Exploring the Relationship between Safety Climate and Worker Safety Behavior on Building Construction Sites in Taiwan

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Abstract: Construction occupational accidents are often attributed to workers’ having an insufficient perception of how their actions influence safety in the construction site. This research explores the relationship between safety climate (SC) and personnel safety behavior (SB) of construction workers operating on building construction sites in Taiwan. The study discovered a significant positive relationship between SC and SB of Taiwan’s building construction sites, and in turn SC level had a positive impact on SB participation and overall safety perceptions. The higher the SC cognition of Taiwan’s building construction workers, the better the performance of SB was found to be. The dimension of “safety commitment and safety training” had the greatest relationship with SB. Safety training also had a deep impact on the cognition of SB. Therefore, the organizational culture and attitudes to safety coupled with the successful implementation of safety education and training can effectively enhance SC and worker SB on building construction sites in Taiwan, thereby potentially reducing the impacts of the underlying organizational factors behind safety related incidents.

Keywords: building construction; construction occupational accidents; safety climate; safety behavior

1. Introduction

With frequent incidents resulting in serious injury, fatalities the construction industry is one of the most dangerous industries in the world [1]. Internationally construction workers account for 7% of the total labor force, but account 30–40% of all workplace fatalities [2]. Furthermore, with the trend towards larger and more complex construction projects safety management has greater ramifications for project delivery [3]. The economic losses attributed to construction worker fatalities is estimated at more than 1.2 trillion US dollars annually [4].

Unsafe worker behavior is recognized as a major contributing factor in work site accidents [5]. As much as 98% of all accidents are in some aspect related to unsafe behaviors [6]. In the case of Hong Kong, most construction site fatalities are due to one following causes; falls from heights, being struck by moving objects, or collisions with moving plant [7,8].

A growing awareness of the role that organizational factors have in construction safety management has led to an increased focus on safety climate (SC) to better understand influences on construction site safety. The term SC is used to explain organizational factors which influence safety practices and behaviors of worker [9,10]. According to Mosly [11], SC must be a top priority to have a construction site equipped with a high level of safety performance. The value of SC is as a leading indicator of unsafe behaviors and worker
related accidents (Zohar, 2010) [12]. The effects of SC on worker occupational safety behavior (SB) has been a long-standing focus of research [11,13–15]. While there is no consensus on the exact nature of the relationship between SC and SB, some research found a close relationship between SC and SB measures [16,17], while other research suggests no direct link between SC and SB. In some studies, there is evidence to suggest that this relationship is mediated by other variables such as safety training, transformational leadership, work context, communication practices, and production pressures [18–24]. Cooper et al. [25] explored the connection between SC and safety performance, but they failed to identify any relationship between the SC and selected behavioral observation measures of safety performance. The perception of SC and SB by field staff is an important leading factor for the association between SC and SB. Construction site SBs relate to the perceptions and beliefs held by the workers [14]. Zohar [26] suggested that perceptions of SB held by workers provides another dimension for understanding perceptions of organizational climate using measures of trust, cohesion, pressure, innovation, and equality between both workers and organization.

2. Literature Review
2.1. Safety Climate
2.1.1. Concept of SC

The concept of SC has been well established in the construction industry and has become a unique area of research. Zohar [26] first proposed the concept of safety climate defined as “a unified set of cognitions regarding the safety aspects of the organization”. Since then, many authors have endeavored to refine and enhance the definition of SC [19,27,28]. Although there is no consensus on the definition of SC, there are several similarities being: “(a) a psychological phenomenon typically well-defined perceptions of the status of site safety at a given point of time; (b) SC is attentively concerned with elusive issues such as conditional and environmental factors; and (c) SC represents, a “snapshot” of safety culture, as such by its nature is somewhat unstable and subject to change” [29].

The term SC is often applied interchangeability with safety culture (SU), which reflects the values of individuals and groups within an organization including, attitudes, perceptions, abilities, behavior patterns, and organizational safety management styles. Culture refers to the more established and enduring characteristics of the organization and is associated with dimensions. Essentially SU reflects underlying values, customs, assumptions, and expectations, which in many ways, relate to those of societal culture” [30]. Whereas climate, represents the visible manifestation of culture. For this study SC considered is a “snapshot” of SU in the organization consistent with O’Connor et al. [31].

2.1.2. Dimensions of SC

SC is a latent variable measured based on selected dimensions shown to measure selected attributes. As shown in Table 1 the dimensions used to represent SC, ranges from 2 dimensions [32] up to 28 dimensions [33]. This disparity in the number and type of SC dimensions is a source of uncertainty among construction researchers and practitioners [34]. However, creating a unified set of SC dimensions has limitations as due to the influences of factors of different countries [35,36]. However, several similarities exist between the findings of many SC studies [37]. Wu et al. [34] identified four frequently used dimensions the core structure of SC.
Table 1. Table of research of dimensions of safety climate (SC) in the Construction Field.

| Research                      | Qty. | Major Dimensions Identified                                                                 |
|-------------------------------|------|---------------------------------------------------------------------------------------------|
| Dedobbeleer and Beland [32]   | 2    | (1) management commitment to safety (2) workers involvement in safety                        |
| Flin et al. [38]              | 5    | (1) management/supervision (2) safety system (3) risk (4) work pressure (5) competence       |
| Griffin and Neal [39]         | 6    | (1) management values (2) safety communication (4) safety practices (5) safety training (6) safety equipment |
| Glendon and Litherland [18]   | 6    | (1) communication and support (2) adequacy of procedures (3) work pressure (4) personal protective equipment (5) relationships (6) safety rules |
| Mohamed [14]                  | 10   | (1) safety attitudes and management commitment (2) safety consultation and safety training (3) supervisor role and workmates role (4) risk taking behavior (5) safety resources (6) appraisal of safety procedure and work risk (7) improper safety procedure (8) worker involvement (9) workmate influence (10) competence |
| Fang et al. [35]              | 10   | (1) safety attitude and management commitment (2) safety consultation and safety training (3) supervisor’s role and workmate’s role (4) risk taking behavior (5) safety resources (6) appraisal of safety procedure and work risk (7) improper safety procedure (8) worker’s involvement (9) workmate’s influence (10) competence |
| Zhou et al. [15]              | 5    | (1) safety management systems and procedures (2) management commitments (3) safety attitudes (4) workmate influences (5) employee involvement |
| Poussette et al. [40]         | 4    | (1) management safety priority (2) safety management (3) safety communication (4) workgroup safety involvement |
| Choudhry et al. [41]          | 2    | (1) management commitment and employee involvement (2) inappropriate safety procedures and work practices |
| Bhasi and Vinodkumar [42]     | 6    | (1) management commitment (2) safety training (3) workers involvement in safety (4) safety communication and feedback (5) safety rules and procedures (6) safety promotion policies |
| Jiang et al. [43]             | 3    | (1) safety training (2) management commitment and communication for safety (3) safety equipment and maintenance |
| Kines et al. [44]             | 7    | (1) management safety priority, commitment and competence (2) management safety empowerment (3) management safety justice (4) workers safety commitment (5) workers safety priority and risk non-acceptance (6) safety communication, learning, and trust in coworkers safety competence (7) workers trust in the efficacy of safety systems |
| Cigularov et al. [45]         | 4    | (1) management commitment to safety (2) supervisor support for safety (3) safety practices (4) work pressure |
| Lingard et al. [46]           | 4    | (1) perceptions of the extent to which safety is prioritized over other objectives (2) perceptions of managers commitment to safety (at both client and contractor levels) (3) perceptions of first level supervisors safety behaviour (4) perceptions of the quality of safety communication within construction projects |
| Tholén et al. [47]            | 4    | (1) management safety priority (2) management safety commitment (3) safety communication (4) workgroup safety involvement |
| Hon et al. [16]               | 3    | (1) management commitment (2) safety rules (3) safety responsibility |
| Wu et al [34]                 | 4    | (1) safety priority (2) safety supervision, training and communication (3) safety rules and procedures (4) safety involvement |
| Research          | Qty. | Major Dimensions Identified                                      |
|-------------------|------|------------------------------------------------------------------|
| Shin et al. [48]  | 5    | (1) management values (2) immediate supervisor (3) communication (4) training (5) safety system |
| Seo et al. [17]   | 5    | (1) managerial priority (2) safety communication (3) safety regulation (4) safety education (5) supervisor |
| Guo et al. [49]   | 3    | (1) management safety commitment (2) social support (3) production pressure |
| Mosly             | 2    | (1) management-related safety climate factors (2) workers-related safety climate factors |
| Chen et al. [50]  | 5    | (1) safety attitude (2) safety training and policies (3) risk decision-making (4) safety commitment and communication (5) workmate mutual care |
| Makki and Mosly [36] | 3 | (1) safety commitment (2) safety interaction (3) safety support |
| Cheung and Zhang [51] | 2 | (1) group-level safety climate (2) organization-level safety climate |

The list of SC related literature provided in Table 1, was systematically screened to identify essential SC dimensions. The approach to categorization of SC dimensions varies across different industries. The research found that these studies regarding SC constructs mostly focus on the safety training provided by managers’ safety commitment, personnel’s safety attitude regarding communication in organization and between colleagues, and personnel’s awareness of operation risks. There are also personnel’s awareness of operational risks and attitudes when responding to risks. These items were used as the basis of this study for dimension categorization. Of the studies reviewed to the most frequently used dimensions include safety attitudes and communication, management commitment, safety training, and risk decision making. This paper synthesized SC dimensions into four main sub-dimensions namely safety commitment, risk decision making, safety attitudes and communication, and safety training.

### 2.2. Safety Behaviour

The term SB refers to the actions of individuals executed for self-protection, such as adhering to safety regulations to avoid harm [13,17]. Griffin and Neal [39] divided SB into the dimensions of safety compliance and safety participation. Safety Compliance reflects compulsory actions completed by individuals to safeguard worksite safety through adhering to specified safety procedures. Whereas the “Safety Participation” dimension refers to worker driven behaviors such as actively engaging in safety meetings and initiatives or participating in voluntary safety activities. While these behaviors may not directly impact overall worksite safety, they do assist to ensure an environment that fosters personal accountability for safety [39]. Table 2 provides a summary of the literature reviewed on SB dimensions for the construction industry.
### Table 2. Safety behavior (SB) Dimensions used in the construction field.

| Researcher                          | Research Dimension | Safety Participation | Safety Compliance | Others              |
|-------------------------------------|--------------------|----------------------|-------------------|---------------------|
| Griffin and Neal (2000) [39]        |                    | √                    |                   |                     |
| Neal et al. (2000) [13]             |                    | √                    |                   |                     |
| Zhou et al. [15] (2008)             |                    | √                    |                   |                     |
| Bhasi and Vinodkumar [42] (2010)    |                    | √                    |                   |                     |
| Jiang et al. [43] (2010)            |                    | √                    |                   |                     |
| Kapp [52] (2012)                    |                    | √                    |                   |                     |
| Fugas et al. [53] (2012)            |                    | √                    |                   | Proactive Safety    |
| Griffin and Hu [54] (2013)          |                    | √                    |                   | Behaviors           |
| Al-Haadir et al. [37] (2013)        |                    | √                    |                   |                     |
| Hon et al. [16] (2014)              |                    | √                    |                   |                     |
| Shin et al. [48] (2015)             |                    | √                    |                   |                     |
| Seo et al. [17] (2015)              |                    | √                    |                   |                     |
| Guo et al. [49] (2016)              |                    | √                    |                   |                     |

In addition to research focused on SB itself, further research has examined the relationship between SB and other related factors. Choudhry and Fang [55] found that the factors of: a lack of safety awareness, culture of being “tough guys”, work pressure, co-worker attitudes; and other organizational, economic, and psychological factors contributed unsafe behavior. Bhasi and Vinodkumar [42] examined safety management practices and their influence on SB, results showed safety training is a key predictor of safety motivation, safety knowledge, safety participation, and safety compliance. The practice of transferring safety knowledge is of particular interest as it shown to deliver favorable SB outcomes [56]. Site interaction between laborers and supervisory staff all also plays an important role where effective communication has a significant influence on safety [23]. Focusing more on human factors. Chi et al. [57] explored the associations among human-behavior-related and working-condition-related risk factors, including identifying significant behaviors and condition factors and their influence on accident types. Zin and Ismail [58] focused on employer behavior related factors to influence employee behavior towards compliance with safety and occupational initiatives in the construction. The contributing factors identified, correlated with the SC dimensions of safety commitment, safety attitude and communication, safety training within this study.

#### 2.3. The Relationship between SC and SB

The relationship between organizational factors and SB was postulated by Zohar [26] which found that SC increases the effectiveness of safety improvement programs and decreases accident rates [17]. Several empirical studies have established the relationship between SC and SB in the construction industry. Neal et al. [13] studied the impact of organizational climate and SC on individual SB, the result supports SC as a predictor of safety performance. Mohamed [14] indicated a positive association between the SC and SB. Zhou et al. [15] discovered that SB was more sensitive to the SC factors of management commitments and workmates influences, however, personal experience factors such as education experience and work experience were less sensitive. The multi-level influence was considered important as much of existing literature has limited exploration of the relationships between SC, safety awareness, and SB the interaction between different levels [22]. The role of organizational support and how it cascades down to cultivate a positive group-level SC is important in guiding targeted improvements [51].
The review of existing studies into the relationship of SC and SB on building construction sites reveals the following findings:

1. The relationship between SC and SB has been examined in many industrial fields, but the conclusions of the relationship between SC and SB differ depending on the field. Some studies suggest that no significant relationship existed between SC and SB in manufacturing industry [25], while most studies [13–15,22,26] in the construction sector showed that there is a correlation between SC and SB.

2. Both SC and SB can be divided into multiple dimensions however, each individual dimension of SC has its own relationship with SB.

3. SC is related to self-reported SB [13,40]. Nevertheless, few studies have established a predictive relationship between SC and SB, and nor considered the predictive ability of SC for SB. Thus, the study of predicting SB by SC deserves attention and warrants further exploration.

Based on research gaps identified, the objective of this research is to investigate the relationship between SC and SB in Taiwan construction industry based on selected workers’ characteristics. While the actions of the management team have been shown to greatest influence on SC [11], the study further differences based on roles to give a multi-level perspective. In doing so, provide a predictive model suitable to build on the current construction safety knowledge.

3. Research Methods

3.1. Questionnaire Design

The data for the study was obtained using a questionnaire of construction workers based on their perceptions of personal and site safety practices and behaviors. The first part of the two-part questionnaire aims to capture the background personal characteristics of respondents. The second part investigates the respondent’s perceptions of items related to the selected SB and SC dimensions as follows:

1. Safety commitment: Worker safety is regarded as the core value of the organization’s culture and has robust safety management systems and provides sufficient safety related resources and equipment. The organization is concerned about the staff’s physical and mental conditions and safety on the worksite and educates the employees on work site dangers and empowers them to act when needed. The supervisor is engaged in daily activities and provides hazard information and supports precautionary measures.

2. Risk decision making: Based on standard operating procedures, the risk decision making processes provide adequate measures for identifying and controlling potential hazards. There is also support for staff’s ownership of safety in the working environment, and the risk conditions faced by them on the worksite.

3. Safety attitude and communication: all personnel are aware of safety related expectations. Workers understand that worksite safety takes priority over competing interests such as the drive for productivity. During the completion of the construction project, there is constant two-way safety communication between workers and supervisors.

4. Safety training: The organization provides ongoing safety-related training courses. Regular evaluation of the effectiveness of safety training is conducted to ensure training meets the continuously changing nature of the construction industry.

5. Safety participation: Personnel take the initiative to identify safety issues in the working environment and communicate to their superiors. Further, workers participate in the safety-related activities, and provide feedback. Participation is to not only done with the intent to proactively share safety knowledge or information with colleagues but also to assist each other in complying with safety procedures to ensure work safety is paramount.

6. Safety operation: All personnel should work in compliance with site safety requirements and expectations. All personnel should take appropriate protective measures
before the commencement of operations and are supported to comply with risk-based safety controls throughout operations.

To capture the different element of each dimension a total of 45 questions were included in the initial questionnaire. Respondents were asked to rate each question by a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The study did no employ a pilot survey, instead, a pretest was undertaken. This pretest involved six senior experienced construction safety practice experts with construction safety management professional licenses issued by the Taiwan’s Occupational Safety and Health authority to ensure adequacy of the questionnaire. The intent of the pretest was conducted to ensure the questionnaire fully reflects the awareness of SC and SB of construction site workers, and ensure that terminology and writing of the questions can be accurately understood by the targeted respondents. The individual questions in the questionnaire were scored on a five-point Likert type scale. A higher score for a question indicates that the experts consider the question appropriate and reflective of the perception of a SC and SB, and vice versa for lower scores.

Following the review three questions were modified to improve clarity and a further seven questions were deleted. The final questionnaire comprised of 38 items was considered suitable for distribution. The questionnaire was distributed to construction site personnel, and management positions (site director, safety personnel, work supervisor, and site operation supervisor) and laborer positions (rod buster, formwork worker, concrete worker, and cement worker). Companies included were civil engineering contractors and general construction business (GCB) categorized into three grades of A, B, and C. Civil engineering contractors are licensed to do small-scale renovation and construction jobs. General construction businesses are larger than CECs and have greater expertise and experience in various faces of construction. A total of 485 copies of the questionnaires were distributed with a total of 336 copies returned, representing a return rate of 69.3%. Out of these 336 questionnaires, 302 were valid giving an effective return rate of 62.3%. Table 3 summarizes the questionnaire respondents’ personal information.

3.2. Data Analysis Methodology

The first step was to investigate the results using descriptive statistics of the responses received. Further analysis involved using Pearson correlation coefficient to explore the relationships between safety commitment, risk decision making, safety attitude and communication, safety training, safety participation, and SB dimensions. One-way analysis of variance (one-way ANOVA) was used to explore differences in the mean responses based on the background of respondents. For significant differences in the means further post hoc comparisons were performed to understand the factors which influence perceptions of SB and SC. Further multiple regression analysis aims to explore the relationship between several predictive variables and a criterion variable using Stepwise Regression Analysis (SRA) to test whether each SC dimensions can effectively predict SB dimension. All statistical analysis was completed using the SPSS software package.
Table 3. Background attributes of questionnaire respondents.

| Attribute                | Classification | No. | Attribute          | Classification | No. |
|--------------------------|----------------|-----|--------------------|----------------|-----|
| Gender                   | Male           | 277 | Management Roles   | Site Director  | 32  |
|                          | Female         | 25  |                    | Safety Personnel| 28  |
|                          |                |     |                    | Work Supervisor | 32  |
| Age Group                |                |     | Position Level     | Site Operation Supervisor | 26  |
|                          | <24            | 9   |                    | Rod Buster      | 52  |
|                          | 25–31          | 36  |                    | Formwork Worker | 62  |
|                          | 32–38          | 88  |                    | Concrete Worker | 41  |
|                          | 39–45          | 96  |                    | Cement Worker   | 29  |
|                          | 46–54          | 68  |                    |                |     |
|                          | >55            | 5   | Laborer Roles      |                |     |
| Highest Education Level  | Junior High or Below | 54  |                    |                |     |
| Level Obtained           | Senior High    | 149 |                    |                |     |
|                          | Junior College | 66  |                    |                |     |
|                          | College        | 31  |                    |                |     |
|                          | Graduate Institute | 2   |                    |                |     |
| Marital Status           | Married        | 228 | Job Tenure (yrs.)  |                |     |
|                          | Unmarried      | 67  | <2 Years           |                |     |
|                          | Others         | 7   | 2–3                |                |     |
|                          |                |     | 4–7                |                |     |
| Company Category *       | Grade A Construction | 55  | No. of incidents   |                |     |
|                          | Grade B Construction | 41  | encountered over   |                |     |
|                          | Grade C Construction | 34  | the past year      |                |     |
|                          | Civil Engineering Construction | 172 |                |                |     |
| Engineering Attribute    | Public Construction | 112 | No. of education   |                |     |
|                          | Civil Construction | 190 | and training events|                |     |
|                          |                |     | attended over the  |                |     |
|                          |                |     | past year          |                |     |

* Category based on the Taiwanese classification of construction companies.

4. Results and Discussion

The SC component in the questionnaire comprised of the dimensions such as safety commitment, risk decision making, safety attitude and communication, safety training, safety participation, and safety operation. All the questionnaire results fell within the “credible–very credible” range, showing that the dimensions of SB and SC on this questionnaire were supported by the respondents. As shown in Table 4, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy values for the responses were all greater than 0.7, indicating that the question items are suitable for factor analysis [59].

Table 4. Results of Kaiser-Meyer-Olkin (KMO) and Bartlett Test for Safety Climate and Safety Behavior Dimensions.

| Dimension                                | Safety Climate | Safety Behavior |
|------------------------------------------|----------------|----------------|
| Kaiser–Meyer–Olkin (measure of sampling adequacy) | 0.718          | 0.795          |
| Bartlett’s Sphericity Test               |                |                |
|Chi-squared Distribution Approximation    | 3307.844       | 1195.764       |
|Degree of Freedom                        | 300            | 78             |
|Significance                              | $p = 0.000$    | $p = 0.000$    |
The typical reliability test for the Likert type responses is “Cronbach α” where a reliability coefficient above 0.9, indicates very good consistency [60]. The minimum acceptable is 0.7 [61,62]. Levels or constructs with Cronbach’s α below 0.5 (indicating low credibility) should be rejected [50]. As shown in Table 5 all Cronbach α values were above a value to be considered to have reliable internal consistency and support suitability for further analysis.

Table 5. Reliability Analysis Results of SC and SB Dimensions.

| Dimension                                      | Management Group | Labour Group | All Groups |
|------------------------------------------------|------------------|--------------|------------|
| SC                                             |                  |              |            |
| Safety Commitment                              | 0.687            | 0.711        | 0.714      |
| Risk Decision Making                           | 0.705            | 0.716        | 0.737      |
| Safety Attitudes and Communication             | 0.702            | 0.733        | 0.740      |
| Safety Training                                | 0.703            | 0.755        | 0.750      |
| All SC dimensions combined                     | 0.817            | 0.792        | 0.829      |
| SB                                             |                  |              |            |
| Safety Participation                           | 0.701            | 0.778        | 0.770      |
| Safety Operation                               | 0.727            | 0.797        | 0.783      |
| All SB dimensions combined                     | 0.765            | 0.760        | 0.785      |

4.1. Descriptive Statistical Analysis

The mean value of the Likert type scales is used to represent the collective perception and cognition of the respondents. For the positive design items, the higher the average score the higher the recognition of the item’s importance of the respondents. The score calculation of the reverse design is the higher the average score of the items represents the less agreement on importance by the respondents for the items. Table 6 shows the descriptive statistical results of the SC and SB items, the results show that the respondents felt the safety advice and the employees’ awareness of it was a weak area requiring improvement.

The three items with the highest scores of SB dimensions respectively was “32.” (average score 3.71); “27.” (average score 3.70); “35.” (average score 3.58); While the three items with the lowest scores respectively was “38. “ (average score 2.88); “28. “ (average score 2.87); “36.” (average score 2.82). These results indicate that for performance of the construction site personnel in relation to the persuasion of colleagues, their participation in the safety-related activities and completing work in accordance with standard procedures of further improvement required.

Analysis of Dimension Assessment

The construction site personnel are divided into two groups namely management role and the laborer role, in order to explore whether these different roles demonstrate similar level of cognition for each dimension. Table 7 shows that for most dimensions the average value of respondents in management roles is greater for each dimension of SC and SB compared to the average values of respondents in laborer roles. From these results it can be inferred that people in management roles have higher cognition of SC and SB than the labor roles.
### Table 6. Mean Scores of the SC and SB Questionnaire Items.

| Dimension                        | Items                                                                 | Average Score | Average Score Ranking | S.D.  |
|----------------------------------|-----------------------------------------------------------------------|---------------|-----------------------|-------|
| **Safety Commitment**            | 1. Your company values and cares about the safety of its employees   | 3.73          | 1                     | 0.874 |
|                                  | 2. Your company respects and evaluates the safety opinions proposed by others and make improvements | 2.75          | 22                    | 1.071 |
|                                  | 3. Your site does not have adequate and appropriate safety equipment * | 3.67          | 2                     | 0.857 |
|                                  | 4. Your company attaches great importance to the safety training of its employees | 3.60          | 5                     | 0.844 |
|                                  | 5. When your supervisor conducts safety inspection or supervision, encounters a violation of work safety regulations that will immediately prevent | 3.63          | 4                     | 0.825 |
|                                  | 6. Your company does implement safety code of practice                | 3.12          | 14                    | 0.868 |
| **Risk Decision Making**         | 7. You are sometimes confused about how to work safely *              | 2.83          | 21                    | 1.072 |
|                                  | 8. Some colleagues are simply not aware of what kind of harm may cause at work * | 2.85          | 19                    | 1.082 |
|                                  | 9. Sometimes you have to carry on the work at a risk of unwilling hazard in order to complete the job done * | 2.92          | 16                    | 0.909 |
|                                  | 10. Aspects of safety related procedures or regulations are impractical to comply with * | 2.93          | 15                    | 1.006 |
|                                  | 11. The actual situation of some construction sites will cause unable to perform the work safely * | 3.59          | 6                     | 0.876 |
|                                  | 12. There are some safety procedures or regulations that cannot be practical applied at work * | 2.87          | 17                    | 0.933 |
|                                  | 13. Some jobs do not have the means to be work completely safely *    | 2.83          | 21                    | 1.020 |
| **Safety Attitude and Communication** | 14. You are willing to accept personal work safety advice from others | 3.65          | 3                     | 0.860 |
|                                  | 15. Do you think “duration” is more important than “work safety” *    | 3.45          | 12                    | 0.841 |
|                                  | 16. The accurate implementation of work safety processes or regulations will prevent accidental occurrence | 3.46          | 11                    | 0.895 |
|                                  | 17. You are aware of your job responsibilities and fully understand the safety procedures or regulations | 2.84          | 20                    | 0.918 |
|                                  | 18. Sometimes you will omit the work steps for the momentary convenience * | 3.59          | 6                     | 0.838 |
|                                  | 19. In addition to paying attention to your own safety at work, you will also be aware to colleagues who possible in affected area | 3.50          | 9                     | 0.896 |
|                                  | 20. When you have safety related issue at work, you will discuss it with your colleague and request for assistance | 3.18          | 13                    | 0.863 |
| Dimension          | Items                                                                 | Average Score | Average Score Ranking | S.D. |
|-------------------|----------------------------------------------------------------------|---------------|-----------------------|------|
| Safety Training   | 21. Your supervisor will conduct safety announcements and provide information notices about related safety | 3.55          | 7                     | 0.812|
|                   | 22. Safety training is of practical help for your work                | 3.53          | 8                     | 0.935|
|                   | 23. Your company will familiarize workers with safe work procedures   | 3.55          | 7                     | 0.902|
|                   | 24. Your company will carry out the necessary safety training for new employees | 3.48          | 10                    | 0.877|
|                   | 25. Your company has a perfunctory attitude towards safety training * | 2.86          | 18                    | 0.917|
| Safety Participation| 26. You encounter any safety problems at work will take the initiative to reflect to the supervisor | 3.12          | 10                    | 0.836|
|                   | 27. You will assist your work partner to ensure safety at work        | 3.70          | 2                     | 0.874|
|                   | 28. You will take the initiative to participate in safety-related activities and meetings | 2.87          | 12                    | 1.045|
|                   | 29. You will take the initiative to improve the safety of the working environment | 3.57          | 4                     | 0.811|
|                   | 30. You will share safety knowledge or information with the supervisor or colleague mutually | 3.54          | 5                     | 0.864|
|                   | 31. When your colleague has unsafe behavior, will take the initiative to remind them | 3.19          | 9                     | 0.858|
| Safety Operation  | 32. You will use personal protective equipment correctly               | 3.71          | 1                     | 0.849|
|                   | 33. Even if the management is not there, you will still comply with safety regulations | 3.53          | 6                     | 0.826|
|                   | 34. You will omit the use of protective tool (equipment) because of convenience * | 3.52          | 7                     | 0.956|
|                   | 35. You will follow the instruction of management to guide the safe behavior | 3.58          | 3                     | 0.881|
|                   | 36. You will usually work according to the standard procedure         | 2.82          | 13                    | 0.903|
|                   | 37. You will actively cooperate with the safety requirements of the site | 3.50          | 8                     | 0.892|
|                   | 38. When colleague reminded the safety precautions, will actually follow their persuasion | 2.88          | 11                    | 0.951|

Note: * Reverse Factor; SD: Standard Deviation.
Table 7. Analysis of Average Score for Each Dimension.

| Dimension                      | Management Roles (N = 118) | Laborer Roles (N = 184) | Overall (N = 302) |
|--------------------------------|-----------------------------|-------------------------|-------------------|
|                                | Mean  | S.D.    | Mean  | S.D.    | Mean  | S.D.    |
| Safety Climate                 |       |         |       |         |       |         |
| Safety Commitment             | 3.58  | 0.551   | 3.31  | 0.562   | 3.41  | 0.573   |
| Risk Decision Making          | 3.22  | 0.569   | 2.82  | 0.594   | 2.97  | 0.615   |
| Safety Attitude and Communication | 3.56  | 0.497   | 3.27  | 0.547   | 3.38  | 0.546   |
| Safety Training               | 3.57  | 0.577   | 3.28  | 0.637   | 3.39  | 0.629   |
| Overall Safety Climate        | 3.47  | 0.379   | 3.15  | 0.373   | 3.28  | 0.405   |
| Safe Behavior                 |       |         |       |         |       |         |
| Safety Participation          | 3.55  | 0.536   | 3.19  | 0.603   | 3.33  | 0.604   |
| Safety Operation              | 3.51  | 0.530   | 3.27  | 0.607   | 3.36  | 0.590   |
| Overall Safety Behavior       | 3.53  | 0.437   | 3.23  | 0.455   | 3.35  | 0.470   |

4.2. Correlation Analysis between SC and SB

The Pearson correlation results in Table 8 show that the SC and SB dimensions of are all significantly positive correlated with each other with varying strength of relationship. The correlation between “safety commitment” and “safety participation” ($r = 0.859$, $p < 0.01$) showed the strongest relationship. Other strong relationships were found between “safety attitude and communication” and “safety training” ($r = 0.678$, $p < 0.01$), and “safety operation” ($r = 0.717$, $p < 0.01$). This result shows that safety attitude of personnel affects their recognition and effectiveness in safety education and training. Moreover, the organisational culture and the rapport held between colleagues not only promotes a safe working climate which may reduce the occurrence of worksite accidents. The items of safety training and safety operation were also highly correlated ($r = 0.831$, $p < 0.01$), confirms the importance of safety training for enabling personnel to perform their operations in a safe manner.

Table 8. Results of Pearson Correlation Analysis.

|                   | Safety Commitment | Risk Decision Making | Safety Attitude and Communication | Safety Training | Safety Participation | Safety Operation |
|-------------------|-------------------|----------------------|-----------------------------------|----------------|----------------------|------------------|
| Safety Commitment | 1                 |                      |                                   |                |                      |                  |
| Risk Decision     | 0.354 **          | 1                    |                                   |                |                      |                  |
| Making            |                   |                      |                                   |                |                      |                  |
| Safety Attitude   | 0.258 **          | 0.222 **             | 1                                 |                |                      |                  |
| and Communication|                   |                      |                                   |                |                      |                  |
| Safety Training   | 0.141 *           | 0.143 *              | 0.678 **                          | 1              |                      |                  |
| Safety Participation (SB) | 0.859 ** | 0.361 **       | 0.312 **                         | 0.185 **       | 1                    |                  |
| Safety Operation (SB) | 0.181 ** | 0.243 **       | 0.717 **                         | 0.831 **       | 0.243 **             | 1                |

* Significant at $p < 0.05$, ** significant at $p < 0.01$.

In general, the Pearson correlation results, highlight the related nature of the SC an SB dimensions. Construction operations will inevitably encounter unpredictable problems, and each construction site has its own characteristics, as such each construction enterprise needs to consider the role of SC and SB before commencement of operations. This enables workers to understand the operating environment of the site and engage in safety discussions, which will, in turn, prepare personnel to resolve safety problems they would face.
4.3. Analysis the Differences of Personal Variables between SC and SB

Table 9 shows the results from the further examination of the mean value of items in SC and SB, using one-way ANOVA based on the respondent’s background characteristics. Comparing the results of safety attitude and communication based on gender reported in SC dimension there is a significant difference, however, no significant differences were found in the SB dimensions. Respondents’ age did not seem to appear significant differences in both the SC and SB items. Based on educational level significant differences were observed for safety participation and the overall SC of SB dimension. The significance differences related to education observed were further investigated using the Scheffe post hoc comparisons yielding the results given as follows:

Significant differences were found for overall SC (F = 5.586, p < 0.05) and the SC related dimensions’ significations differences were found with safety commitment (F = 5.683, p < 0.05), risk decision making (F = 8.114, p < 0.05). The post hoc comparisons showed that for these SC dimensions that for education, the higher the level obtained the greater the level of SC cognition. For overall SB significant differences in perceptions were also found based on reported educational level (F = 5.925, p < 0.05) with further differences found for the SB dimension of safety participation (F = 7.946, p < 0.05). As with SC dimensions, the SB post hoc analysis also found that respondents with “university” level qualifications showed higher cognition than those reporting either “junior high” and “senior high” qualifications.

Participant’s responses showed statistically significant differences based on the company category for the items in both the SC and SB dimensions. Company category reported showed significant influence overall SC (F = 30.055, p < 0.05). For the individual SC dimensions, statistically significant differences were observed in the dimension of risk decision-making (F = 21.096, p < 0.05), safety attitude and communication (F = 10.521, p < 0.05), safety training (F = 8.021, p < 0.05). The post hoc analysis results of the differences in perceptions had a common theme that when it comes to company category “Class-A construction” had better cognition than those respondents with “Class-C construction” and “civil engineering construction”. Respondents with “Class-B construction” had better cognition than those respondents with “civil engineering construction”. Respondents with Class-C construction had better cognition than those respondents with civil engineering construction.

For SC dimensions statistically significant differences in the dimension of risk decision-making (F = 21.096, p < 0.05), indicating that the company category would affect the perception of respondents to the risk decision-making. Further post hoc analysis found that respondents with Class-A construction had better cognition than those respondents with civil engineering construction. Respondents with Class-B construction had better cognition than those respondents with Class-C construction and civil engineering construction. In general, the larger the company the greater the safety cognition of staff.

Significant differences were found in the responses for of overall SB (F = 20.333, p < 0.05) and in both the individual dimensions of safety participation (F = 17.973, p < 0.05) and safety operation (F = 7.902, p < 0.05). As with SC when it comes to SB the post hoc analysis shows a similar pattern where respondents in Class-A construction displays better cognition than those respondents with civil engineering construction. Respondents with Class-B construction displayed better cognition than those respondents with civil engineering construction.
Table 9. Analysis of the Difference for Individual Variable between SC and SB.

| Safety Climate | Safety Behavior |
|----------------|-----------------|
|                | Safety Commitment | Risk Decision Making | Safety Attitude and Communication | Safety Training | Overall SC | Safety Participation | Safety Operation | Overall SB | F Value | p Value | F Value | p Value | F Value | p Value | F Value | p Value | F Value | p Value | F Value | p Value |
| Gender         | 0.351 0.554     | 0.051 0.821 | 4.351 * 0.038 | 2.193 0.140 | 1.274 0.260 | 0.600 0.439 | 1.530 0.217 | 0.146 0.703 |
| Age            | 2.196 0.056     | 1.673 0.141 | 0.263 0.933 | 0.983 0.428 | 1.036 0.397 | 1.536 0.178 | 0.538 0.748 | 0.460 0.806 |
| Education Level| 5.683 * 0.003   | 8.114 * 0.000 | 2.259 0.063 | 2.015 0.092 | 8.566 * 0.000 | 7.946 * 0.000 | 1.789 0.131 | 5.925 * 0.000 |
| Marital Status | 1.579 0.208     | 2.457 0.087 | 0.052 0.950 | 0.069 0.934 | 0.944 0.390 | 3.282 * 0.039 | 0.148 0.862 | 1.693 0.186 |
| Company Category| 14.554 * 0.000 | 21.096 * 0.000 | 10.521 * 0.000 | 8.021 * 0.000 | 30.055 * 0.000 | 17.973 * 0.000 | 7.902 * 0.000 | 20.332 * 0.000 |
| Engineering Attribute | 21.569 * 0.000 | 77.629 * 0.000 | 0.270 0.604 | 0.803 0.371 | 24.758 * 0.000 | 20.880 * 0.000 | 0.070 0.791 | 8.077 * 0.005 |
| Position Level | 7.119 * 0.000   | 8.963 * 0.000 | 3.474 * 0.001 | 3.242 * 0.002 | 11.685 * 0.000 | 8.577 * 0.000 | 2.403 * 0.021 | 7.785 * 0.000 |
| Job Tenure     | 2.389 0.051     | 0.741 0.565 | 1.211 0.306 | 1.945 0.103 | 2.349 0.054 | 3.513 * 0.008 | 1.067 0.373 | 2.230 0.066 |
| Project Site   | 1.378 0.254     | 3.676 * 0.026 | 1.163 0.314 | 3.266 * 0.040 | 2.103 0.124 | 0.783 0.458 | 1.727 0.189 | 1.815 0.165 |
| Unit Cost      | 2.816 * 0.039   | 0.324 0.808 | 3.091 * 0.027 | 2.584 0.053 | 2.666 0.048 | 1.687 0.170 | 1.813 0.145 | 2.053 0.107 |
| No. of Occupational Disasters | 1.527 0.219 | 1.608 0.202 | 5.401 * 0.005 | 3.798 * 0.024 | 3.788 * 0.024 | 1.061 0.347 | 2.122 0.122 | 1.349 0.261 |
| No. of Participation in Education and Training | 2.411 * 0.049 | 1.740 0.141 | 1.204 0.309 | 1.409 0.231 | 1.950 0.102 | 1.680 0.154 | 1.144 0.336 | 1.360 0.248 |

* Significant at $p < 0.05$, ** significant at $p < 0.01$. 
The respondents reported position level has a significant influence on the responses for both SC and SB dimension. Significant differences were found for overall SC (F = 11.685, p < 0.05), and for the SC dimensions safety commitment (F = 7.119, p < 0.05), risk decision making (F = 8.963, p < 0.05), safety attitude and communication (F = 3.474, p < 0.05). The post hoc analysis found that in general that respondents in the position of “site supervisor” had better SC cognition than those in positions of “rod busters”, “formwork workers”, and “concrete workers”. Those respondents in position of “safety personnel” had better cognition than those “rod busters”, “formwork workers”, and “concrete workers”. Those respondents in the position of “work supervisors” had better cognition than those “rod busters” and “concrete workers”.

Significant differences were found for overall SB dimension F = 2.403, p < 0.05) and in the individual dimensions of safety participation (F = 8.577, p < 0.05) and safety operation (F = 2.403, p < 0.05). The post hoc analysis of the differences Post analysis found that respondents of site supervisor had better SB related cognition than those rod busters and concrete workers. It seems the worker position influences both SC and SB related dimensions equally.

When it came to influence of work experience significant difference was found in the SB dimension of safety participation (F = 3.513, p < 0.05). Post analysis found that respondents with “6–12 years” working experience had better cognition than those respondents with “2–6 years” working experience highlighting the benefits of experience.

The number of occupational incidents encountered by a respondent over the past year showed no significant influence on the perceptions related to SB dimensions. Conversely for the SC dimensions there were significant differences for the safety attitude and communication (F = 5.401, p < 0.05), the safety training F = 3.788, p < 0.05), and the overall perception of SC (F = 3.788, p < 0.05). Using the Scheffe post comparisons, the significant differences of the dimensions were investigated. The analysis found that respondents had experienced safety incidents “2–3 times” in the past 12 months demonstrated better cognition than those respondents had experienced safety incidents “1 (inclusive) or less times”.

There was no statistically significant difference for dimensions of risk decision making, safety attitude and communication, safety training as well as the overall SC. There was no statistically significant difference for the various SB dimensions. The number of education and training events participated in over the past year was statistically significant difference for the safety commitment of the SC dimension. There exists statistically significant difference in the dimension of safety commitment (F = 2.411, p < 0.05), indicating that education and training participated in the previous year would affect how the respondents perceived the safety commitment.

4.4. Estimating SB Based on SC

The relationship between SB and SC was further explored using stepwise regression analysis (SRA) was used to explore the predictive power of SC dimensions (safety commitment, risk decision making, safety attitude and communication, safety training) against the SB dimensions namely safety participation, and safety operation. The four dimensions of SC served as predictor variables with safety participation and safety operation as the dependent variables.

The results for safety participation are shown in Table 10, the predictor variables included safety commitment, and safety attitude and communication. The coefficient of determination for the model was 0.746. For safety participation, the total variation explained by the two variables was 74.6%. Table 11 shows the predictive importance of safety participation in relation to safety commitment (β = 0.834), safety attitude and communication (β = 0.097). All β values were significant (p < 0.05) and had a positive relationship with safety participation. The intensity of individual influence in sequence was safety commitment, safety attitude and communication, that is the higher the measurement score, the higher the measurement value of safety participation on the SC of a construction.
site. Non-standardized regression equation (Equation (1)) and standardized regression equation (Equation (2)) are shown below:

\[
\text{safety participation} = -0.028 + 0.878 \text{ (safety commitment)} + 0.107 \text{ (safety attitude and communication)} \\
\text{safety participation} = 0.834 \text{ (safety commitment)} + 0.097 \text{ (safety attitude and communication)}
\]

(1)

(2)

Table 10. Summary of Stepwise Regression Analysis (SRA) for Predict Safety Participation.

| Model | \( R \) | \( R^2 \) | Adjusted \( R^2 \) | Change Statistics |
|-------|--------|--------|-----------------|------------------|
|       |        |        | \( R^2 \) Change | \( F \) Change |
|       |        |        | \( \text{Numerator Degree of Freedom} \) | \( \text{Denominator Degree of Freedom} \) | \( \text{Significant F Change} \) |
| 1     | 0.859 \(^a\) | 0.737  | 0.736 | 0.737 | 840.830 | 1 | 300 | 0.000 |
| 2     | 0.864 \(^b\) | 0.746  | 0.744 | 0.009 | 10.253 | 1 | 299 | 0.002 |

\(^a\): predictive variables: (constant), safety commitment; \(^b\): predictive variables: (constant), safety commitment, safety attitude and communication.

Table 11. Coefficient of SRA for Predict Safety Participation.

| Model | Non-Standardized Coefficient | Standardized Coefficient | \( t \) | \( p \) Value | VIF |
|-------|------------------------------|--------------------------|-------|------------|-----|
|       | Estimated Value of B | Standard Error | Beta Distribution |       |     |     |
| 1     | (Constant) | 0.244 | 0.108 | 2.256 | 0.025 | 1.000 |
|       | Safety Commitment | 0.904 | 0.031 | 0.859 | 28.997 | 0.000 |
| 2     | (Constant) | -0.028 | 0.136 | -0.205 | 0.837 |       |
|       | Safety Commitment | 0.878 | 0.032 | 0.834 | 27.614 | 0.000 |
|       | Safety Attitude and Communication | 0.107 | 0.033 | 0.097 | 3.202 | 0.002 |

As shown in Table 12, three models were selected by SRA, of which the predictor variables selected included safety training, safety attitude and communication, as well as risk decision making, the coefficient of determination was 0.742. For safety operation, the total variation explained by the two variables was 74.2%. Table 13 shows the results for importance of safety operation in the sequence as safety training (\( \beta = 0.639 \)), safety attitude and communication (\( \beta = 0.263 \)), and risk decision making (\( \beta = 0.093 \)). All \( \beta \) values were significant (\( p < 0.05 \)) and had a positive relationship with safety operation. The sequence of individual influence was safety training, safety attitude and communication, risk decision making, which is the higher the value, the greater the measurement value of safety operation on SC dimensions. Non-standardized regression equation (Equation (3)) and standardized regression equation (Equation (4)) are shown below:

\[
\text{safety participation} = 0.102 + 0.599 \text{ (safety training)} + 0.284 \text{ (safety attitude and communication)} + 0.089 \text{ (risk decision making)}
\]

(3)

\[
\text{safety participation} = 0.639 \text{ safety training} + 0.263 \text{ safety attitude and communication} + 0.093 \text{ risk decision making}
\]

(4)
Table 12. Summary of SRA for Predict Safety Operation.

| Model | R    | R Squared | Adjusted R² | Change Statistics | R² Change | F Change | Numerator Degree of Freedom | Denominator Degree of Freedom | Significant F Change |
|-------|------|-----------|-------------|-------------------|-----------|----------|-----------------------------|-------------------------------|---------------------|
| 1     | 0.831 a | 0.690     | 0.689       |                   | 0.690     | 667.847  | 1                           | 300                          | 0.000               |
| 2     | 0.857 b | 0.734     | 0.732       |                   | 0.044     | 49.075   | 1                           | 299                          | 0.000               |
| 3     | 0.861 c | 0.742     | 0.739       |                   | 0.008     | 9.440    | 1                           | 298                          | 0.002               |

a: predictive variables: (constant), safety commitment; b: predictive variables: (constant), safety commitment, safety attitude and communication; c: predictive variables: (constant), safety commitment, safety attitude and communication, risk decision making.

Table 13. Coefficient of SRA for Predict Safety Operation.

| Model | Non Standardised Coefficient | Standardised Coefficient | t | p Value | VIF |
|-------|------------------------------|--------------------------|---|---------|-----|
|       | Estimated Value of B | Standard Error | Beta Distribution |       |       |
| 1     | (Constant) | 0.718 | 0.104 | 689.8 | 0.000 | 1.000 |
|       | Safety Training | 0.779 | 0.030 | 0.831 | 25.843 | 0.000 |
| 2     | (Constant) | 0.293 | 0.114 | 2.565 | 0.011 |       |
|       | Safety Training | 0.598 | 0.038 | 0.638 | 15.711 | 0.000 |
|       | Safety Attitude and Communication | 0.307 | 0.044 | 0.284 | 7.005 | 0.000 |
| 3     | (Constant) | 0.102 | 0.128 | 0.797 | 0.426 |       |
|       | Safety Training | 0.599 | 0.038 | 0.639 | 15.959 | 0.000 |
|       | Safety Attitude and Communication | 0.284 | 0.044 | 0.263 | 6.474 | 0.000 |
|       | Risk Decision Making | 0.089 | 0.029 | 0.093 | 3.072 | 0.002 |

5. Conclusions

Improving safety outcomes in the Taiwanese construction industry has been a longstanding challenge. To better design targeted strategies for improving construction site safety outcomes can be enhanced through understanding influencing factors for safety cognition of organizational personnel. This study explored the relationship between SC and SB on Taiwanese construction sites with three core objectives: (1) to find out the SC correlation factors affecting the SB; (2) to develop the questionnaire and to test the predictive effect of SC and SB; and (3) to explore the site personnel performance of SC and SB.

When it comes to perception and performance of various dimensions of the SC and SB, the management level of perception was found to be typically higher than that of the laborer roles. However, for the executive director level was found to be slightly inferior to other management levels, perhaps because most people at director level have limited operational level business scope and responsibilities. At the director level being overly focused on project progress without due regard to safety has the potential for workers on site, to priorities the rapid completion of the work over compliance with the safety procedures and expectations. As such there is potential that as time passes, the degree of safety attention of laborer will gradually decline. In such a situation person in management roles need to employ their cognition of SC and SB to maintain effective safety management programs and support executives to understand site SC.

In this study, the stronger the knowledge of SC, the stronger the cognition and safety performance of SB. Enhancing SC is an essential requirement for both the organization
and the site management. For Taiwan such an approach requires providing safety-related guidelines, engaging with site staff and understanding their needs can help to build safety-related culture of an organization, and thus site-based workers are more willing to cooperate with relevant measures and stay focused on their own and coworkers’ safety.

The analysis of individual safety variables showed that most of the dimensions had significant differences based on the class of works being undertaken. Respondents who undertook public works were equipped with better perception and performance than those who undertook private works. This might have been the fact that public works were under the supervision of people. Organizations and workers involving public works would pay more attention to on-site risk and staff situation, in order to avoid accidents and the loss due to duration delay in this regard.

Education level also strongly influences safety commitment, risk decision making, and safety participation. The respondents with higher levels of education showed better levels perception and performance. This observation might have been the fact that most staff in management roles were equipped with higher levels of education as based on the positions held significant differences were also found in SC and SB. This further supports that safety performance management needs to be led by the management positions with a view towards building safety cognition of staff in laborer roles.

For number of safety incidents experienced over the past year, significant differences were only found in the dimension’s safety attitude and safety training, while no significant difference was found in SC or SB related to the number of safety training events over the past year. This result shows the personal experience and training of workers is not as influential on safety cognition on Taiwanese construction sites as expected, rather it is the organizational factors and position held which hold the greatest influence over safety cognition.

The regression analysis of the relationship between SB and SC displays the critical role of training and communication in influence positive outcomes for SB. Often this element of interaction on safety matters is not well establish on construction sites. Furthermore, the SC dimensions of safety participation and safety operation influence the positive impact of safety commitment, safety attitude and communication on the over SB safety participation showing that the higher the cognition of safety commitment, safety attitude and communication of construction site personnel was, the better their safety participation performance would be. Such outcomes demonstrate Taiwanese construction organizations need more appropriate structures in place that ensure employees are confident that adequate support from management for improving safety is available. Further support is required to maintain safety training and communications given the largely transient nature of the construction workforce in Taiwan.

Furthermore, the results showed a positive impact of safety training, safety attitude and communication, risk decision making on safe operation. The higher the cognition surrounding safety training, safety attitude and communication, risk decision making of construction site personnel was, the better their performance of safety operation would be. It is therefore clear that safety training for construction workers engaged in high-risk operations is indispensable. Top management continues to have a tremendous influence on the operation of the safety program. Taiwanese construction organizations need to develop a culture which supports employee participation in safety-related learning and development activities. Furthermore, good relationships and communication channels among members of the organization are required to support safety initiatives with special attention on the welfare of employees. Meanwhile, it is also vital to encourage good performance of the staff and provide them with timely assistance. On-site management should not only focus on site inspections as a compliance function but also consider measures of SB displayed by on-site personnel. Furthermore, the action of supervisors to support safety is conducive to the promotion of SB among site personnel. As such good SC mainly originates from good work attitudes and habits of laborer level workers therefore...
importance needs to be place on making sure all personnel on the site aware of their own behaviors in relation to safety performance and the safety-related regulations.

The study highlights the relationship between SC and SB on construction sites in Taiwan and the influence of respondents’ characteristics on safety cognition. The findings are limited to that of the experiences of the Taiwanese construction industry. To build on this knowledge and further understand additional studies on the outcomes of safety programs using the relationships observed in the study findings is required.

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