A RESILIENCE SAFETY CLIMATE APPROACH AMONG CONSTRUCTION WORKERS IN RESIDENTIAL PROJECTS

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Abstract

Construction industry is one of the most injury-prone industries. Construction workers face risks culture in which safety is sometimes neglected. Safety climate culture in construction projects can include management commitment, safety training, safety communication, housekeeping and safety equipment, and work pressure supervision. There are three objectives: (1) to identify initiatives on awareness of safety climate approach; (2) to explore factors of safety climate approach; and (3) to investigate strategies on resilience safety climate approach among construction workers in residential projects. Data collection was conducted via a questionnaire survey to 48 respondents among construction workers on residential projects in Tanjung Malim, Perak. The data were then analysed using the means score of descriptive analysis and path modeling method of Structural Equation Modeling - Partial Least Squares (PLS-SEM) via smartPLS software. Findings show that equipment on site, employees' support, and transparent procedures are keys to have safety climate among construction workers and on-site. In implementing these key elements, initiatives to raise awareness to prevent accidents and mitigate any risks at construction sites. Thus, it would be beneficial to the employees to avoid deep compensation post-incidents and to the construction workers in terms of their safety and well-being.

Keywords: *resilience, safety climate, construction workers, residential projects, smartPLS*

INTRODUCTION

In construction projects, safety is a critical component since it affects the well-being of people and their lives. Integration of safety measures is required for construction workers. The construction industry is dangerous, with high injury and death rates when compared to other industries. Based on Ayob et al. (2018), the secondary data from the Malaysia Social Security Organization (SCOSO) showed that the number of occupational accidents in 2020 was 32,674 cases, a 19.9 percent decrease from the 40,811 cases recorded in 2019. Due to fewer cases, the rate of occupational accidents per 1,000 workers in 2020 will be 2.18 (2019 = 2.71). The number of occupational fatalities fell by 266 cases, from 578 in 2019 to 312 in 2020, lowering the occupational fatality rate per 100,000 workers to 2.09 in 2020, down from 3.83 the previous year (Department of Statistics Malaysia, 2021).

There is no denying the importance of this industry, as it provides the infrastructure required by other industries and reflects the economic development of the country. When hazards are not identified and safety risks are underestimated, disastrous accidents might occur. Stakeholders' awareness should be focused on developing strong solutions in a critical industry with high levels of safety risks. There is a critical need for site managers to understand the importance of safety and health, supervisors to perceive the importance of safety, and co-workers to maintain a high level of safety awareness in the construction industry (Mosly & Makki, 2020). As a result, training and research are tools that can aid in changing the industry's situation.

Meanwhile, for project managers who have a higher overall safety culture evaluation, a large number of workers perceive production as a priority, which indicates that workers may take more risks to meet deadlines and expose themselves to injuries and illnesses (Chen & Jin, 2015). The emphasis on raising safety awareness should begin with the workers, who are the most vulnerable and physically harmed group in this industry. Because of the widespread use of subcontractors in the construction industry, general contractors, researchers, and safety and health organisations have expressed serious safety concerns. This highlights the importance of conducting safety research to improve construction site safety. Safety climate measurement can identify areas for safety improvement.

The term "safety climate" refers to workers' perceptions and consciousness, attitudes, and beliefs about risk and safety, and it is typically measured through questionnaire surveys to provide an idea of

the current safety situation (Mosly & Makki, 2020). Therefore, safety climate is an important initial intervention tool. Implementing a safety climate in construction organisations can be measured on a regular basis because it will assist competent safety personnel in identifying and improving that organization's policies, procedures, and practices (Chan, Javed, Wong, Hon, & Lyu, 2017). It is essential that construction entities embrace their construction workers to ensure a solid commitment to implementing safety policies and plans. Safety participation and compliance have a significant impact on the safety climate. The training of competent safety teams led by competent leaders on construction sites will improve safety. Safety leadership supports the development of a positive safety climate, which may lead to increased construction safety.

For this study, there are three research objectives to fulfil. These are (1) *to identify initiatives on awareness of safety climate* approach among construction workers in residential projects; (2) *to explore factors of safety climate* approach among construction workers in residential projects; and (3) *to investigate strategies on resilience safety climate* approach among construction workers in residential projects.

SAFETY CLIMATE RESILIENCE

Previous research has identified several dimensions of the safety climate. According to Bosak et al. (2013), safety climate has three dimensions: management commitment to safety, the priority of safety, and production pressure, whereas Li et al. (2017) believe that safety climate has six dimensions: workers' self-perception of safety, workers' involvement in safety, co-workers' interaction, safety environment, safety management involvement, and safety personnel support. Other studies identify five critical dimensions of safety climate: management commitment, safety behaviour and employee involvement, incentives and rewards systems, communication and information systems, and work pressure (Fernández-Muñiz, Montes-Peón, & Vázquez-Ordás, 2012).

The concept of resilience, which is still being developed, has shown the ability to continuously improve safety performance. It is defined as the ability to respond positively and heal normally while maintaining a high level of safety in stressful or disruptive situations (Bruyelle et al., 2014; Ross et al., 2014). The application of resilience is especially appropriate for high-risk systems with complex characteristics, such as (a) a high degree of interconnection between system components and (b) uncertainty and variability. Because a construction site is a complex, dynamic, and unpredictable system, resilience is required to develop prevention strategies (Carmeli, Friedman, & Tishler, 2013). Furthermore, management commitment, reporting culture, learning culture, anticipation, awareness, and flexibility are the most widely recognised resilience dimensions.

Initiatives on Awareness of Safety Climate

On the job, safety awareness was more important to keep you safe and, more importantly, to keep you from hurting or killing others. Table 1 depicts there are six (6) factors that influence the initiatives on awareness, such as *safety training*; *management commitment; Supervision and co-workers' perception; safety communication; housekeeping and safety equipment;* and *work pressure*. Firstly, based on He et al. (2020), out-of-role safety-related behaviours, which are voluntary for employees to help co-workers, belong to the safety climate. It entails actively participating in safety training activities and making safety recommendations.

Table 1 Initiatives on awareness of safety climate

Initiatives on awareness of safety climate	He et al. (2020)	Kim et al. (2019)	Chen et al (2018)	Roshanira & Demong (2008)
B1. Safety Training	/			
B2. Management Commitment	/	/	/	/
B3. Supervision and co-workers' perceptions	/	/	/	
B4. Safety Communication		/		/
B5. Housekeeping and Safety Equipment			/	/
B6. Work pressure		/		

Secondly, the commitment of management, who create the company's policies and have the authority to allocate resources, is critical to the successful implementation of Safety Management System (He et al. (2020), Kim et al. (2019)). Chen et al. (2018) said there is an overlap between safety climate and resilience in safety research; both concepts emphasise the importance of management

commitment. Similarly, Roshanira and Demong (2008) it was part of the overall management system to help with the management of occupational health and safety risks associated with the organization's business. This includes the organisational structure, planning activities, responsibilities, practices, procedures, processes, and resources for developing, implementing, achieving, reviewing, and managing the health and safety policy of the organisation.

The third initiative on safety climate awareness is supervision and co-workers' perceptions, which refers to employees' perceptions of how their supervisors implement these policies and procedures on a daily basis (He et al., 2020). Furthermore, the effect of the group (supervisor) safety climate on work group safety behaviours is moderated by the effect of the organisational safety climate (Kim et al., 2019). Meanwhile, the new resilience safety climate concept was built using supervisor and co-workers' safety perceptions. Additionally, a construction worker's supervisor and co-workers' safety perceptions likely affect the safety climate awareness (Y. Chen et al., 2018).

Next, in on safety communication. Open communication about safety may influence employees' perceptions of the importance of safety in their workplace Kim et al. (2019), which will ultimately influence workers' safety behaviour, and a lack of emergency communication was the contributing factors that gave the to the operational level working in order to avoid any accidents at work (Roshanira & Demong, 2008). Finally, safety climate awareness initiatives include housekeeping and safety equipment. Employee perceptions of good routine housekeeping were found to be significantly related to both the leading and lagging indicators of environmental impact incidents, as well as the outcomes of fires/explosions and property damage (Y. Chen et al., 2018). Housekeeping and safety equipment were the factors that made every company's employees aware of their safety and health while at work or on the job (Roshanira & Demong, 2008). Finally, Kim et al. (2019) added that work pressure (i.e., workload or work pace) need to be balanced and maintained accordingly on the construction site to get the idea of safety climate and reduce the potential of being the source of risks or accidents.

In short, the above discussions on initiatives on awareness of safety climate by previous researchers, it is important to incorporate those six (6) initiatives (*safety training, management commitment and worker participation; safety communication; housekeeping and safety equipment;* and *work pressure*) to prevent from any accidents. Therefore, this is in line with Research Objective 1.

Safety Climate Factors

Given the importance of human factors in the occurrence of workplace accidents, a positive safety climate is one of the most important factors to consider when striving for prevention excellence (Rebelo et al., 2014). This idea has been strongly supported by construction industry research studies. Based on Table 2, there are five (5) factors of safety climate on construction projects. These are *successful safety training*; *management commitment to safety*; *supervision and co-workers' perception*; *communication and support*; and *work pressure*.

Table 2 Factors of Safety Climate on Construction Projects

Factors of Safety Climate	Borgheipour et al. (2020)	Newaz et al. (2019)	Alruqi et al. (2018)	Chen & Mccabe (2017)
C1. Successful Safety Training	/		/	
C2. Top Management Commitment to safety	/	/	/	/
C3. Good Supervision and co-workers' perceptions		/		/
C4. Communication and Support	/	/		
C5. Low work pressure	/			/

Borgheipour et al. (2020) identified that principal components of safety climate are perceived management attitudes toward safety, the effect of safe work practices on promotion, the social status of individuals, the status of the safety officer, the status of the safety committee, the importance/effectiveness of safety training, workplace risks, and enforcement versus guidance. In another findings by Alruqi et al. (2018), it highlighted that injury rates at construction workplaces were significantly correlated with management commitment to keep the safety on construction by conducting training which create awareness on the individual responsibilities to keep the safety rules and procedures on site.

Secondly, Borgheipour et al. (2020) top management's safety response has a direct impact on safety climate. Meanwhile, Newaz et al. (2019) and Alruqi et al. (2018) both agreed that the factors that contribute to a safety climate in construction projects are also the top management commitment in making sure the safety requirement is intact throughout the entire project. Additionally, a multi-level

safety climate measurement was developed, which included the behaviour of the Principal Contractor, Sub-contractor, Supervisor, Co-worker, and Individual workers. A safety climate measurement scale was developed based on the role of safety agents, who play critical roles in managing workers' perceptions of safety on construction sites. In this study, their findings are applied to the construct of safety climate, introducing/validating the role of the psychological contract in predicting safety climate. In addition to management commitment to safety, it investigates the importance that management places on safety, particularly when it conflicts with production (Y. Chen & Mccabe, 2017). Ultimately, these studies support the inclusion of top management and supervisors' perceptions of safety climate measurement and prediction of resilience safety climate.

Third factors that contribute to a resilience factors safety climate is good supervision and co-workers perception. Newaz et al. (2019) developed a safety climate measurement scale based on the role of safety agents, who play critical roles in managing workers' perceptions of safety on construction sites. Besides that, researchers are continuing to look into the various factors that contribute to a resilient safety climate, such as *communication and support*, as well as *low work pressure* (Borgheipour et al., 2020; Newaz et al., 2019; Chen & Mccabe, 2017). Thus, there is a push to develop industry-specific safety climate factor structures to improve understanding of the positive and negative outcomes of safety initiatives.

The above discussions on factors safety climate on construction projects by previous researchers, it is inevitable to incorporate those five (5) factors (*successful safety training; top management commitment to safety; good supervision and co-workers' perception; communication and support;* and *low work pressure*) to prevent from any accidents. Therefore, this is in line with the Research Objective 2.

Strategies on Resilience Safety Climate

Accidents cause not only operational and project delivery delays, but also direct and indirect costs (Sahiran et al., 2021). Coincidely, all construction companies are required by the Occupational Safety and Health Act of 1994 (OSHA) to provide a safe and conducive working environment for their workers and subcontractors at construction and fabrication sites. Based on Table 3, it shows that there are five (5) strategies on resilience on safety climate. This includes *management dedication and employee participation; workplace evaluation and hazard identification; hazard prevention and control; health and safety training;* and *services & procedures following an incident.*

Table 3 Strategies on Resilience Safety Climate

Strategies of Resilience on Safety Climate	Sahiran et al. (2021)	Lestari et al. (2020)	Mosly & Makki (2020)	Fargnoli & Lombardi (2019)
D1. Management dedication and employee participation	/	/	/	/
D2. Workplace Evaluation and Hazard Identification	/	/		/
D3. Hazard Prevention and Control	/	/		
D4. Health and Safety Training	/	/	/	
D5. Services and procedures following an incident	/	/		/

Sahiran et al. (2021) suggested there are five strategies to become a resilient construction working sites including management dedication and employee participation; workplace evaluation and hazard identification; hazard prevention and control; health and safety training; and services and procedures following an incident. While management is perceived to be reasonably committed to OHS, Lestari et al. (2020) proposed that the strategies to improve the safety climate in construction include the management dedication and employee participation, workplace evaluation and hazard identification, hazard identification and control, health and safety training, and services and procedures following an incident. Meanwhile, as pointed out, supervisors' motivational communication can foster a positive safety climate and influence workers' safety behaviour. Construction managers are in charge of increasing overall construction safety levels through safety training and improved practises. Furthermore, Fargnoli & Lombardi (2019) suggest that the proposed approach can support safety management measures in the initial risk characterization risk scenarios, such as management commitment and worker participation, worksite analysis and hazard identification, and post incident procedure and services, to improve the effectiveness of preventive measures at the task level. Research studies in this area emphasised the resilience of safety climate strategies.

To sum up on the above discussions on strategies of resilience safety climate by previous researchers, it is important to incorporate those five (5) strategies (*management dedication and employee participation; workplace evaluation and hazard identification; hazard Prevention and control; health and safety training;* and *services & procedures following an incident*) to prevent from any accidents among construction workers for residential projects. Therefore, this is in line with Research Objective 3.

Resilience Safety Climate for Construction Workers

The concept of resilience has proven to be effective at improving the safety environment for employees. It is regarded as having the ability to respond positively to normal operations, to heal, and to maintain a high level of safety when under stress or disturbance. (Y. Chen et al., 2018). This idea has been strongly supported by construction industry research studies. Table 4 shows three (3) resilience safety climate for construction workers. These are *safety training*; *safety communication* and *services and procedures following an incident*.

Table 4 Resilience Safety Climate for Construction Workers

Resilience Safety Climate for Construction Workers	Sahiran et al. (2021)	He et al. (2020)	Kim et al. (2019)
E1. Safety training	/	/	
E2. Safety communication			/
E3. Services and procedures following an incident	/		/

Previous research has looked at how resilience and safety climate contribute to a construction worker. Based on Sahiran et al. (2021), safety training can help prevent workplace violence among construction workers. Therefore, good services and standard procedures before and after an accident serve as an example for them to be more cautious. Secondly, He et al. (2020), out-of-role safety-related behaviours that are voluntary for employees to assist co-workers are part of the safety climate. It entails actively participating in safety training activities and making safety recommendations to ensure that construction workers have a resilient safety climate. Next, is on safety communication. Resilience safety climate among employee perceptions of the importance of workplace safety may be influenced by open communication about safety. Kim et al. (2019), which will ultimately influence workers' safety behaviour, and a lack of emergency communication were contributing factors that led to the operational level working to avoid any workplace accidents.

Based on the above discussions on resilience contribute safety climate for construction workers by previous researchers, it is important to incorporate those three (3) resilience safety climate for construction workers. These are *safety training*; *safety communication* and *services and procedures following an incident* to prevent from any accidents.

RESEARCH METHODOLOGY

A quantitative method of questionnaire survey is conducted. The distribution of questionnaires is intended to collect data on safety climate initiatives (Research Objective 1), safety climate resilience factors (Research Objective 2), and safety climate resilience strategies (Research Objective 3). Due to restricted physical activity during COVID-19 pandemic, the data collection was held via an online platform. The questionnaire survey would be distributed to 48 construction workers on residential projects in Tanjung Malim, Perak. The sampling size is the recommended by Hair, Hult, Ringle, & Sarstedt (2017) in conducting PLS-SEM for a Statistical Power of 80%, with 5% significance level, and for detecting R^2 values of at least 0.25. Tanjung Malim was chosen as the site for the questionnaire survey because it is a growing community. The data collected were then analysed using descriptive analysis via SPSS and path modeling method of Structural Equation Modeling - Partial Least Squares (PLS-SEM) via *smartPLS* software. The analysis conducted was path analysis and measurement model.

FINDINGS AND DISCUSSIONS

Table 5 shows the mean score derived from the descriptive analysis. The ranking method was selected to determine the sequence of variables that is essential on the respective themes. For theme B – initiatives on awareness of safety climate shows that the equipment on site is the top priority to determine the safety awareness on construction sites, followed by perception; work pressure; communication skills, training, and commitment. Meanwhile, for theme C – factors of safety climate on construction projects ranked support, training, commitment, perception, and work pressure. Whilst

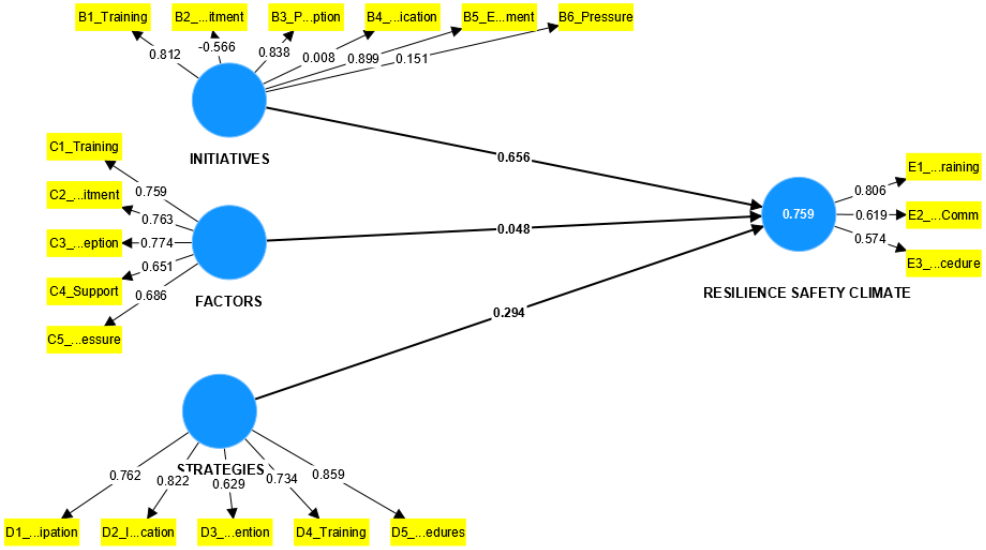
theme D – are based on these sequences, procedures, participation, prevention, training, and identification.

Table 5 Results on Mean score of the variables and its ranking, based on its theme

Theme	Item	Mean	Ranking
B - Initiatives on awareness of safety climate	B5_Equipment	4.265	1
	B3_Perception	4.235	2
	B6_Pressure	4.235	2
	B4_Communication	4.206	4
	B1_Training	4.176	5
	B2_Commitment	2.735	6
C- Factors of Safety Climate on Construction Projects	C4_Support	4.324	1
	C1_Training	4.294	2
	C2_Commitment	4.294	2
	C3_Perception	4.118	4
	C5_Pressure	4.118	4
D - Strategies on Resilience Safety Climate	D5_Procedures	4.647	1
	D1_Participation	4.588	2
	D3_Prevention	4.529	3
	D4_Training	4.441	4
	D2_Identification	4.412	5
E - Resilience Safety Climate for Construction Workers	E3_Res_Procedure	4.647	1
	E2_Res_Communication	4.441	2
	E1_Res_Training	4.176	3

The data were then analysed for path model and measurement model analysis, as in Figure 1. It shows the three (3) nodes that represents theme B, theme C, and theme D, connected to the theme E. The arrows direction from the nodes(blue circle) pointing towards the items (yellow rectangular box, also known as variables), indicates that it is a reflective path model. The characteristics of reflective path model are it does not posses a sensitive node and the variables are independent (Hair et al., 2017). The numbers shown on the arrow lines indicate the reading of outer loadings of measurement model, which will be reported in the next paper.

Figure 1 Path Model and Data for Hypothetical PLS-SEM



CONCLUSIONS

Safety climate interventions and resilience strategies are in need to be proposed and implemented in getting lower risks of accidents and injuries that might occur on construction sites. In previous research, it shown that with integration of knowledge about safety and making it as a normal practice among construction workers can help to reduce the number of risks or accidents that could potentially happened on site. This is due to the presence of consciousness about danger on construction sites. As for this research, the objectives came in three (3) fold, to identify initiatives on awareness of safety climate approach among construction workers in residential projects; to explore factors of safety climate

approach among construction workers in residential projects; and to investigate strategies on resilience safety climate approach among construction workers in residential projects. From the findings, it shows that theme B - initiatives on awareness of safety climate is to have a good awareness on sound housekeeping and safety equipment on construction sites. As for theme C - factors of safety climate on construction projects, topmost preferred factor is to have a functional safety agents on site who optimise its roles in supervising the workers and empowering workers' perception of safety on construction sites. Whilst findings on theme D - strategies on resilience safety climate, to have proper procedures post any incidents on construction sites which indicates mind-ease among the construction workers to face the risks. These findings highlight the safety climate resilience in construction projects that can be integrated and implemented to lower risks on any unwanted and avoidable incidents on sites.

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