climate at higher levels (Darr and Johns, 2004; James and James, 1989), is easier to measure and change compared with safety climate at higher levels (Guldenmund, 2010), and yet can be indicative of relationships at higher levels (Parker et al., 2003). Despite substantial research on safety climate and related outcomes, there is still paucity of research about the how safety climate forms. Therefore, as an appropriate starting point to examine how safety climate forms at higher levels, this paper focuses on how to form a psychological safety climate.

The paper is structured as follows. First, it elaborates on the research question against the backdrop of safety climate research in construction. Second, it examines the contributing factors to the psychological safety climate from a four-perspective framework, and develops a model depicting the formation of psychological safety climate. Third, after discussing the feasibility of empirically testing the model, preliminary results of the validation of the model using data from a large scale questionnaire survey are reported. Finally, both theoretical and practical implications of the model are discussed, along with limitations.

In this paper, we propose to categorize relevant factors into general factors and safety-specific factors. For example, organizational climate concerns employees' perceptions of the general environment, whereas safety-specific climate (i.e. safety climate) refers to those perceptions about safety measures (including policies, procedures, and practices). Similarly, leadership can be defined as the process of influencing others to act as the leader intends, whereas safety-

specific leadership refers to leaders' efforts toward safety (de Koster et al., 2011). Safety-specific factors (Barling et al., 2002; Conchie and Donald, 2008, 2009; de Koster et al., 2011; Kelloway et al., 2006) have recently been studied, and are more likely to be under the control of project team members compared with those general factors though some general factors, such as job demands, commitment, and leadership, have implications for safety performance (Nahrgang et al., 2007). Unless otherwise indicated, this paper takes all the factors as general factors.

2. Safety climate research in construction

Based on the review of studies from 1980s, Cooper and Phillips (2004) propose four directions of safety climate research, namely, a) the design of psychometric measurement instruments and determination of the latent factor structure of the construct of safety climate; b) the development and test of theoretical models to identify antecedents of safety behavior and accidents; c) the examination of the relationship between safety climate and actual safety performance; and d) the exploration of the relationship between safety climate and organizational climate. Table 1 summarizes safety climate studies in construction since 2000 (Choudhry et al., 2009; Cigularov et al., 2010; Dingsdag et al., 2008; Fung et al., 2005; Gillen et al., 2002; Glendon and Litherland, 2001; Kapp, 2012; Lingard et al., 2010b, 2012; Meliá et al., 2008; Molenaar et al., 2009; Pousette et al., 2008; Siu et al., 2003, 2004; Teo and Feng, 2009; Zhou et al., 2011; Zhou et al., 2008). Two patterns are evident: a) the studies primarily focus on psychometric measurement issues of psychological safety climate, as noticed by Beus et al. (2010); and b) most of the studies concern the factor structure of safety climate scales and the predictive relationship between safety climate and related outcomes, as proposed by Zohar (2010). What is lacking in these studies, however, is the formation of psychological safety climate (Barling et al., 2002;

DeJoy et al., 2004; Guldenmund, 2000; Zohar, 2010), which is the primary objective of this paper.

(Insert Table 1 here)

This research also has implications for construction project safety management practice. Project management involves sense-making (Thomas, 2000), and project management research calls for the examination of the social and human aspects of project works (Hanisch and Wald, 2011). Faced with seemingly stagnant safety performance after 2000 in the Hong Kong construction industry, researchers and practitioners began reflecting upon existing safety management systems and proposing new initiatives. One lesson learned is that, existing initiatives are deficient as they focus on “the internal and static aspects of the production (construction) system” (Koh and Rowlinson, 2012, p. 134). Hence, efforts from the social and dynamic aspects of construction organizing come to the fore in effectively implementing safety management systems. The safety climate theory views employees’ safe behaviors as a function of their shared appraisals of safety policies, procedures and practices in the workplace, and hence captures the social and dynamic elements of the organization process. Yet another expected practical contribution as an anonymous reviewer mentions is that, the construction project manager as a facilitator of the project team would gain insight into how to create a safety climate and therefore determine suitable safe behavioral styles before the commencement of the project. This is especially relevant, against the backdrop of Robens-style occupational health and safety legislation which bestows construction project managers with considerable discretion, and consequentially tremendous safety responsibilities.

3. Sources of psychological safety climate

Safety climate is almost unanimously accepted as an aspect of organizational climate (Silva et al., 2004), which serves to describe and provide understanding of individuals' behaviors in organizations (Hellriegel and Slocum Jr., 1974). An examination of the etiology of organizational climate should precede the contributing factors of safety climate.

Researchers have discussed the formation of organizational climate (Ashforth, 1985; Burke et al., 2002; Kuenzi and Schminke, 2009; Moran and Volkwein, 1992; Schneider and Reichers, 1983). Four perspectives of organizational climate have been proposed, i.e. structural, perceptual, interactive, and cultural perspective (Moran and Volkwein, 1992). Structural perspective characterizes climate as “an objective manifestation of the organization’s structure” (p. 24 & 25); perceptual perspective views climate as “a psychologically processed description of organizational conditions” (p. 26); interactive perspective perceives organizational climate on the basis of shared agreement which is engendered by “the interaction of individuals in responding to their situation” (p. 29); and the cultural perspective refers to organizational climate as “created by a group of interacting individuals who share a common, abstract frame of reference, i.e., the organization’s culture, as they come to terms with situational contingencies” (p. 35). Using these definitions, we can categorize relevant factors into these different perspectives, as shown in Table 2.

(Insert Table 2 here)

There are two points worth noting. First, the categorization is provisional, albeit justified. For example, we temporarily group individualism-collectivism under the cultural perspective, since it is the least controversial (national) culture dimension (Hofstede and Hofstede, 2005). Second, there are other categorizations. In essence, these contributors are constructs, which are

conceptual abstractions of phenomena impossible to observe directly and apply at different levels of organizations (Suddaby, 2010). For example, the construct of leadership is intended to be applied at the group level, whereas the construct of individualism-collectivism at the individual level. Figure 1 further illustrates this categorization. The following section elaborates further upon how these factors can influence the formation of psychological safety climate from four perspectives.

4. Perspectives of psychological safety climate

4.1. Structural perspective

From a structural perspective, organizational structure, in terms of size, configuration, centralization, specialization, procedures standardization and formalization, and interdependence of subsystems, affects organizational climate (James and Jones, 1974). Organizational climate is a characteristic or an attribute of an organization, which exists independently of the individual members' perceptions (Moran and Volkwein, 1992). Taking a project structural characteristics point of view project team organizational structure and the client involvement are likely to impact psychological safety climate formation as explained below.

4.1.1. Safety-specific organizational structure and psychological safety climate

Cross-functional structures that “invariably involve bringing people together from two or more usually separated organizational functional areas to undertake a task on either a temporary basis (as in a project team) or on a relatively permanent basis (as in a matrix organization)” (Ford and Randolph, 1992, p. 269) are employed to organize projects. In particular, dedicated project teams are usually adopted in project-based businesses such as the construction sector (Larson, 2004). In construction projects, Walker (2007) maintains that the ideal organization should garner

bureaucratic elements to secure accountability, in addition to non-bureaucratic elements which allow innovations. There are at least three dimensions of the organizational structure, i.e. centralization, formalization, and standardization, which seem relevant to construction site safety. Centralization concerns the degree of decision-making authority at the top, formalization refers to the degree of written instructions and procedures, and standardization indicates the degree of standard rules and procedures (Payne and Pugh, 1976). Establishing a set of rules and procedures can integrate or coordinate activities, especially those cross-functional activities (Pinto et al., 1993). Lower centralization and greater formalization contribute to positive organizational climate (Sommer et al., 1995), and procedural formalization can improve safety climate (Zohar and Luria, 2005). With highly standardized work, organizational climate is more likely to correspond with the group climate (Zohar, 2008). We argue that in a centralized workplace where the top management makes every single decision about safety policies, procedures, and practices, the employees would feel that safety is the responsibility of the top management, and hence have low perceptions or appraisals of relevant safety measures. However, in a formalized and standardized environment where safety policies are displayed prominently, safety procedures are written clearly, and safety practices are standardized, the employees would realize that safety is taken as a high priority. Hence, safety-specific centralization, formalization, and standardization, have different impacts on the psychological safety climate.

4.1.2. Client safety involvement and psychological safety climate

The relationship between the owner and the project manager is similar to the principal-agent relationship. On the one hand, the owner needs to incentivize the project manager to align their objectives. On the other hand, the owner needs to exert control mechanisms to stop the project manager's possible opportunistic behavior. Possibly due to such complex dual nature of the

owner-project manager relationship, Walker (2007) claims that the ideal project management should be exercised by the client. In real life, he opines that the appropriate integration of the client with project team depends primarily on the magnitude of authority that the client delegates to the project manager. Alternatively, some factors, such as owner business philosophy, project size, project risk and uncertainty, and alliance partner availability and capability, should be considered when deciding the involvement of the client in executing the project (Turner and Simister, 2001). However, the client integration is a critical project success factor (Voss, 2012), and sufficient communication is necessary between the client and the project manager through diversified channels or boundary spanners (Turner and Müller, 2003). This is also relevant in construction safety management.

Against the backdrop of increasing concern for corporate social responsibility in modern construction, the efforts made by stakeholders including the client should not be neglected (Manu et al., 2013). Clients are recognized to have enormous impact on safety climate and hence the safety performance of the construction projects. In the UK, the Construction (Design and Management) Regulations 1994 marked a milestone by placing specific and explicit duties of health and safety management on the client and the designers (The Chartered Institute of Building, 2010). Both contractor's workforce and project management invariably opine that the client has more impact on the contractor's safety culture than the contractor's own top management (Yule and Mearns, 2006). Researchers such as Lingard (1995), Huang and Hinze (2006), and Lingard et al. (2009) have studied possible client actions to improve construction safety. They have identified four avenues: 1) contract management; 2) active participation; 3) contractor selection; and 4) financial support, as shown in Table 3. By contract management, the client makes arrangements to secure contractors' safety performance. Through active

participation, the client demonstrates commitment to safety performance. In selecting contractors, the client attaches importance to the safety records. With financial support, the client incentivizes contractors' safety performance.

(Insert Table 3 here)

4.2. Perceptual perspective

The perceptual perspective depicts climate as individual members' "psychologically processed description of organizational conditions" (Moran and Volkwein, 1992, p. 26). In simple terms, the concept of organizational climate may be summarized as "what it feels like to work here" (Gray, 2001, p. 103). Alternatively, Zohar (2008) relates organizational climate to members' shared perceptions of the organization's policies, procedures, and practices. In organizations, policies prescribe strategic goals and achievement methods; procedures delineate tactical action guidelines concerning those goals and methods; and practices concern implementing policies and procedures. Since organizations possess diversified goals and achievement methods, top management must formulate policies and procedures with regard to each aspect, e.g., customer service, product quality, and safety. Relevant policies must be sufficiently clear and definite before employees reach consensus on these aspects (i.e. multiple climates result) (Zohar, 2003). This observation has relevance to construction projects. For example, a project team should have explicit objectives, and the project manager must ensure that all members work towards the same objective. As most projects are developed by a diversified group of independent contributors, the project manager must resolve any possible conflict and ensure that those contributors accept, understand, and interpret the project objectives in a consistent manner (Walker, 2007). Otherwise, the project objectives are likely to sway towards the contributors' own interests (Liu and Walker, 1998). In a supportive organizational climate developed by initiatives including Baiden et al.

(2006) and Gray (2001), the clear message that safety is ranked as a top priority is expected to be well conveyed and received. Therefore, the general organizational climate presents a context for and facilitates the generation of safety climate (Neal et al., 2000; Schneider et al., 2011). In this regard, extant studies have shown that safety climate mediates the relationship between organizational climate and safety behavior (Neal et al., 2000) and occupational accidents (Wallace et al., 2006). DeJoy et al. (2004) find that in combination with environmental conditions and safety policies and programs, general organizational climate explains more than 50% of the variance in psychological safety climate, and organizational climate contributes significantly to safety climate even after controlling for other variables.

4.3. Interactive perspective

Project activities are complex, emergent, and “achieved through the collective interactions of project participants and other interested stakeholders” (Sense and Fernando, 2011, p. 505). Early and regular interactions in an open and trusting environment contribute to project performance (Pocock et al., 1996). The interactive perspective views the formation of psychological safety climate as a product of social interactions among individuals, including leader-member exchange and team-member exchange. Since leadership requires interaction and involves at least two individuals (i.e. the leader and one follower), it is temporarily categorized into the interactive perspective.

4.3.1. Transactional-transformational leadership and psychological safety climate

Leadership refers to a process of influencing others to accept certain objectives and achievement methods and facilitating their individual and collective efforts in achieving those shared objectives (Yukl, 2006). James M. Burns proposes two leadership styles; transactional and transformational leadership (Lowe et al., 1996). Transactional leaders focus on organizing tasks

and leading followers to act reliably and efficiently; transformational leadership focuses on followers' potential and commits them to more challenging objectives (Zohar, 2002).

Complementing the former with the latter, a transactional-transformational leadership paradigm is broad enough to measure and understand the leadership construct (Bass, 1997), and produces an "augmentation effect" (Bass et al., 2003).

Compared with the general management literature, leadership has been almost ignored in the project management context (Turner and Müller, 2005). The probable reason is that, in the context of projects, the balance between management and leadership is struck in favor of management (Kaulio, 2008). Despite that, relevant studies suggest that project managers can make up for "authority-gap" through four leadership techniques, i.e. negotiation, personality and/or persuasive ability, competence, and the use of reciprocal favors (Hodgetts, 1968). Both relationship and task oriented leadership styles are needed to deal with challenges in different project phases (Slevin and Pinto, 1991). Project managers should be capable of developing shared visions, exercising participative management styles, creating the harmonious working climate, resolving conflicts, dealing with external contacts, enhancing internal communication and acquiring pertinent information and knowledge (Packendorff, 1995). In addition, project leaders in multi-project settings should take care of technical difficulties, dyadic leadership, group dynamics, linked dyadic-group processes, re-prioritization between projects, consultant relations, client relations, peer relations, project formation, and dependencies between (sub)projects (Kaulio, 2008). In construction projects, Raiden et al. (2004) maintain that effective team leadership is needed to form a supportive organizational climate. Construction firms need both transformational and transactional leadership, the extent to which is however culture specific (Ozorovskaja et al., 2007). The leadership style the project managers and engineers are

likely to adopt is also related to their emotional intelligence (Sunindijo et al., 2007), mental abilities, ability to carry out complex tasks (Yang et al., 2011), the project type (i.e. simple or complex) (Dulewicz and Higgs, 2004), and the phase in the project life cycle (Turner, 1999).

Leadership determines climate (González-Romá et al., 2002; Kozlowski and Doherty, 1989; Zohar and Tenne-Gazit, 2008). For example, during strategic change a pivotal leader's behavior will be "to influence the sensemaking and meaning construction of others toward a preferred redefinition of organizational reality" (Gioia and Chittipeddi, 1991, p. 442). Middle managers can also exert their influence in shaping strategies through their participation in decision-making (Maitlis, 2005). In a similar way, leaders at all levels can play a key role in forming safety climate (Andriessen, 1978; Clarke and Ward, 2006; Hofmann and Morgeson, 2004; Neal and Griffin, 2004; Zohar and Tenne-Gazit, 2008), although some authors emphasize general leadership (Hofmann and Morgeson, 1999; La Porte, 1996; Roberts and Bea, 2001), while others attach importance to safety-specific leadership (Kelloway et al., 2006). Avolio et al. (1999) developed a measurement model of leadership covering six factors, i.e. charisma/inspirational, intellectual stimulation, individualized consideration, contingent reward, active management-by-exception, and passive-avoidant leadership. Among them, the former three measure transformational leadership, and the latter three concern transactional leadership (Zohar, 2002). The former three factors are usually combined into "an overall measure of transformational leadership" (Kelloway et al., 2006, p. 78 & 79). By inspirational appeals, e.g. using emotional language to highlight new tasks and arouse enthusiasm, leaders develop employee commitment (Clarke and Ward, 2006). Through intellectual stimulation, leaders build among followers a consensus with regard to the emerging issues. Individualized consideration helps leaders win trust, and hence achieve obedience from the followers. Contingent reward encourages followers

to act as required. Active management-by-exception, in terms of a foreman as a leader of workers (Shohet and Laufer, 1991) spending more time on site monitoring employees' performance (Mattila et al., 1994), is likely to convey the message that the management really cares about employees. Hence, the three elements of transformational leadership and the first two elements of transactional leadership are conducive to forming safety climate. However, passive-avoidant leadership, e.g. avoiding decisions or responsibilities (Avolio et al., 1999), undoubtedly discourage employees to act actively and responsibly, and hence adversely affects their perceptions of safety climate.

4.3.2. Leader-member exchange and psychological safety climate

To gain a comprehensive understanding of the impact that leadership has on safety climate, we follow Christian et al.'s (2009) suggestion and examine how leader-member exchange impacts on safety climate, in addition to the transactional-transformational leadership. The difference between them is that, the former emphasizes the relationship between the leader and the followers, whereas the latter highlights the leader's influence tactics (Hofmann and Morgeson, 2004). According to Graen and Uhl-Bien (1995), the construct of leader-member exchange has been studied in sequence as a group-level effect, a dyad-level effect, and a dyads-within-group effect. In this study, leader-member exchange is taken as a group-level effect.

The nature of interactions between leaders and their followers mediates and organizes the followers' interpretations of relevant organizational events (Kozlowski and Doherty, 1989). Social exchange theory suggests that one party's action benefiting another party would produce an implied responsibility for the beneficiary to act in return for the benefit of the initiating party (Hofmann and Morgeson, 1999). Applying the theory to safety research, Hofmann and Morgeson (1999) find that leader-member exchange is significantly correlated with employees'

perceived organizational support, and related with safety communication. Effective project managers are good at team building, communicating, demonstrating trust, and focusing on results (Loo, 2002; Zimmerer and Yasin, 1998). In construction projects, the central and core ability of leaders is to establish and maintain sound relationships with staff and workers (Dingsdag et al., 2008). Safety communication, in terms of circulating information about unusual events, potential hazards and safety training sessions between management and workers, characterizes a sound safety climate (Katz-Navon et al., 2005) and can significantly increase safety levels (Kines et al., 2010). Hence, a safety-specific leader-member exchange is conducive to a psychological safety climate.

4.3.3. Team-member exchange and psychological safety climate

Human interaction is a source of emotional support, affection, and love (Aronson et al., 2002). Team-member exchange refers to the exchange relationships between individuals and their colleagues. Research shows that team-member exchange improves individual and team performance in that those who are well connected with other individuals are more likely to share information, ideas, and feedback, and hence develop strong group identity (Tse and Dasborough, 2008). The accomplishment of the project works involves collective interactions of practitioners from different professions (Koh, 2010; Rowlinson et al., 2008), and co-ordination, communication, commitment, competence, compatibility and co-operation are critical project success factors (Oyedele, 2013).

Team-member exchange is positively associated with climate perceptions (Beus et al., 2010; Sherony and Green, 2002). One common feature among various definitions of safety climate indicates that safety climate is derived from the negotiated and socially construed agreements, i.e., social interaction and influence precede safety climate (Zohar, 2010). Hence, a safety-

specific team-member exchange in which safety related information is disseminated freely among colleagues contributes to the formation of psychological safety climate.

4.4. Cultural perspective

The cultural perspective maintains that culture conditions climate. Culture affects individuals' perceptions, interpretations, and sense-making of their situations, and the effects are often multitudinous against the backdrop of projects which are usually featured with multiple and divergent organizational cultures (Sense and Fernando, 2011), although the temporary nature of projects renders it difficult rather than impossible to form project cultures (Baiden et al., 2006). Here, consideration is given to the impacts of the cultural dimensions of individualism-collectivism. Mirroring the degree to which individuals cherish self-determination as opposed to subjecting their behavior to the collective group will (Håvold, 2007), individualism-collectivism constitutes the basic assumptions at the core of cultures (Schein, 1992) and ranks as one of the common basic problems worldwide (Hofstede and Hofstede, 2005; Hofstede, 1991).

Individualism and collectivism are also relevant to construction projects. Walker (2007) observes that the sentience due to allegiance to a firm or a profession or both orientates project contributors' perception of the construction process only towards their specialism, neglecting issues from other professions or firms. This is especially true for those skilled personnel. For example, architects usually focus upon architectural aesthetics and builders upon buildability, with almost no overlap between the two. With safety management, Mohamed et al. (2009) found in their study that construction workers with a collectivistic attitude were more likely to identify and communicate safety issues among themselves, and help each other. Hence, we argue that employees who take into account the interests of others in accomplishing their jobs are more likely to perceive a favorable safety climate.

Up to this point, an inexhaustive list of contributors to the psychological safety climate has been identified and discussed through a comprehensive literature review. These four perspectives of safety climate discussed are complementary, rendering possible the integration of the contributing factors into a general framework (Burke et al., 2002). Schneider and Hall (1972) maintain that two categories of factors contribute to individuals' perceptions of organizational climate, i.e. "(a) the objective events in and characteristics of the organization and (b) characteristics (e.g., values, needs) of the perceiver" (p. 447). Similarly, the linkage model proposed by Indik (1965) states that two processes (i.e. organizational process and psychological process) link an objective organizational variable and a dependent variable (e.g. members' organizational participation) (James and Jones, 1974). The list of contributing factors to psychological safety climate can be alternatively categorized as shown in Figure 1. The signs in the parentheses against the factors indicate the nature of their impacts on the psychological safety climate. For example, the minus sign following *safety-specific centralization* suggests the negative relationship between centralization and psychological safety climate.

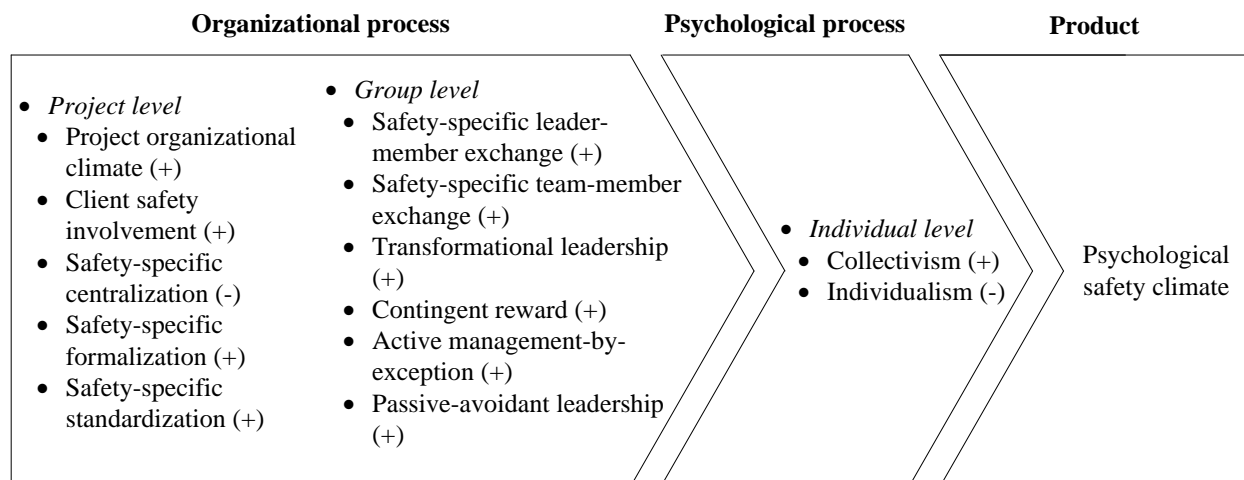


Figure 1. The 'production' of psychological safety climate

The figure is not intended to portray a mediational process in terms of different categories of factors as some factors could moderate some relations or as argued are directly related to psychological safety climate. Also, the model is nonrecursive, demonstrating just a section of the *production* process. As human beings have reflexive capacity, the generated psychological safety climate may in turn impact those *production* factors, but this is however beyond the scope of this paper. Further, the constructs (i.e. contributing factors) are specified at different levels of analysis. For example, leader-member exchange is specified at the group-level, but we acknowledge that others have studied the same construct as a group-level effect, dyad-level effect, and dyads within groups effect (Graen and Uhl-Bien, 1995).

5. Feasibility of testing the model empirically

The field of industrial and organizational psychology subsumes organizational climate research (James and Jones, 1974), and hence safety climate related research. Quantitative approaches dominate the field of psychological research (Gelo et al., 2008), and questionnaire survey is the mainstream method for investigating safety climate or safety culture (Guldenmund, 2000). Relevant empirical research cited earlier exemplifies and supports the feasibility of empirically testing the model. Although the relevance of each construct of interest to the construction practice has been elaborated, in testing the model great care should be taken of the construction project management context. For example, the indicators that are intended to measure the relevant constructs should be adapted to the construction projects. The instrumentality of measurement tools should also be dealt with given the varying levels of literacy among construction practitioners.

Structural equation modeling (SEM) could be employed to test the model based on the questionnaire survey responses, primarily because it takes into account the measurement errors

of relevant constructs in estimating their effects and hence yields more accurate estimates. This is particularly essential in the social sciences, where the constructs are usually multi-dimensional (Guldenmund, 2000). SEM has been employed in safety research (Cheyne et al., 1998; Clarke and Ward, 2006; DeJoy et al., 2010; Fernández-Muñiz et al., 2007; Mohamed, 2002; Neal et al., 2000; Tomás et al., 1999), and a wide range of other disciplines.

6. Preliminary validation

Organizational measurement can be both objective and subjective, with the former directly assessing organizational properties without any conceptual transformation and the latter indirectly assessing perceptions of organizational properties (Payne and Pugh, 1976). Subjective measures have a stronger impact on individual outcomes (Kristof, 1996), possibly because perceptual processes directly impact peoples' behaviors (Hellriegel and Slocum Jr., 1974). However, they might not function as surrogates (Bommer et al., 1995). Objective measures outperform their subjective counterparts in verifiability; their access however might be prohibited due to legal barriers (McFadden et al., 2009) or their narrow focus (Bommer et al., 1995). The assumed homogeneous organizational characteristics is not necessarily invariable, because when the organizational characteristics are investigated at the individual level, the relevant construct is no longer representing the verifiable organizational characteristics, but individuals' perceptions of them (Kristof, 1996). The accuracy of the measurements is contingent on whether the emphasis is put on the individual or the objective situation (James and Jones, 1974).

Since this study focuses on the psychological safety climate, perceptual measures of the relevant constructs were adopted. The measures (Avolio et al., 1999; Choudhry Oyserman et al., 2002; Tuuli, 2009; Van de Ven and Ferry, 1980) shown in Table 4 were adapted for the

construction project settings and revised based on the results of a pre-test. In the main round of the questionnaire survey, the hardcopy questionnaire was sent to a random sample of 2996 construction practitioners who were drawn from sub/contractors, clients and consultants. In total, 292 valid responses were obtained, among which 119 respondents were from sub/contractors, 84 from clients, and 89 from consultants. Taking into consideration of 865 non-deliverables, the effective response rate, 13.7%, was acceptable (Shen, 2013). Table 5 displays the inter-correlations among the constructs of interest at the individual level. Figure 2 demonstrates the results of confirmatory factor analysis of the structural model linking the contributing factors directly to psychological safety climate. As shown in the table and the figure, the correlation and path coefficient results generally support the nature of the relationships indicated in the preliminary model as discussed further below. It is worth mentioning that, many paths in Figure 2 are not significant. The standardized path coefficients reflect the relative importance of these contributing factors, taking into account measurement errors of latent constructs. The present data support the significant impacts of Clients' safety involvement and Project organizational climate, as compared to other factors.

(Insert Table 4 here)

(Insert Table 5 here)

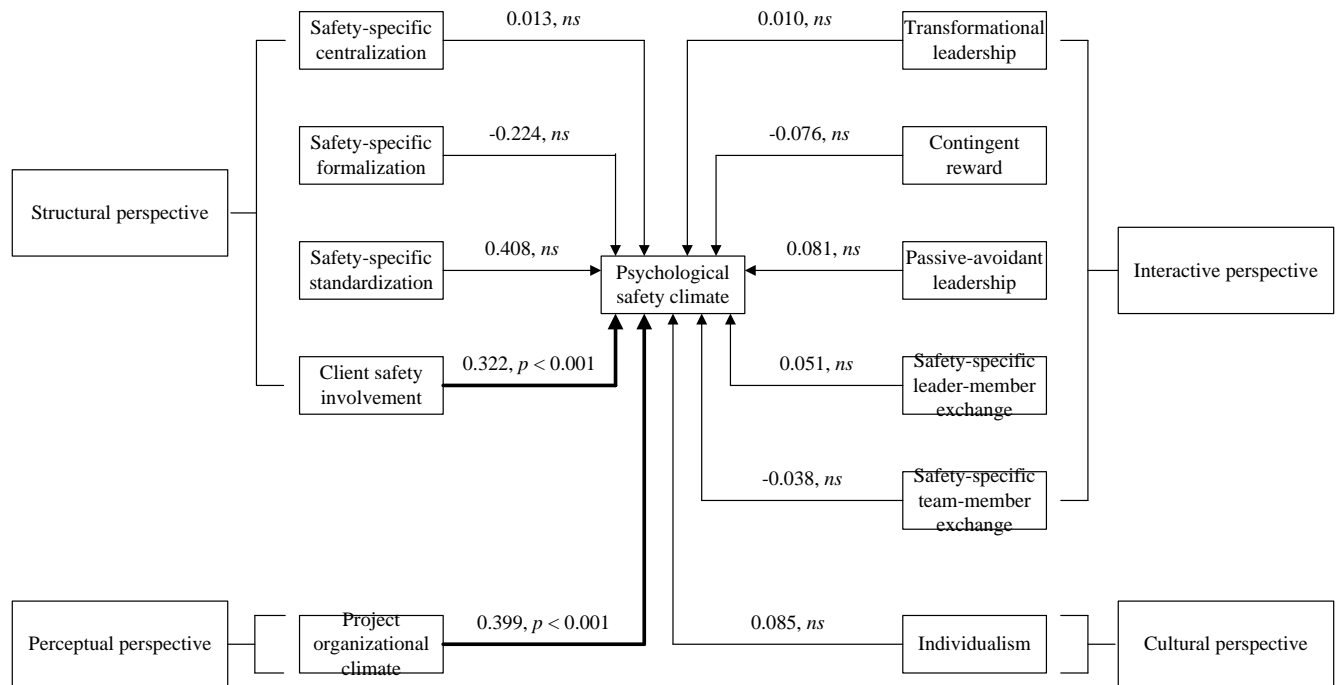


Figure 2. Path analysis of the conceptual model (model fit statistics: chi-square = 592.8; $df = 339$; $p < 0.001$; CFI = 0.971; RMSEA = 0.051)

7. Discussion and Conclusion

According to Söderlund (2004), there are two primary theoretical traditions in project management research. The first tradition takes intellectual root in the engineering science and applied mathematics, focuses on the planning techniques and methods to manage projects, and aims at avoiding uncertainty to reach determinateness. The second tradition is intellectually rooted in the social sciences, focuses on the organizational and behavioral dimensions of project organizations, and takes for granted uncertainty and indeterminateness. Organizational climate theory follows the second tradition. At the conceptual level, the safety climate construct facilitates considerable description and understanding of safety behaviors, providing access to

managerial staff in particular to improve employees' safety behaviors and corporate safety performance. In the face of devastating accidents which are exacerbated by a complex combination of factors, researchers propose the notion of safety climate in the hope that through shaping a positive safety climate people (not just limited to employees) can adaptively act safely and hence mitigate risks and avoid accidents. Unfortunately, the contributors to the psychological safety climate (i.e. safety climate at the individual level) have been rarely investigated, a curious lacuna in current safety climate research.

Based on the view that safety climate is the organizational climate of safety, we propose a tentative model of the contributors of construction practitioners' psychological safety climate, using the framework of the sources of organizational climate. In general, the psychological safety climate is derived from four perspectives, i.e. structural, perceptual, interactive, and cultural perspective. Structural perspective maintains that organizational structure, in terms of safety-specific centralization, safety-specific formalization, safety-specific standardization, and client safety involvement, contributes to the psychological safety climate. Perceptual perspective views that people's perceptions towards the general organizational environment, such as goal congruency, appraisal and recognition, participative decision-making, professional growth, and role clarity, contextualize their own safety perceptions and attitudes. Interactive perspective asserts that the psychological safety climate arises out of interactions with others. Cultural perspective attributes the psychological safety climate to people's shared consciousness.

In this study, we have proposed a theoretical model and conducted a preliminary validation of the model using data from a large scale questionnaire survey with construction practitioners in Hong Kong. The results show that the relationship between the contributing factors and psychological safety climate are generally in the direction as specified in the model and mostly

significant. Significant relationships were particularly confirmed between Psychological safety climate and Safety-specific formalization ($r = 0.22, p < 0.01$), Safety-specific standardization ($r = 0.45, p < 0.01$), Client safety involvement ($r = 0.50, p < 0.01$), Project organizational climate ($r = 0.52, p < 0.01$), Transformational leadership ($r = 0.23, p < 0.01$), Contingent reward ($r = 0.27, p < 0.01$), Safety-specific leader-member exchange ($r = 0.43, p < 0.01$), and Safety-specific team-member exchange ($r = 0.36, p < 0.01$). However, none significant relationships also emerged between Psychological safety climate and Safety-specific centralization ($r = -0.07, ns$), Passive-avoidant leadership ($r = 0.11, ns$) and Individualism ($r = 0.08, ns$). Taking into account other contributing factors from other perspectives, two factors, the client safety involvement from the structural perspective and the project organizational climate from the perceptual perspective, have significant impacts on psychological safety climate.

It is also worth noting that the model does not take into account an exhaustive list of contributing factors to psychological safety climate. For example, some person level variables (James et al., 1978), such as self-esteem, social cognitive ability, need for control, need for cognition, past experience, cognitive biases, and employment status (temporary or permanent), have not yet been considered. The reasons for this are twofold. First, no relevant empirical studies have been carried out to suggest that these person level factors have any direct relevance to psychological safety climate. Second, unlike those organizational factors considered, the person level variables are relatively stable, emergent overtime, and cannot be manipulated. In addition, it will seem that a multilevel approach is required both in the measurement and testing of the model and this will require deliberate design to enable adequate exploration of the relationships between the factors specified in the model as well as others yet to be identified and psychological safety climate. The model developed in this study is however a starting point

which future empirical research can build on to provide a more comprehensive and coherent picture of the determinants of psychological safety climate.

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Table 1. Empirical safety climate studies in the construction industry

References	Goals or causal models
Glendon and Litherland (2001)	1. Determination of safety climate factor structure; and 2. Investigation of the relationship between safety climate and safety performance.
Gillen et al. (2002)	1. Evaluation of injured workers' perceptions of workplace safety climate, psychological job demands, decision latitude, and coworker support; and
Pousette et al. (2008)	2. Investigation of the relationship of the above-mentioned variables to the injury severity. 1. Investigation of the dimensionality of safety climate; 2. Test of hypothesized sharedness among members of a social unit; and 3. Test of the predictive validity of safety climate with regard to safety behavior.
Lingard et al. (2010b)	1. Examination of two distinct properties of group safety climate, i.e. climate level and climate strength; and 2. Examination of the relationship between those two safety climate properties with injury frequency rate.
Siu et al. (2003)	Exploration of the relationship between age and safety performance, as well as safety attitudes.
Fung et al. (2005)	1. Investigation of the relationship between construction practitioners' behaviors and their attitudes and perceptions towards safety culture; and 2. Comparison of safety culture divergences among three levels of construction personnel, i.e. top management, supervisory staff and frontline worker.
Choudhry et al. (2009)	1. Determination of factor structure of safety climate; and 2. Exploration of the relationship between the factors determined and workers' perceived safety performance.
Molenaar et al. (2009)	1. Multi-attribute analysis of corporate safety culture embracing three aspects of people, process, and value to obtain its five characteristics, i.e. safety commitment, safety incentives, subcontractor involvement, safety accountability, and disincentives; and 2. Quantification of the relationships between corporate safety culture and safety performance.
Siu et al. (2004)	Examination of relations among safety climate, psychological strains, and safety performance.
Meliá et al. (2008)	1. Analysis of the safety climate from the perspectives of the agents (organization, supervisors, co-workers and workers), i.e. the relationship among the safety responses of those agents; and 2. Examination of the link between safety responses of those agents and the perceived risk.
Dingsdag et al. (2008)	1. Examination of construction workers' opinions, attitudes, and perceptions of skills, behaviors, and knowledge

	contributing to safety culture; and
Zhou et al. (2008)	2. Identification of safety critical positions from the perspective of construction workers.
Cigularov et al. (2010)	Identification of the abilities of safety climate and personal experience in predicting safety behaviors.
Kapp (2012)	Examination of multi-level effects of two important indicators of safety climate, i.e. contractor error management climate and worker safety communication, on safety behavior, injury, and pain among union construction workers.
Zhou et al. (2011)	Investigation of the moderating role of group safety climate on the leadership-safety compliance relationships.
	1. Examination of the consistency of safety climate factor structure over time; and
	2. Exploration of positive safety climate improvement stimulators.
Teo and Feng (2009)	Examination of the relationship between safety climate and safety culture on construction sites.
Lingard et al. (2012)	1. Measurement of multiple levels of safety climate in Australian construction workers;
	2. Exploration of the relationship between safety climate perceptions and injury frequency rates; and
	3. Examination of the mediating role of the group-level safety climate in the relationship between the organizational level safety climate and injury frequency rate.

Table 2. Contributors to a psychological safety climate in construction projects

Perspectives	Prospective contributors
Structural perspective	Safety-specific organizational structure (SOS) Client safety involvement (CSI)
Perceptual perspective	Project organizational climate (POC)
Interactive perspective	Safety-specific leader-member exchange (SLMX) Safety-specific team-member exchange (STMX) Transactional-transformational leadership (TL)
Cultural perspective	Individualism-collectivism (IND-COL)

Table 3. The client's role in promoting construction safety (Huang and Hinze, 2006; Lingard et al., 2009)

Routes	Description
(1) Contract management	A complete and feasible safety plan should be included in the tender documents. The contract should stipulate clearly that sufficient safety training is provided to personnel. The contract should set a realistic safety goal. The client should require an immediate accident report.
(2) Active participation	The client inspects the site on a regular or irregular basis. Safety should be the top priority on the client-contractor interface meetings.
(3) Contractor selection	Previous safety performance must be considered in selecting main contractor and subcontractors.
(4) Financial support	Safety reimbursement is expected to be made to main contractor in time, preferably to the subcontractor directly.

Table 4. Measures of the relevant constructs

Construct	Description	Source
Safety-specific centralization	Decision-making with regard to safety matters	(Dewar and Werbel, 1979)
Safety-specific formalization	There are safety rules and procedures to follow	(Dewar and Werbel, 1979)
Safety-specific standardization	Safety rules and procedures are clear and strictly followed	(Van de Ven and Ferry, 1980)
Client safety involvement	The roles of the client in managing safety	Exploratory literature review; discussion with practitioners
Project organizational climate	What it feels like working in the project	(Neal et al., 2000)
Transactional-transformational leadership	The leadership style of the immediate supervisors	(Avolio et al., 1999)
Safety-specific leader-member exchange	Communication about safety information between the respondent and his supervisor	(Hofmann et al., 2003)
Safety-specific team-member exchange	Communication about safety information between the respondent and his peers	(Tuuli, 2009)
Individualism-Collectivism	Whether the respondent has an individualistic or collectivistic attitude	(Oyserman et al., 2002)
Psychological safety climate	What the respondent feels about the safety measures in the project	(Choudhry et al., 2009)

Table 5. Inter-correlations between relevant constructs

	Cronbach's alpha	Mean	S.D.	SC	SF	SS	CSI	POC	TFL	CR	PL	SLMX	STMX	IND	PSC
SC	.797	2.99	1.279	<i>.66</i>											
SF	.767	4.14	1.171	.297**	<i>.65</i>										
SS	.837	4.30	.945	.079	.574**	<i>.63</i>									
CSI	.868	4.89	.978	-.004	.263**	.433**	<i>.61</i>								
POC	.833	4.52	.750	-.103	.194**	.401**	.274**	<i>.50</i>							
TFL	.807	4.39	.850	.114	.134*	.268**	.093	.281**	<i>.60</i>						
CR	.863	4.25	.996	-.117*	.040	.256**	.103	.463**	.494**	<i>.77</i>					
PL	.768	4.06	1.040	.076	.066	.120*	.089	.124*	.243**	.122*	<i>.65</i>				
SLMX	.810	4.66	.780	-.115*	.142*	.340**	.203**	.583**	.483**	.641**	.141*	<i>.59</i>			
STMX	.841	4.11	.813	.058	.168**	.353**	.297**	.485**	.304**	.428**	.157**	.426**	<i>.53</i>		
IND	.809	4.01	1.090	.177**	.060	.008	-.064	.122*	.098	.111	.057	.146*	.112	<i>.59</i>	
PSC	.791	5.47	1.013	-.074	.217**	.449**	.504**	.519**	.227**	.271**	.105	.428**	.358**	.081	<i>.50</i>

Note: 1) Abbreviation: SC = Safety-specific centralization; SF = Safety-specific formalization; SS = Safety-specific standardization; CSI = Client safety involvement; POC = Project organizational climate; TFL = Transformational leadership; CR = Contingent reward; PL = Passive-avoidant leadership; SLMX = Safety-specific leader-member exchange; STMX = Safety-specific team-member exchange; IND = Individualism; PSC = Psychological safety climate. Other constructs (e.g., collectivism, management-by-exception) are omitted, because of unsatisfactory construct validity or reliability.

2) Average variances extracted (AVEs) of the constructs are on the diagonal in italics, and correlations are below the diagonal.

3) Constructs but the psychological safety climate are measured on 6-point Likert scales, whereas the construct of psychological safety climate is measured on a 7-point Likert scale.

4) ** $p < .01$, * $p < .05$

