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An Empirical Investigation of Factors Contributing to the Psychological Safety Climate on Construction Sites

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Abstract

Employees' safety climate perceptions dictate their safety behavior, as individuals act based on their perceptions of reality. Extensive empirical research in applied psychology confirmed this relationship. However, rare efforts have been made to investigate the contributing factors to a favorable safety climate in the construction research. As an initial effort to address the knowledge gap, this paper examines contributing factors to psychological safety climate, an operationalization of safety climate at the individual level and hence the basic element of safety climate at higher levels. A multi-perspective framework of psychological safety climate contributors is estimated by the structural equation modeling technique using individual questionnaire responses from a random sample of construction project personnel. The results inform management of three routes to psychological safety climate: client's proactive involvement in safety management; a workforce-friendly workplace created by the project team; and transformational supervisors' communication about safety matters with the workforce. This paper contributes to the field of construction engineering and management by highlighting a

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broader contextual influence in a systematic formation of psychological safety climate perceptions.

Key words: Psychological safety climate; Construction project; Structural equation modeling; Random sample.

Introduction

Both structural and cultural characteristics of the industry pose numerous challenges to improving safety performance in construction projects (Lingard and Rowlinson, 2005). Individuals take actions based on their perceptions of reality (Robbins 2001). In a perceived pro-safety environment, therefore, the workforce would act in a safe manner. Safety climate-based interventions aim at creating and maintaining such a perceived pro-safety environment (Shen et al. 2015). These interventions are especially important for the ill-structured and dynamic construction process, where the workforce should be highly perceptive of safety stimuli around.

Kozlowski and Doherty (1989) trace the concept of climate to Lewin and colleagues' exploratory work. According to Lewin and colleagues, climate is "a characterization of salient environmental stimuli and an important determinant of motivation and behavior", and therefore, serves as "the key functional link between the person and the environment" (Kozlowski and Doherty 1989, p. 546). Hence, the climate determines an individual's behavior. Organizational climate emerges when the climate perception is shared by organizational members, and the shared climate perception determines the organization's behavior. In this sense, the concept of organizational climate has significant implications for an individual's behavior when it is operationalized at the individual level. When operationalized at the organizational level, the construct implicates an organization's behavior.

The organizational climate construct has more practical implications if it refers to a specific outcome (Schneider and Reichers 1983). When the outcome in question is safety, safety climate is derived. That is, safety climate is the organizational climate of safety. Like organizational climate, the concept of safety climate has significant implications for both the individual's and group's safety behavior. Specifically, Zohar (1980) considers safety climate as a frame of reference for employees to respond to safety infrastructure present in the workplace.

Given the conceptual and practical significance of safety climate in cultivating and maintaining safety behavior, a growing body of empirical research has been conducted in the applied psychology domain. In a recent meta-analysis of the safety literature, Christian et al. (2009) presented a comprehensive list of safety climate related studies. On the list there have been both concurrent (e.g., Probst 2004) and longitudinal (e.g., Neal and Griffin 2006) safety climate studies. To assess the predictive ability of safety climate, some studies (e.g., Hofmann and Stetzer 1998) have used subjective criteria like self-reported safety participation, whereas other studies (e.g., Fullarton and Stokes 2007) used such archival criteria as injuries. These studies cover a wide range of work settings, including steel mills (Brown et al. 2000), car manufacturing plants (Clarke 2006), retail stores (DeJoy et al. 2004), hospitals (Neal et al. 2000), and university laboratories (Wu et al. 2008). These studies have been carried out at the organization level (Zohar and Luria 2005), the group level (Zohar and Luria 2004), and the individual level (Seo et al. 2004). Indeed, among the four directions in the safety climate literature (Cooper and Phillips 2004), three concern the relationships between safety climate and related outcomes, with the remaining one dealing with the impact of organizational climate on safety climate. In the construction management domain, safety climate studies demonstrate two patterns (Shen et al. 2015). The first stream focuses on psychometric issues of safety climate scales (Griffin and Neal

2000, Morrow et al. 2010, Kuenzi and Schminke 2009), and the second concerns the causal relationship between safety climate and related outcomes (Zohar 2010). Despite a substantial body of safety climate related research in applied psychology, what is lacking is an empirical investigation into the formation of safety climate perceptions, i.e., contributing factors to safety climate (Guldenmund 2000; Barling et al. 2002; DeJoy et al. 2004; Lingard et al. 2010; Zohar 2010).

This knowledge gap remains to be addressed not only in applied psychology but also in construction. In the post-Robens era, the client and project managers have been jointly tasked with creating a pro-safety site. In bridging the knowledge gap, this paper attempts to inform the client and project managers of how to enhance and maintain construction project personnel's perceptions of safety stimuli on sites, so that they can make training and education provisions for construction project personnel before commencing the project.

From the technical perspective, it is reasonable to address the knowledge gap at the individual level. Like many others, there is considerable debate in conceptualizing and operationalizing the climate construct (Klein et al. 1994). The concept of safety climate is no exception. For example, Glendon (2008) reported that the safety climate construct can be conceived of as a psychological, a psychosocial, or a socio-cultural concept. Furthermore, he observed that the construct has been operationalized at the group and higher levels. The measurement of the construct at the individual level is relatively easy to do in a questionnaire survey, and therefore a majority of relevant empirical studies operationalize safety climate at the individual level (Shen 2013). Psychological safety climate is the operationalization of safety climate at the individual level, and an elementary component of safety climate at higher levels (James and James 1989). Regarding the climate construct relationships at the individual level are indicative of similar relationships at higher levels (Parker et al. 2003). In addition, scholars dealing with other topics in construction, cooperation (Phua and Rowlinson 2003) for instance, argued that the efforts of increasing cooperation should logically stem from the individual level to tackle poor performance in the industry. Therefore, it is at the individual level that this paper attempts to answer the questions of what factors and in what manners they contribute to project personnel's psychological safety climate perceptions.

The paper is structured as follows. First, it examines the formation of safety climate and proposes a conceptual framework embodying relevant hypotheses. Second, it describes the sample, survey instruments and data analysis methods. Third, the results are presented, with an emphasis on psychometric properties of relevant scales and hypothesis testing. Finally, both theoretical and practical implications of the findings are discussed, along with limitations and future research directions.

Conceptual Framework and Hypotheses

Formation of Safety Climate

A number of scholars (e.g., Schneider and Reichers 1983; Ashforth 1985; Moran and Volkwein 1992) have discussed the formation of organizational climate. Schneider and Reichers (1983) reviewed a structural approach and a selection-attraction-attrition (SAA) approach, and further developed an integrative symbolic interactionist perspective. Structuralists maintain that organizational structure (e.g., the centralization of decision making authority) influences employees' perceptions of organizational features, events and processes. The SAA approach attributes similar perceptions and understandings among organization members to their undergoing a similar combination of organizational processes (e.g. selection into the organization) and individual processes (e.g. attraction to and attrition from the organization). Symbolic interactionists contend that the meanings of things “arise and change out of interactions between people” (p. 32), and “the individual and the environment mutually determine each other” (p. 32). Ashforth (1985) extended the interactionist approach by considering the roles of workgroup, affect, corporate culture, symbolic management, and physical settings in forming climate perceptions. Based on the interactive approach, Moran and Volkwein (1992) developed a cultural approach, in recognition of the predominant influence of shared knowledge and meanings (in terms of organizational culture) on the interactions.

Using Moran and Volkwein’s (1992) categorization scheme, a list of contributing factors to psychological safety climate can be organized as shown in Table 1. Three points are worth mentioning. First, there are justifications as shown in the following sections for including these factors. For example, Neal et al. (2000) confirmed that an organizational climate engenders a favorable safety climate. Second, due to the likely confusion between organizational climate and organizational culture, the paper excludes cultural factors because it considers the organizational climate construct. Finally, although the list is organized in Moran and Volkwein’s (1992) categorization scheme, it does not mean that there are no other categorization schemes. For example, the factors can be classified into general and safety-specific factors (Shen et al. 2015). The next section elaborates on the justifications for these factors and their hypothesized relations with psychological safety climate.

Hypotheses and Model Development

Structural Perspective

The structural perspective views climate as "an objective manifestation of the organization's structure" (Moran and Volkwein 1992, p. 24–25). In construction, the client is the buyer and the ultimate risk-bearer of the project product, and hence has the authority to make decisions which the project team must follow (Walker 2007). Depending on how much authority the client delegates to the project manager, the extent of the client's involvement inevitably affects the power structure in the project team. Therefore, the paper categorizes the client's involvement in safety management into the structural perspective. The notion of client's safety involvement is intended to capture the client's roles in managing project safety performance.

The involvement of the client in managing a project benefits the project realization process (Walker 2007), and hence is a critical success factor (Voss 2012). Empirical evidence supports the client playing a proactive role in managing safety performance. For example, both the contractor's workforce and project team constantly maintain that the client is more influential on the contractor's safety culture than the contractor's top management (Yule and Mearns 2006). Without the client's insistence, construction projects' safety performance is always sacrificed for other objectives (Lingard and Rowlinson 2005). Based on previous works (e.g. Huang and Hinze 2006; Lingard 1995; Lingard et al. 2009), Shen et al. (2015) summarized four avenues (i.e., contract management, active participation, contractor selection, and financial support), through which the client exercises their potential in safety management. Hence, it can be hypothesized that

H1. Client's safety involvement is positively related to psychological safety climate.

Perceptual Perspective

The perceptual perspective depicts climate as “a perceptually-based, psychologically-processed description” (Moran and Volkwein 1992, p. 26) of the organizational situation. The factor of organizational climate is categorized into the perceptual perspective, because organizational climate, in and of itself, is a product of a perceptual process. The relationship between organizational climate and safety climate basically occurs in employees’ perceptual world.

The introduction of organizational climate into the area of occupational health and safety (OHS) is due to the finding that some dimensions of organizational climate (e.g. role stress, supportiveness, organizational goals) change individuals’ safety behaviors (Lingard and Rowlinson 2005). The consequent changed safety behaviors would serve as frame of reference, from which an individual infer his attitudes and perceptions about safety measures in the environment, especially when these attitudes and perceptions are unclear or weak. This is the central tenet of the self-perception theory. Therefore, changes in safety behaviors can yield changes in safety climate. In this sense, organizational climate has an impact on safety climate.

In addition to empirical evidence from other industrial sectors (e.g. Neal et al. 2000; DeJoy et al. 2004), the above notion has resonance in construction. As most projects are developed by a diverse group of independent contributors, the first priority for a project manager is to ensure that these contributors achieve consensus regarding the project objectives (Walker 2007). In a positive organizational climate created by the project manager implementing relevant initiatives (e.g. Baiden et al. 2006; Gray 2001), where the workforce perceives that the project management team ranks their well-being as a top priority, their psychological safety climate perceptions would be naturally higher. Therefore, the authors posit that

H2. Positive organizational climate is positively related to psychological safety climate.

Interactive Perspective

Essentially, leaders across hierarchical levels determine organizational climate (e.g. Andriessen 1978; Clark and Ward 2006; Hofmann and Morgeson 2004; Neal and Griffin 2004; Zohar and Tenne-Gazit 2008). This is because, leaders are an extremely important source of policies, procedures, practices and behaviors that obtain reward and support in work settings (Schneider et al. 2011), and consequently through leader–member exchange subordinates develop their climate perceptions based on the leaders' words and actions. However, this process does not necessarily produce a sound safety climate. For example, through interactions with management, the workforce strongly sense that management puts progress first under production pressure. In this case, a production climate, rather than a safety climate, results. Therefore, the authors specify the interaction as safety-specific leader–member exchange, and hope that a favorable safety climate would result through safety-specific interactions between leaders and subordinates. There are two leadership styles: transactional and transformational leadership (cf. Lowe et al. 1996). The former focuses on organizing tasks and leading subordinates to get the job done in a reliable and efficient way; the latter's focus is on committing subordinates to challenging objectives and developing their potentials (Zohar 2002). Transactional leaders develop relationships with subordinates based on mutually beneficial transactions, whereas transformational leadership influences subordinates to transcend self-interests for the collective good (Chemers 2000). Transformational leadership affects climate perceptions via leader–member exchange (Zohar and Tenne-Gazit 2008), and hence the authors take into consideration the construct of transformational leadership. The interactive perspective maintains that climate is engendered by "the interaction of individuals in responding to their situation" (Moran and Volkwein 1992, p.

29). Therefore, the paper puts both of the constructs (i.e., safety-specific leader–member exchange and transformational leadership) into the interactive perspective.

Both of the two constructs are relevant to construction projects. Transformational leaders are essential in construction (Walker 2011), where continual changes in the work settings entail transformational leadership styles (Chan and Chan 2005). Project activities are “achieved through the collective interactions of project participants and other interested stakeholders” (Sense and Fernando 2011, p. 505). Safety-specific leader–member exchange goes on with safety meetings as the primary forum for supervisors communicating safety matters with the workforce. The workforce is more likely to realize the importance of safety behaviors if their transformational supervisors raise the salience of safety goals over other competing demands in the interactions. Based on the discussion, it can be hypothesized that

H3. Safety-specific leader–member exchange mediates the relationship between transformational leadership and psychological safety climate.

Based on these hypotheses, a conceptual framework is established as shown in Fig. 1.

Method

Population and Sample

The target population was the construction site personnel grouped into eight sub-categories under three main categories. That is, the category of contractor covers main contractors and subcontractors/workers, the category of consultant includes engineers, architects, and quantity surveyors, and the category of client covers those clients from the public, private, and quasi-government sectors. The number of members in each category is unknowable, and it is impossible to study the whole population (Koh 2010). Therefore, a sampling frame was constructed by incorporating members with construction background from local trade associations, professional institutions, government agencies, and property developers. The researchers drew a random sample from the sampling frame and sent them hard-copy questionnaires for completion. Initially 2996 hard copy questionnaires were sent out, and five months later 292 valid responses secured. Mainly due to the inherently high mobility of local construction practitioners, 865 questionnaires were returned as non-deliverables. Considering the non-deliverables, the survey yielded a response rate of 13.7%. A time trend extrapolation test was conducted to check on non-response bias (Armstrong and Overton 1977). Specifically, the research team designated the valid responses received in the first month after the dispatch of the questionnaires as early responses, and the rest as late responses. Then the researchers carried out a series of chi-square tests to compare the early and late responses in terms of demographic information in two categories (i.e., project details and respondents' individual attributes). No significant differences are found between the two waves, as shown in Table 2. Hence, non-response bias is not an issue with the sample.

Among the respondents, 92% were male, 76% were over 40, and 87% had been in the industry for more than 10 years. The demographic information demonstrated that with adequate expertise and experience, the respondents were able to provide accurate information as to the phenomena described by the statements in the questionnaire. Amongst the referred projects, 43% were new buildings, 51% were new civil engineering projects, and the rest were fitting-out, demolition, repair, maintenance, alteration and addition, etc. Public, quasi-government, and private works accounted for 52%, 18%, and 30% respectively. In terms of Fung et al.'s (2005) role classification, top management, supervisory staff, and workers accounted for 55%, 39%, and 6% respectively. More than 60% of the respondents were from large firms hiring more than 99 employees, 23% from medium-sized companies with 21 to 99 employees, and the remaining from small firms with less than 21 employees. 41%, 31%, and 28% of the respondents were respectively from sub/contractors, clients, and consultants.

Survey Instrument

In carrying out a questionnaire survey, it is important to secure cooperation from potential respondents and to make questionnaires self-contained and self-sufficient (Ruane 2005). In order to achieve these goals, the research team undertook the following tasks when designing the questionnaire: a) using a straightforward rating format with regard to the degree of respondents' belief in the described phenomena, to enhance the instrument's reliability, validity and interpretability (Fowler 2009); b) adopting a scale-reordering method that places the items measuring psychological safety climate determinants before those measuring psychological safety climate, to address the issue of consistency motif (Aibinu et al. 2012); c) using different response scales (i.e., six-point Likert scales to measure psychological safety climate determinants and a seven-point Likert scale to measure psychological safety climate), to address common method variance often associated with self-report questionnaires (Rousseau et al. 2008; Podsakoff et al. 2003); d) assuring prospective respondents of their rights and confidentiality, to increase accuracy and completeness of the information provided; and e) eliciting advice from a group of researchers and practitioners regarding the relevance of measurement scales, and conducting a pilot study with 18 poorly educated construction workers, to maximize the content validity of the scales.

The following subsections present the measurement scales.

Client's Safety Involvement

The construct captured to what extent the client contributes to the project safety performance in his power. The research team conducted an exploratory literature review and obtained a list of items to reflect the construct. After that the researchers discussed the list with local experienced construction practitioners, and produced an eight-item scale for the construct. A sample item was "Client requires safety training of all project employees."

Positive Organizational Climate

The construct captured employees' positive and general feelings of working on the project. It was measured by an adapted 14-item version of Hart et al.'s (2000) School Organizational Health Questionnaire scale ($\alpha = .94$), which comprised two items each for the seven selected dimensions of a positive organizational climate (i.e., appraisal and recognition, goal congruence, reasonable work demands, participative decision-making, professional growth, professional interaction, and role clarity). Amongst others, these seven dimensions are common organizational behavior and human resource management issues in all organizations (Hart et al. 2000). The authors treated these dimensions as indicators of a higher order positive organizational climate factor. In other words, these 14 items as a whole was intended to measure the construct of positive organizational climate. This is because, a) Hart et al. (2000) reported a moderate to strong relationships between these dimensions in their study 1; and b) one of this paper's purposes was to examine the impact of construction project personnel's positive and general feelings of working on the site (i.e. positive organizational climate) on their individual perceptions of safety stimuli around (i.e. psychological safety climate). Sample items included "I am happy with the quality of feedback about my work performance" for the appraisal and recognition dimension and “There is agreement in the work philosophy of this project” for the goal congruence dimension.

Transformational Leadership

The construct referred to the behavioral style of a leader who inspires followers to go beyond their own self-interests for the collective good. It was measured by six adapted items, which were selected from the transformational leadership proportion of the Multifactor Leadership Questionnaire (MLQ, Form 5X). Using the MLQ (Form 1), Bass (1985) developed a six-factor model of transactional and transformational leadership. Based on a larger and more heterogeneous sample, Avolio et al. (1999) confirmed the six-factor model of leadership using an updated version of MLQ Form 5X. Hence, the researchers selected and adapted six items, which described the transformational behaviors of respondents’ immediate supervisors, to measure the construct of transformational leadership. A sample item read “My immediate supervisor has my respect.”

Safety-specific Leader–Member Exchange

The construct reflected the interactions between employees and their immediate supervisors on safety matters. It was measured by an adapted version of LMX-7, which has “the soundest psychometric properties of all instruments” (Gerstner and Day 1997, p. 827). A sample item was “I know how satisfied my immediate supervisor is with what I am doing.”

Psychological Safety Climate

The construct captured construction personnel’s individual perceptions of safety policies, procedures, and practices (Zohar 2003). It was measured by a 24-item scale refined by Fang and colleagues (Fang et al. 2006; Choudhry and Fang 2008; Choudhry et al. 2008; Choudhry et al. 2009; Zhou et al. 2008) in a large scale safety climate questionnaire survey with construction personnel of a leading Hong Kong-based contractor. Therefore, it was suitable for the Hong Kong construction practice (Shen 2013). It is premature to determine the factor structure of a higher order safety climate factor (Griffin and Neal 2000), and hence, this paper intended the 24 items together to measure the construct of psychological safety climate. A sample item read "Accidents and incidents which happen here are always reported."

Demographic Information

The survey collected two types of demographic information (i.e. respondents' individual attributes and project-specific details) for two reasons. First, the information is used to check on non-response bias, as shown in Table 2. Second, empirical evidence suggests that project personnel's individual attributes have implications for their own safety climate perceptions. For example, Fang et al. (2006) found that employees, who are older, married, supporting more family members, or non-drinkers, tend to have more positive safety climate perceptions. Individual attributes include gender, age, marital status, number of dependents, industrial experience, smoking habit, and drinking habit. Project-specific details cover the nature of project (building, civil engineering, etc.), nature of the client (public, private, and quasi-government), project contract sum (<= HK$ 99 million, HK$ 100–499 million, HK$ 500–999 million, and >= HK$ 1000 million), project stage (start-up, advanced, and near close-out), and project procurement strategy (traditional design-bid-build, management contracting, construction management, design & build, turnkey/package deal, etc.).

A complete questionnaire is available from the corresponding author on request.

Data Analysis

Using the data from a questionnaire survey of a random sample of Hong Kong-based construction project personnel, the authors tested the hypotheses with the structural equation modeling (SEM) technique for two reasons. First, the constructs involved were difficult to measure directly, but could be approximately measured by multiple indicators. In this regard, SEM can deal with poorly measured constructs (Molenaar et al. 2000). In this study, the authors intended the indicators to be reflecting and caused by the focal construct. For example, the item of "Client requires safety training of all project employees" is used to measure the construct of *client's safety involvement*. That is, the greater concern that the client shows for the project safety performance, the stricter would be his requirement that all project personnel receive safety training. Reflective indicators are supposed to be interchangeable, and any single indicator can be deleted without changing the focal construct (Hair et al. 2010). Second, compared to standard multiple regression techniques, SEM can provide more accurate and reliable estimates of the relationships between constructs by accounting for measurement errors. There are two types of constructs in an SEM model: exogenous and endogenous constructs. The former are determined by factors outside of the model, whereas the latter are dependent on the former.

Generally, the SEM method follows two steps. First, it measures the reliability and validity of a combined set of indicators in representing the intended construct (i.e., the measurement model assessment component of SEM). Reliability concerns the extent to which an indicator or set of indicators is consistent in measuring the intended construct, whereas validity refers to the extent to which an indicator or set of indicators is free from systematic errors in measuring the intended construct (Hair et al. 2010). Specification of a complete measurement model entails a) loading each item (i.e., reflective indicator) on the corresponding construct; b) correlating each pair of constructs; and c) specifying an error item for each item. Second, after obtaining reliable and valid measures of the constructs based on the measurement model assessment, the structural model estimates the relationships between constructs by assessing the significance of relationships between corresponding measures (i.e., the structural model assessment component of SEM). Converting a measurement model into a structural model involves specifying relationships from exogenous construct(s) to endogenous construct(s) based on the researcher's conceptual framework. Each hypothesis is embodied by a specified relationship. Hypotheses are supported under two conditions: a) the structural model secures acceptable fit; and b) path estimates—usually in terms of standardized path coefficients—related to the hypotheses are statistically significant and in the hypothesized direction (Hair et al. 2010).

In this study, AMOS-17 software package was used to carry out the SEM procedures. In a typical AMOS path diagram output, an ellipse represents an unobservable construct, whereas a rectangle indicates an observable indicator.

Results

Relationships between Respondents' Individual Attributes and Psychological Safety Climate

With the sample, Table 3 shows no statistically significant correlations between respondents' individual attributes and psychological safety climate. To discern the relationships, probably a larger and more heterogeneous sample is needed. For example, the sample size in Fang et al.'s (2006) work is as large as 4,127.

Construct Reliability and Validity

To measure overall goodness-of-fit for both the measurement and structural models, the authors used four indices—one incremental index (i.e., comparative fit index, CFI), one absolute index (i.e., root mean square error of approximation, RMSEA), the chi-square (χ^2) value and the associated degrees of freedom (*df*)—as recommended by Hair et al. (2010).

A number of statistic indicators are used to measure the reliability and validity of each construct. A commonly used construct reliability measure is Cronbach's alpha, with a threshold value of .70 often acknowledged. Two types of frequently reported construct validity are convergent and discriminant validity. Convergent validity concerns the extent to which indicators of a construct are highly correlated, whereas discriminant validity assesses the degree to which a construct is truly distinct from others. The average variance extracted (AVE), an indicator of convergent validity, is calculated as the mean variance extracted for the indicators of a construct. Usually a construct with the value of AVE no less than .50 is considered to possess convergent validity. Discriminant validity of two constructs is secured if both of their AVEs are larger than the squared correlation between them (Hair et al. 2010). Both convergent and discriminant validity can be tested in assessing the measurement model. After rounds of model modification based on model diagnostic indicators, the final measurement model with acceptable fit is shown in Figure 2. The means, standard deviations, Cronbach's alpha, correlations, and AVEs are shown in Table 4. None of the correlations exceeds 0.85, suggesting the absence of multi-collinearity. The Cronbach's alphas are all above 0.7, supporting construct reliability. AVE of each construct is no less than 0.5, supporting convergent validity. Discriminant validity of all constructs is achieved as the AVEs of any two constructs are larger than the squared correlation between them.

In addition, the factor loadings of indicators to their respective construct are statistically significant at .001 level, and all larger than an acceptable value of .60.

Structural Model and Hypothesis Testing

Figure 3 shows the final structural model with acceptable fit, along with indicators and their standardized factor loadings, standardized path coefficients, error terms for endogenous constructs, and correlations between exogenous constructs. It is reasonable to assume that exogenous constructs correlate, because they are determined by factors outside of the model.

However, with the final structural model the authors are interested in the standardized path coefficients which represent the hypotheses. A hypothesis is supported, if the related standardized path coefficient(s) is statistically significant and in the hypothesized direction. Overall, the three paths to psychological safety climate are statistically significant and in the hypothesized direction. Therefore, all the three hypotheses are supported. Specifically, a) client's safety involvement → psychological safety climate (standardized path coefficient = .44; $p < .01$); b) positive organizational climate → psychological safety climate (standardized path coefficient = .43; $p < .01$); and c) transformational leadership → safety-specific leader–member exchange (standardized path coefficient = .63; $p < .01$) → psychological safety climate (standardized path coefficient = .16; $p < .01$). Taken together, these three avenues explained 58% of the psychological safety climate variance.

Discussion and Conclusion

The client and project managers are responsible for creating a pro-safety workplace and achieving sustainable safety behaviors, under contemporary construction safety management regimes. In what ways management can fulfill such safety responsibilities is an issue that requires an urgent answer.

Individuals behave according to their perceptions of reality, rather than reality itself. Therefore, employees would act safely in a perceived pro-safety environment, which is labeled as a *safety climate*. Safety climate refers to employees' (shared) perceptions and appraisals of safety policies, procedures, and practices in the workplace. It serves as a mental schema for employees to interpret safety measures in the work settings, and also a frame of reference for them to adapt their behaviors (Shen et al. 2015). Hence, a strong safety climate induces and sustains employees' safety behaviors. In safety research, many empirical studies have been conducted to explore how safety climate influences employees' safety behavior across industrial sectors, including agriculture, nuclear power, and construction. Few efforts, however, have been made to explore the contributing factors to a positive safety climate. Safety climate can be operationalized at the individual and higher levels. Psychological safety climate, an operationalization of safety climate at the individual level, is the basic element of safety climate at higher levels. Therefore, as an initial effort to address the knowledge gap, this paper examined the contributors to psychological safety climate. Furthermore, the results were expected to inform management of avenues to a pro-safety environment before commencing the project.

The authors conducted a random questionnaire survey of construction project personnel based in Hong Kong, and analyzed the data with SEM procedures. The results reveal three avenues at three levels of a construction project organization to project personnel's individual safety climate perceptions. At the top level of client–contractor interface, the proactive involvement of the client in safety management is conducive to forming strong psychological safety climate. In this regard, measures at the client's disposal include raising the weighting of safety track record in selecting contractors, requiring a comprehensive and feasible safety plan in tendering, demanding sufficient safety trainings before entry into the site, setting motivational yet realistic safety goals, encouraging immediate accident reports, conducting regular and irregular safety inspections, prioritizing safety matters in meetings with project participants, and timely reimbursing contractors for safety provisions. Taking these measures in a consistent manner conveys to the sub/contractors and workers a message that the client is genuinely concerned about safety, and it is inadvisable to cut safety corners or take risks. For example, the client demonstrates his visibility through both regular and irregular safety inspections, reminding project personnel that safety takes priority over other competing objectives. With this visibility, project personnel's individual safety climate perceptions increase.

At the middle level where the project team is concerned, a positive organizational climate (characterized by prompt appraisal and recognition, participative decision-making, encouraging professional interaction and growth, goal congruence, role clarity, and reasonable work demands) plays a generative role in developing project personnel's individual safety climate perceptions. Suppose on a project, management encourages workers to report both minor and major injuries, out of their genuine care about workers' well-being (i.e., a positive organizational climate). Consistent enforcement of such a policy prompts workers' openly talking about mishaps, and consequently enhances their safety climate perceptions. Similar findings have been reported in nursing (Neal et al. 2000) and retailing (DeJoy et al. 2004). This paper found a similar generative role of the positive organizational climate in construction.

At the workgroup level, transformational supervisors who often communicate about safety matters with subordinates help enhance subordinates' individual safety climate perceptions. A transformational supervisor is a model, mentor and considerate friend to subordinates.

Subordinates are likely to recognize the importance of safety practices, if transformational supervisors are concerned about safety matters in their daily interactions.

The findings, however, should be read in light of limitations of this study. One of main limitations is the use of a cross-sectional design. Therefore, causal inferences could not be drawn from the findings. Though the contributing factors can help enhance psychological safety climate, they do not necessarily cause psychological safety climate. Another limitation is that, the study was conducted in Hong Kong, and hence whether the findings can be generalized entails replicating the study in other cultural settings.

Limitations notwithstanding, this paper makes both theoretical and practical contributions. The theoretical contribution is that, it has delineated a systematic formation of psychological safety climate perceptions by highlighting the saliency of interactions among multi-level contributors. This line of conception highlights a broader contextual influence in the formation of psychological safety climate. This paper includes an inter-organizational level contributor (i.e., client's safety involvement), an organizational level phenomenon (i.e., positive organizational climate), and the dyadic level interaction among the leader and subordinates (through leader–member exchange) into a unified framework. Therefore, it provides practitioners a lens to engage in a more organizational diagnosis of forming psychological climate perceptions. In this respect, this paper informs management of three avenues to enhancing construction project personnel's individual safety climate perceptions: a) increasing the client's proactive involvement in safety management; b) creating a workforce-friendly site under the leadership of the project manager who is in charge of the site; and c) cultivating supervisors' transformational leadership skills and encouraging their communication about safety matters with subordinates. In future research, a longitudinal multi-level study could be conducted to obtain a more comprehensive and coherent picture of the antecedents of safety climate.

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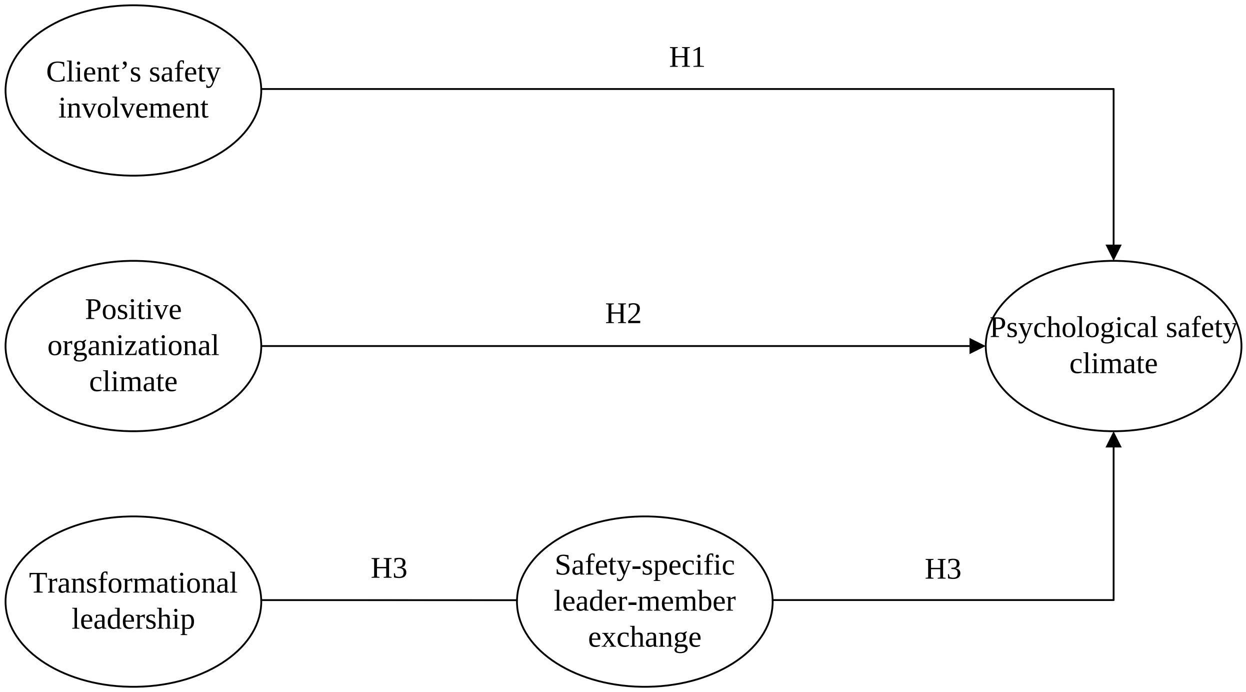
Figure Captions List

Fig. 1. The hypothesized structural model

Fig. 2. The final measurement model (chi-square = 244.70; *df* = 142; CFI = .958; RMSEA = .050)

Fig. 3. The final structural model (chi-square = 320.29; *df* = 144; CFI = .929; RMSEA = .065; **p < .01; * p < .05)



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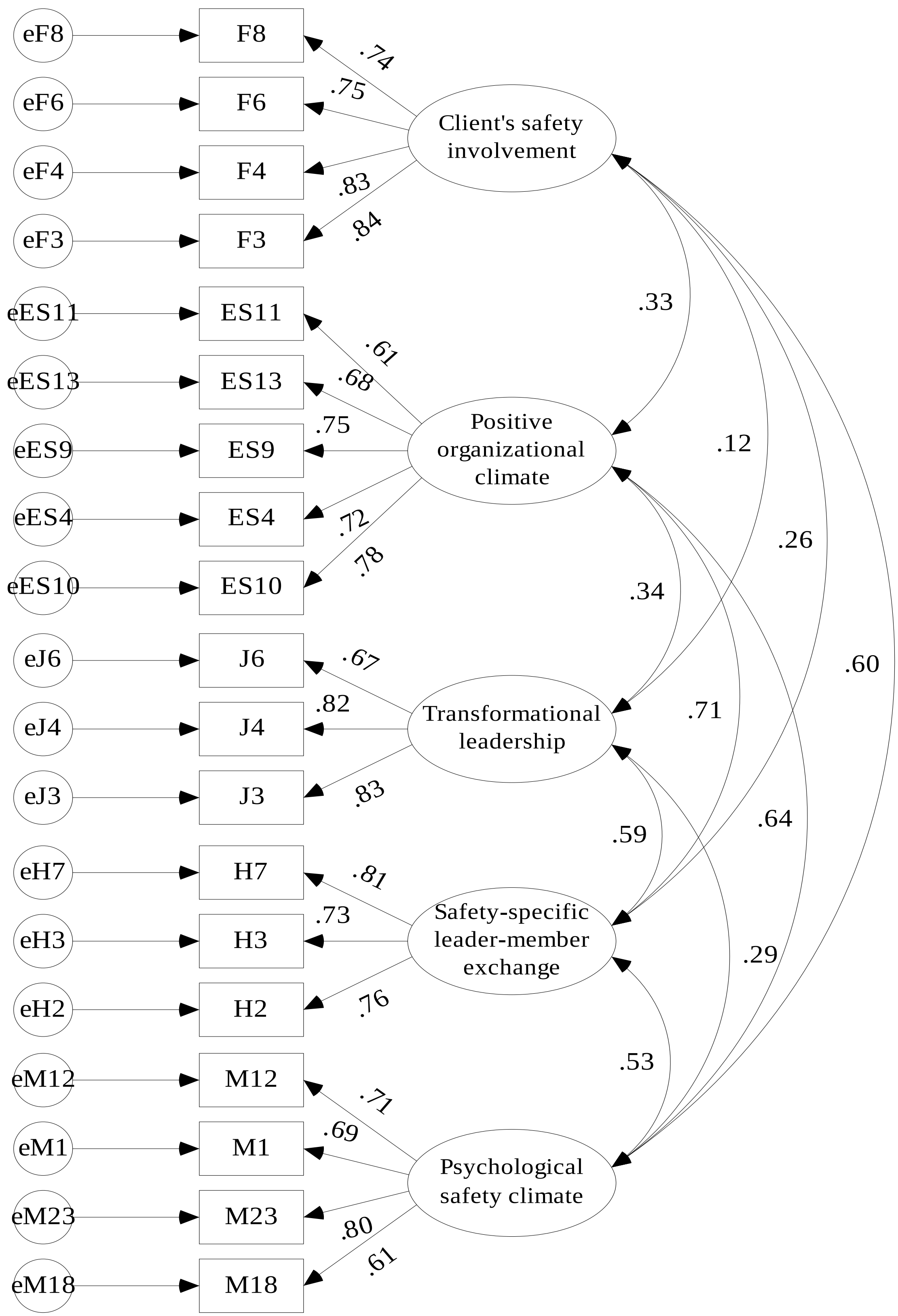

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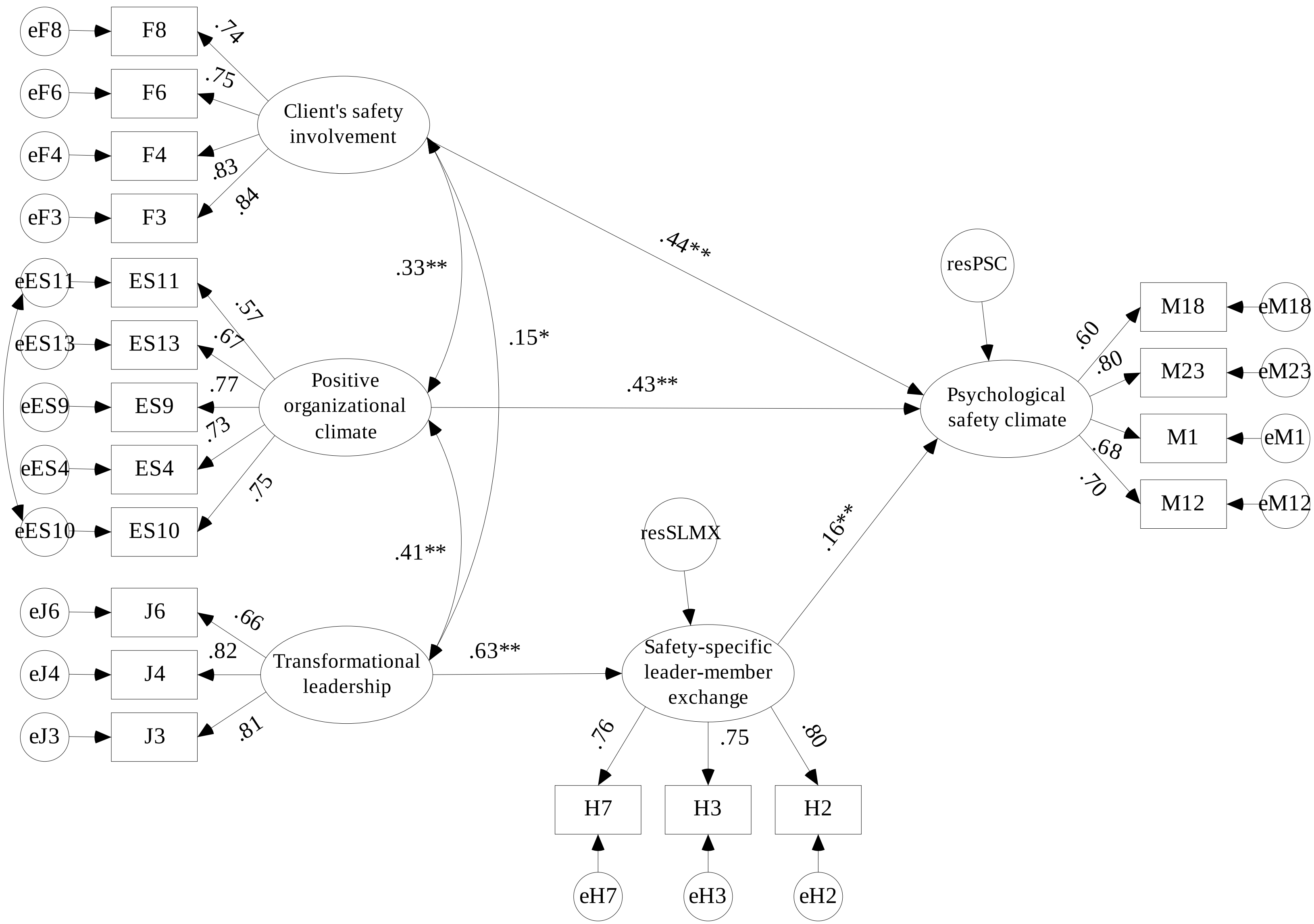

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Table 1. Contributing factors to psychological safety climate on construction sites

Perspectives	Prospective contributing factors
Structural perspective	Client's safety involvement (CSI)
Perceptual perspective	Positive organizational climate (POC)
Interactive perspective	Safety-specific leader-member exchange (SLMX)
	Transformational leadership (TFL)

Table 2. Chi-square tests to check on non-response bias

Demographic variable	χ^2 value	Degree of freedom (*df*)	Sig. (2-tailed)
Nature of project	3.829	2	.147
Nature of the client	1.921	2	.383
Project contract sum	.679	3	.878
Project stage	2.592	2	.274
Project procurement strategy	3.716	2	.156
Gender	.264	1	.607
Age	2.471	3	.481
Marital status	.251	1	.616
Number of dependents	2.434	4	.657
Industrial experience	5.691	4	.223
Smoking habit	.081	2	.960
Drinking habit	.763	1	.382

Table 3. Intercorrelations between respondents' individual attributes and their psychological safety climate

Variable	**Variable** 1	2	3	4	5	6	7	8
1. Gender	–							
2. Age	.210**	–						
3. Marital status	.047	.382**	–					
4. No. of dependents	–.052	.127*	.277**	–				
5. Industrial experience	.325*	.757**	.361*	.059	–			
6. Smoking habit	–.006	–.136*	.098	.055	–.100	–		
7. Drinking habit	.113	.100	–.003	–.055	.140*	.199*	–	
8. Psychological safety climate	.044	.100	.062	.049	.079	.005	.062	–

Note: 1) Codes: 1 = Gender; 2 = Age; 3 = Marital status; 4 = No. of dependents; 5 = Industrial experience; 6 = Smoking habit; 7 = Drinking habit; 8 = Psychological safety climate.

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

Table 4. Means, standard deviations, Cronbach's alphas, average variances extracted, and correlation matrix

Variable	**Cronbach's alpha**	**Mean**	**S.D.**	**Variable** CSI	POC	TFL	SLMX	PSC
CSI	.868	4.89	.978	*.63*				
POC	.833	4.52	.750	.328**	*.50*			
TFL	.807	4.39	.850	.121	.342**	*.60*		
SLMX	.810	4.66	.780	.255**	.706**	.592**	*.59*	
PSC	.791	5.47	1.013	.604**	.642**	.286**	.530**	*.50*

Note: 1) Abbreviations: CSI = Client's safety involvement; POC = Positive organizational climate; TFL = Transformational leadership; SLMX = Safety-specific leader-member exchange; PSC = Psychological safety climate.

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

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