

SAFETY MANAGEMENT

Peer-Reviewed

CONSTRUCT CULTURE &

The Relative Importance

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CONSTRUCTION SAFETY & CLIMATE

of Contributing Factors

THE BUREAU OF LABOR STATISTICS (BLS, 2019a) reported a 5% increase in fatalities in the private construction industry in 2019. A total of 1,061 construction workers were killed in 2019, which represents the largest total since 2007. Overall, the U.S. construction industry accounted for roughly 20% of fatalities over the past 10 years, whereas the construction industry only accounts for roughly 4% of the U.S. workforce (Al-Bayati et al., 2019; Liu et al., 2020). The rate of nonfatal injuries in construction was 71% higher than that of all other industries (Waehrer et al., 2007). Furthermore, BLS (2019b) suggests that the rate of incidents necessitating days away from work has increased by roughly 50 per 10,000 full-time equivalent construction workers. Thus, the construction industry significantly contributes to fatal and nonfatal injuries (Niu et al., 2017).

Safety culture and safety climate have been suggested as leading indicators that could help improve overall safety performance. The construction industry has been trying to utilize safety culture and climate to reduce fatalities and injuries (Goldenhar et al., 2015; Hofmann et al., 2017). However, Zohar and Hofmann (2012) highlighted a noticeable lack of clarity surrounding definitions and measurements for safety culture and climate. The following have been suggested as some of the main challenges to full utilization of safety culture and climate in the construction industry:

- The current definitions of safety culture and climate are often used interchangeably (Al-Bayati et al., 2019; Petitta et al., 2017).
- The current proposed safety culture and climate measurements have not been particularly validated in the construction context because they have been proposed based on other industries' needs (Schwatka et al., 2016). As a result, they do not capture the construction industry's proclivities (Niu et al., 2017).

KEY TAKEAWAYS

- This article provides practical, intuitive definitions for construction safety culture and construction safety climate. Construction safety culture and climate are shared responsibilities, which means that all parties have obligations to maintain them.
- This study highlights the importance of safety personnel in initiating and maintaining higher levels of construction safety culture. The competency of safety personnel is vital and must be carefully assessed by upper management during the hiring process.
- Safety personnel can use the framework presented in this study to benchmark and improve safety efforts in their firms. The relative importance index can help construction firms identify where to start with safety.

The construction industry should develop better strategies to utilize the concepts of safety culture and safety climate. Accordingly, Al-Bayati et al. (2019) suggest a new framework that aims to provide a straightforward, intuitive conception of safety culture and climate for the construction industry. The framework adopts the following definitions of construction safety culture and climate based on research by Casey et al. (2017), Mohamed (2002) and Petitta et al. (2017):

- “Construction safety culture” represents policies and principles that guide safety decision-making (i.e., the firm’s management level).
- “Construction safety climate” represents the manifestation of construction safety culture (i.e., principles and policies) in construction workplaces (i.e., the firm’s project level).

The framework then identifies the individuals responsible for creating and sustaining the proposed definitions at the firm’s management and project levels. As a result, upper management and safety personnel have been recognized as responsible for the construction safety culture through the actions presented in Table 1 (p. 26). Conversely, frontline supervisors and workers have been recognized as responsible for the construction safety climate through the actions presented in Table 1. The proposed framework shows a negative correlation with the experience modification rate (EMR), suggesting its validity (Al-Bayati et al., 2019). The validation is based on the fact that the framework would lead to better safety performance in terms of lower EMR. Construction owners and general contractors have been using EMR to assess overall safety performance for years (Al-Bayati et al., 2020; Brahmasrene & Smith, 2008).

This approach focuses on measurable, observable actions of construction firm members (i.e., upper management, frontline supervisors, workers, safety personnel). In addition, it suits the unique nature of construction work in which upper management and safety personnel often manage multiple construction sites. In contrast, the actions of frontline supervisors and workers create the overall field safety climate. Utilizing this framework, every contractor can categorize employees into one of the four defined categories: upper management, safety personnel, field supervisor and construction worker. This framework classifies the safety responsibilities of the construction stakeholders into management level and project level functions. Accordingly, the four players can benchmark their performance and commitment to safety. As a result, they can make the necessary changes to maintain a positive safety culture and climate. Finally, highlighting the contributions of field personnel to the overall safety climate is crucial because field supervision can set the standard for overall safety performance in decentralized firms.

This framework is compatible with the dynamic nature of construction workplaces. The characteristics of construction sites include multiple subcontractors, a multicultural workforce, high-risk work and more. This dynamic nature requires strong coordination between all parties to achieve higher levels of construction safety culture and climate. The construction safety culture and climate framework works directly with the four main players in a construction firm that must be involved with safety. By doing this, all four stakeholders have an investment and take part in

TABLE 1
VARIABLES OF CONSTRUCTION SAFETY CULTURE & CLIMATE

Factor	Variables		
Construction safety culture	Upper management (UM)	UM1	Upper management has a strong core of safety values that guides decision-making.
		UM2	Upper management responds to all incidents in a positive manner and uses them as a learning opportunity.
		UM3	Upper management allocates time and funds when corrective safety actions are required.
		UM4	Upper management adheres to all safety requirements and procedures.
		UM5	Upper management considers safety an integral part of the job, which receives the same amount of attention as other aspects of the job.
	Safety contractors (SC)	SC1	Safety personnel try to implement incident prevention techniques.
		SC2	Safety personnel clearly communicate safety regulations and expectations.
		SC3	Safety personnel are approachable and receptive.
		SC4	Safety personnel strive to improve overall site safety.
		SC5	Safety personnel communicate incident reports to workers to prevent future incidents of a similar nature.
Construction safety climate	Frontline supervisors (FS)	FS1	Frontline supervisors encourage recording and reporting all near-misses.
		FS2	Frontline supervisors actively participate in reviewing safety procedures.
		FS3	Frontline supervisors correct unsafe conditions quickly.
		FS4	Frontline supervisors lead by example when it comes to safety.
		FS5	Frontline supervisors always ensure that workers are following proper safety regulations.
	Workers' involvement (WI)	WI1	Workers feel secure reporting unsafe conditions.
		WI2	Workers know how and where to file an incident report.
		WI3	Workers follow all safety policies and procedures.
		WI4	Workers' actions suggest that they learn and apply concepts from safety training efforts.
		WI5	Workers actively participate in reviewing safety procedures.
		WI6	Workers feel confident that safety issues will be corrected if they report them.

Note. Adapted from "Construction Safety Culture and Climate: Satisfying the Necessity for an Industry Framework," by A.J. Al-Bayati, A. Albert & G. Ford, 2019, *Practice Periodical on Structural Design and Construction*, 24(4).

the process of aligning their firm's safety culture and climate. Furthermore, this framework applies to all construction projects, regardless of location or project size, because it focuses on the actions of the four players, not the project characteristics.

Study Objective & Methodology

The study's objective is to rank the variables of the construction safety culture and climate framework within a common scale to compare their relative importance. The ranking is used to prioritize the variables to better understand their contributions to overall safety performance. The study adopts the relative importance index (RI) method to determine the relative importance of the variables presented in Table 1. This study uses a numerical rating scale (1 to 10), where 1 indicates total nonimportance and 10 indicates absolute importance. The RI values fall within a range of 0 to 1 (0 not inclusive). The higher the RI, the more critical the variable. Relative importance within the context of this article refers to the contribution a variable makes to ensure higher levels of construction safety culture and climate by itself and in combination with other variables. Generally, RI considers the relative contribution of a variable to other variables and makes no assumptions about the variable's statistical significance (Tonidandel & LeBreton, 2011). A variable's RI is helpful when considering its practical value (Cortina & Landis, 2009). RI provides an acceptable estimation of each variable's practical importance based on participants' opinions. RIs are calculated for each variable utilizing the following equation:

Equation 1:

$$RI = \frac{\sum W}{(A \cdot N)}$$

where:

RI = the relative importance index

W = the weight given to each variable by respondents (ranging from 1 to 10)

A = the highest weight (10 in this case)

N = the total number of respondents

To achieve the study objective, an online questionnaire was used to collect data. The survey was reviewed by eight construction practitioners to ensure its clarity, which resulted in a revised questionnaire. Lawrence Technological University's Human Subject Institutional Review Board reviewed and approved the research protocol in September 2019. Accordingly, a nonprobability convenient questionnaire was administered for 1.5 months, and 275 valid responses were collected. Nonprobability questionnaires are a common method for measuring safety culture and climate (Choudhry et al., 2008).

Study Findings

The participants were construction practitioners operating in various states, including North Carolina (33.1%), Virginia (7.3%), Illinois (5.5%), New Mexico (5.1%), South Carolina (3.6%), Florida (3.6%), New York (2.2%), Michigan (1.5%), multiple states (9.5%) and other states (28.5%). The multiple states category indicates that the construction firms conduct business in more than one state. The other states category includes firms that work in a single state that was mentioned very few times in the questionnaire. Participating firms included residential construction (22.2%), commercial construction (48.7%), special trade contracts (13.8%), and civil and heavy construction (15.3%). The participants included individuals with fewer than 4 years of experience (23.7%), between 4 and 10 years of experience (22.9%), and more than 10 years of experience (53.5%).

Table 2 shows the variable ranking within construction safety culture. Based on the ranking, safety personnel actions seem to contribute more to the achievement of a higher level of construction safety culture. The respondents ranked the five required actions of safety personnel higher than upper management actions, which highlights the importance of safety personnel competency and the overall role of safety personnel. In contrast, workers and frontline supervisors equally contribute to the construction safety climate (Table 3). The ranking tables are crucial for construction firms that aim to improve their safety culture and climate because these tables prioritize the necessary actions. Readers should note the similar values of the variable ranks presented in Tables 2 and 3. This suggests that all variables are essential and should be considered to improve overall safety performance. However, these tables provide a road map indicating where to start.

Discussion & Recommendations

The RI scores of the variables of the construction culture reveal the crucial contributions of qualified safety personnel to overall firm safety performance. Table 2 suggests that, in general, the actions of safety personnel scored higher than the actions of upper management. The role of safety personnel has been overlooked in most of the literature and in current safety culture and safety climate frameworks. The focus has always been on management leadership, supervisor commitment, worker involvement and participation, hazard prevention and control, safety training, and so forth, as can be seen in Al-Bayati (2019), Gittleman et al. (2010) and Schwatka et al. (2019), but the role of safety personnel has not been emphasized. There are few articles that focus on the competencies of safety personnel in construction (Møller et al., 2021). On the practical level, construction safety managers are known for their limited influence over the actions and priorities of other members of their firms. Safety policies and personnel are often viewed as an encumbrance rather than an aid to business operations (Ladewski & Al-Bayati, 2019). Construction safety management, which is initiated and maintained by safety personnel, is a shared responsibility and a core business obligation. Thus, highlighting the vital role of safety personnel in construction operations is an important contribution of this study.

Leadership skills are a critical characteristic of qualified safety personnel due to the vital leadership role of these individuals. In general, leadership is an important professional competency in today's construction field (Simmons et al., 2020). Thus, it is recommended to establish a safety leadership training program for safety personnel that focuses on best practices for interacting with upper management, frontline supervisors and workers to ensure their greatest possible involvement and leadership. Few, if any, training interventions have been created and implemented to improve the interaction skills of safety personnel. In addition, upper management should invest wisely in hiring and qualifying their firms' safety personnel.

The RI scores of the construction safety climate variables reveal the shared responsibility of workers and frontline supervisors in improving overall construction safety climate (Table 3). Thus, safety training materials and safety talks should communicate this finding to improve the overall site safety climate and reduce fatal and nonfatal injuries. This finding supports Lingard et al.'s (2019) suggestion that supervisors' communications with workers could predict the firm's safety climate. In addition, the findings presented in this study suggest that communication should be a two-way channel, meaning that workers should be able to commu-

TABLE 2
RANKING OF CONSTRUCTION SAFETY CULTURE VARIABLES

Variable	Mean	SD	RI	Rank
Safety personnel strive to improve overall site safety.	9.44	1.37	0.944	1
Safety personnel are approachable and receptive.	9.36	1.51	0.936	2
Upper management adheres to all safety requirements and procedures.	9.31	1.28	0.931	3
Safety personnel try to implement incident prevention techniques.	9.31	1.47	0.931	3
Safety personnel clearly communicate safety regulations and expectations.	9.30	1.51	0.930	4
Safety personnel communicate incident reports to workers to prevent future incidents of a similar nature.	9.27	1.44	0.927	5
Upper management has a strong core of safety values that guides decision-making.	9.27	1.26	0.927	5
Upper management allocates time and funds when corrective safety actions are required.	9.26	1.31	0.926	6
Upper management respond to all incidents in a positive manner and uses them as learning opportunities.	9.23	1.36	0.923	7
Upper management considers safety an integral part of the job, which receives the same amount of attention as other aspects of the job.	9.18	1.45	0.918	8

Note. RI = relative importance

TABLE 3
RANKING OF CONSTRUCTION SAFETY CLIMATE VARIABLES

Variable	Mean	SD	RI	Rank
Frontline supervisors correct unsafe conditions quickly.	9.36	1.29	0.936	1
Workers feel secure reporting unsafe conditions.	9.35	1.24	0.935	2
Frontline supervisors always ensure that workers are following proper safety regulations.	9.34	1.31	0.934	3
Workers feel confident that safety issues will be corrected if they report them.	9.29	1.41	0.929	4
Frontline supervisors lead by example when it comes to safety.	9.29	1.41	0.929	4
Workers know how and where to file an incident report.	9.24	1.45	0.924	5
Workers follow all safety policies and procedures.	9.18	1.52	0.918	6
Frontline supervisors actively participate in reviewing safety procedures.	9.12	1.53	0.912	7
Workers' actions suggest that they learn and apply concepts from safety training efforts.	9.07	1.72	0.907	8
Frontline supervisors encourage the recording and reporting of all near-misses.	9.01	1.62	0.901	9
Workers actively participate in reviewing safety procedures.	8.92	1.78	0.892	10

Note. RI = relative importance

nicate their safety-related questions and concerns to management. Accordingly, prompt correction of unsafe conditions by field supervisors and cultivation of an environment where workers feel welcome to report dangerous conditions are of primary importance to achieve higher levels of construction safety climate.

Conclusion

This article evaluates the relative importance of the variables within the construction safety culture and climate framework. The rankings presented in Tables 2 and 3 (p. 27) can be used as a road map to achieve higher levels of construction safety culture and climate while maintaining the understanding that all actions are important. The framework presented in this study emphasizes the overall influence of safety personnel as it relates to establishing higher levels of construction safety culture, which positively influences the construction safety climate. That is, safety personnel should initiate effective interactions to communicate the shared responsibility of safety management. Thus, safety personnel's competency and leadership skills are crucial and must be carefully assessed by upper management during the hiring process.

In addition, the relative importance calculations of safety climate variables reveal a shared responsibility between workers and frontline supervisors in developing a healthy safety climate. Accordingly, the study contributes knowledge critical to improving overall safety performance in construction workplaces. This understanding can help improve construction safety management and reduce fatal and nonfatal injuries. **PSJ**

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