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Performance Indicators for Construction Safety Culture and Climate: A Comprehensive State-of-the-Art Study

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Abstract: Safety culture and safety climate have been of interest to researchers and practitioners since the tragic incident of the Chernobyl nuclear power station in 1986. Numerous research efforts have focused on expanding the industry understanding of these safety performance indicators. However, there still is a significant ambiguity over the definition and elements of construction safety culture and safety climate. It is also worth noting that both terminologies have been used interchangeably by many researchers, suggesting the need for more efforts to clarify this issue. Currently, there are several instruments that have been suggested to measure construction safety culture and climate. Yet, these instruments do not seem to appropriately account for the unique characteristics of the construction industry such as the continual change in the job site environment, the variety and diversity of specialty crafts working side by side, and the relatively short time projects. Accordingly, the goal of this study is to conduct a comprehensive investigation into the state of the art of safety culture and climate to assist in clarifying the vagueness in their definitions and the differences between them. The study has identified the performance indicators and suggests that the construction industry still needs more efforts to clarify and unify the definitions and elements of safety culture and safety climate. These findings will help in focusing future research efforts and in understanding the needed elements for properly evaluating construction safety culture and safety climates, which in turn will help in developing metrics that are relevant to the unique nature of construction sites.

1 INTRODUCTION

Fang et al. (2006) attributed the danger of construction industry to mobility and decentralization. Mobility means that construction industry workers, unlike workers in other industries, are constantly shifted between sites, companies, and positions (Fang et al. 2001). One study defined decartelization as “the employees are separated by sites and although regulations and plans are available, they still have to make decisions by themselves when facing specific problems” (Fang, et al. 2006). In comparison to other industries, construction industry is well known for its poor safety record and yet it continues to heavily relying on traditional measures such as accidents’ compensation statistics (Mohamed 2002). Flin, et al. (2000) stated that in recent years, there has been a movement away from ‘‘lagging indicators,’’ such as accident rates, toward so-called ‘‘leading indicators,’’ such as measurements of safety climate. Longford, et al. (2000) attributed this shift of focus to the raised awareness that accidents are primally caused by organizational,

managerial, and human factors and not purely technical failures. Safety culture and safety climate has been identified as crucial in minimizing and eliminating fatalities and injuries occurring on construction worksites. As suggested by (Goldenhar, et al., 2015), a notable number of contractors have taken initiatives to reduce fatalities and injuries occurring on construction worksites although there exists no scientific or industry literature on how such concepts are to be defined or way of measurement.

One study defined safety culture as "Deeply held but often unspoken safety-related beliefs, attitudes, and values that interact with an organization's systems, practices, people, and leadership to establish norms about how things are done in the organization" (Goldenhar, et al., 2015, p.14). Safety climate has been characterized as a main indicator thinking about how well the advocated safety program is eventually coordinated into the association to support safe effective practices at the purpose of task. It mirrors the common impression of the overall need of security contrasted with other contending organizational needs (Fang & Wu, 2013).

Different scholars agree that the construction industry is the single largest contributor of work-related injuries and fatalities among all the industries (Niuet al. 2017; Zhouet al. 2010, Molenaaret al. 2009; Trinhet al. 2018; Schwatkaet al. 2016; Gaoet al. 2016). Gao et al (2016) associate the high safety risks in the construction industry to the peculiar production process, non-standard workers' behavior, sub-contracting system, and the complicated site conditions. These factors make the fatality rates in the construction sector five times more than the general average fatality rates worldwide as estimated by the International Labor Organization (Gao et al., 2016). In a separate study, Zhou et al. (2010) state that the construction industry, unlike other industries has specific unique conditions such as the intensive workforce and bad weather conditions (e.g., wind and fluctuating temperatures) that make it a risky environment to work. Furthermore, regular safety inspection, provision of technical specifications, and provision of sufficient protection equipment have not been effective in addressing and creating a safe work environment (Zhou, Fang & Mohamed, 2010). According to Tam and Fung (2011), the interventions to address the safety climate and culture has concentrated on the engineering failures, legislation, safety training and awareness, and unsafe practices on the construction industry. Nonetheless, there have been no notable improvements in the safety standards creating the need to explore further the factors that threaten the overall site safety. Other studies recognize that the growing aspect of globalization and technological advancements in the sector could yield positive results by introducing safer approaches of interactions in the construction sites (Choudhry et al., 2009; Choudhryet al., 2007; Molenaaret al. 2009; Schwatkaet al. 2016).

Choudhry et al. (2009) explored the measurement of safety climate of the construction industry using regression analysis. According to their findings, the management commitment, employee involvement, inappropriate safety procedures, and work practices are the most significant factors that predict the perception of workers on the safety performance. The results suggest that the high level of employee involvement and management involvement can deliver an acceptable safety performance on construction workplaces. Furthermore, they argue that these factors can form the basis of improving the overall safety performance, thereby helping the workers and industry regulators to assess the safety performance (Marín & Roelofs, 2017). For example, a high management and employee involvement in the creation of safety practices indicates a better safety performance (Gao et al., 2016). Also, some of these indicators can be negative such as the utilization of inappropriate work practices and safety procedures (Gao et al., 2016). Unlike the positive factors, negative factors are indicators of poor safety climate and culture.

Safety performance indicators and measurements are widely used in assessing the effectiveness of an organization in identifying and addressing the safety risks at the workplace (Trinh, Feng, and Jin, 2018). Schwatkaet al. (2016) review the existing literature of the construction industry in an attempt to contribute to the definition and measurement of safety climate. Accordingly, they state that the safety climate is perception based. According to Schwatkaet al. (2016), the key performance indicators that are used to measure the safety culture and climate are safety policies, procedures, and practices. Further research reveals that management commitment to safety is also a key indicator of the construction safety climate (Abudayyeh et al., 2006).

Based on the current study, Schwatkaet al. (2016) recognize the organizational efforts and workers' actions as major considerations in the prevention of work-related injuries. Therefore, for a safer working environment, the scholars suggest that there should be effective policies and procedures that guide the daily activities at the construction sites. Besides the actions of workers should be consistent with the safety standards at the sites. Although there have been policies to address these issues, they have been largely ineffective, creating the need to explore the extent to which the existing policies fail to address the issues (Trinh, Feng and Jin, 2018). Schwatkaet al. (2016) also identify subcontracting and work for an organization

as important elements in measuring the performance of construction safety. In a construction site, different sub-contractors are often engaged with each of them coming with their policies and safety standards as they work towards the project completion (Zahoor et al., 2017). However, there should be standard policies that contractors apply to ensure a safe culture and climate in the entire project.

In a research to explore the improvement of safety climate in the construction industry, Zhouet al. (2010) identify the safety regulations, training, and support from workmates, attitude towards safety, supervision, and management commitment as the major indicators of the construction safety and climate performance. The results suggest that the extent of supervision will determine the extent to which the workers in a construction site are safe. Workers tend to consider safety practices when there is a close supervision unlike when there is little or none. Additionally, the training on safety and support from the workmates will also influence the safety culture and environment. Arguably, highly trained workers on safety rarely fall victims of site injuries or fatalities. This is because of the general belief that the workers are widely informed about the risk factors and measures towards addressing the risks (Zahoor et al., 2017). The attitude towards safety is yet another important performance indicator. According to Zhou, Fang, and Mohamed (2010), Improving safety awareness for workers will result in a positive attitude and perception of the safety, unlike the workers who are less exposed to safety promotion.

Therefore, to ensure better safety culture and climate, there is a need for construction companies to train their workers and offer the necessary support. Additionally, they should motivate the workers to embrace a positive attitude or perception towards the safety policies and practices.

Molenaaret al. (2009) investigated the framework for measuring the corporate safety culture and the subsequent effect on the performance of construction safety. The findings from this study were highly consistent with past studies. According to the results, the safety culture of an organization is measured by the commitment of the company to safety, safety incentives, safety accountability, and subcontractor involvement. The researchers argue that the involvement of a subcontractor in a construction process minimizes the safety of the working environment. They link the introduction of different policies from the general standards established by the main contractor as the contributing factor to the reduction in safety standards. As more subcontractors are enjoined in the construction process, there is a high likelihood that there will be a relaxation in the adherence to safety policies. This reduces the performance of the safety culture and climate in the construction site. Additionally, safety accountability and incentives are important indicators of safety performance (Niu, Leicht & Rowlinson, 2017). When there are safety incentives, site workers tend to observe the safety standards and practices, thereby creating a safe environment for working. However, without such incentives, the workers often relax and disregard their safety at the sites. Therefore, to improve the safety performance in the construction environment, Molenaar, Park, and Washington (2009) suggest that construction companies should offer incentives to the workers who embrace the safety practices and withdraw such incentives when there is a relaxation on the adherence. The incentives can be in the monetary terms in terms of allowances and safety bonuses.

In a study on the development of safety climate indicators, Niu, Leicht, and Rowlinson (2017) emphasized the need for construction companies to embrace a safe work environment for the benefit of all the people in the sites. The study recommends a number of indicators that should be used to measure the performance and subsequently reduce the high injury rates at construction sites across the globe. Based on the findings, the scholars identify environmental safety climate indicators that are critical in the safety measurement of construction sites. Among the indicators that they identify from the study include the workplace, personnel, time and production, and the physical resources (Niu, Leicht & Rowlinson, 2017). The personnel is a key indicator in the measurement of safety personnel since the whole idea about safety revolves around the workers on the site. The considerations such as the training, perceptions, and adherence to the standards are indicators of the extent to which the workers appreciate the safety culture and climate. The time and production will also provide an indication of the performance of safety culture and environment. A safe working environment saves time and improves the workers; productivity, unlike the safe sites. Therefore, for better performance, it is important that construction companies emphasize the key indicators.

2 METHODOLOGY

In this study, a comprehensive literature review was conducted to achieve the intended goal of the study. The main goal of the study is assisting in clarifying the vagueness in the definitions and the differences

between safety culture and safety climate. All the papers included in this study have the following inclusion criteria to provide state of the art review:

1- Must be written in English.
2- Construction-related study.
3- Published in the period of 2000 to 2018.

Around 23 articles (as shown in Table1) met the criteria all of which were carefully reviewed to assist in clarifying the vagueness in the definitions and differences of safety culture and safety climate.

Table 1: List of Selected Studies

#	Paper Title
1	Behavior, Attitude, and Perception toward Safety Culture from Mandatory Safety Training Course.
2	Comparative Analysis of Safety Culture Perceptions among Home Safe Managers and Workers in Residential Construction.
3	Conceptual Model for Developing Resilient Safety Culture.
4	Core Dimensions of the Construction Safety Climate for a Standardized Safety-Climate Measurement.
5	Defining and Measuring Safety Climate: A Review of the Construction Industry Literature.
6	Determinants of Safety Climate for Building Projects SEM-Based Cross-Validation Study.
7	Developing a Model of Construction Safety Culture.
8	Developing Safety Climate Indicators in a Construction Working Environment.
9	Measuring Safety Climate of a Construction Company.
10	Measurement equivalence of a safety climate measure among Hispanic and White Non-Hispanic construction workers.
11	Multilevel Safety Culture and Climate Survey for Assessing New Safety Program.
12	Political Skill for Developing Construction Safety Climate.
13	Promoting Construction Supervisors' Safety-Efficacy to Improve Safety Climate Training Intervention Trial.
14	Safety climate and culture: Integrating psychological and systems perspectives.
15	Safety Culture and Climate in Construction: Bridging the Gap Between Research and Practice.
16	Safety climate improvement: Case study in a Chinese construction company.
17	The nature of safety culture: A survey of the state-of-the-art.
18	Workers' Perceptions of Safety Climate in International Construction Projects Effects of Nationality, Religious Belief, and Employment Mode.
19	Empirical Investigation of Factors Contributing to the Psychological Safety Climate on Construction Sites.
20	Framework for Measuring Corporate Safety Culture and Its Impact on Construction Safety Performance.
21	Safety Climate in Construction Industry: A Case Study in Hong Kong.
22	Safety Climate in Construction Site Environments.
23	Safety behavior and safety management: Its influence on the attitudes of workers in the UK construction industry.

3 FINDINGS

The comprehensive review of the literature reveals several findings. Clearly, construction safety researchers need to agree on definitions for safety culture and safety climate. This vagueness in the current definitions and in the differences between them led to another finding: using the two constructs of safety culture and safety climate interchangeably. In the studies of the performance indicators for construction safety climate and culture, the use of the concepts of climate and culture becomes of interest to research. Over the years, the two areas have been fully explored, creating a gap in evaluating how researchers use

them interchangeably to performance indicators for construction safety. Therefore, problem of using both safety culture and climate remains a major issue with conflicts arising on whether they can be used interchangeably. Moreover, one more important finding is the lack of safety culture and safety climate search in the field of construction. In most cases, companies have specific defining components of what constitutes the safety culture and climate (He et al., 2016). It implies that there will be little areas of common interests for different organizations in the industry (Zhou, Goh & Li, 2015). This has limited the extent to which the researchers explore the concepts of safety climate and culture. These findings will be expanded in the subsequent part. Table 2 below summarizes the findings:

Table 2: Summary of the Findings

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1	No agreed upon definitions of safety culture and safety climate in the field of construction.
2	Using the two constructs of safety culture and safety climate interchangeably.
3	Lack of safety culture and safety climate research in the field of construction.

4 DISCUSSION

4.1 Researchers use Safety Culture and Climate Interchangeably

Safety culture and climate are interchangeably used by researchers in explaining the safety environment that workers create in a construction site. Safety culture refers to the beliefs and values that workers share in relation to organization risks (He et al., 2016). However, the area still remains of interest considering that there is no standard understanding of how safety culture and safety climate relate in a construction setting. There is an overall perception among safety experts that culture and climate mean the same thing and can be used interchangeably (Zhou, Goh & Li, 2015). Yet, this is far from the truth as the two concepts differ in their meanings in relation to safety of construction workers. It is important for construction workers to be sensitive to the safety needs by creating a culture that prioritizes the safety of the workers.

Although there is no standard definition of safety culture, one thing that comes out is that it is the creation of beliefs, perceptions, and values that employees in an organization recognize or relate to in terms of the potential safety risks (Zhou, Goh & Li, 2015). Thus, it is a component of both the individual and group values, attitudes, and patterns of behavior that define their commitment towards the health and safety of the workers. Safety climate, on the other hand, is the value that people tag on the safety within an organization at a particular time. Unlike in safety culture that results from beliefs and attitudes, the perceptions of safety by workers in creating a safety climate is influenced by the values and opinions of the workers.

Safety culture can be used to explain the safety climate as they both capture the influence of opinions, beliefs, perceptions, and behaviors on the safety of the environment where construction workers operate. While safety culture refers to the creation of beliefs and perceptions, the safety climate explores how these factors influence the construction site. Therefore, safety climate and culture could be used to mean the same thing in explaining the environment that construction companies have created to guarantee the workers high safety standards (McCabe et al., 2016). The culture can either be at individual or organizational level. It raises the question of the actions that the workers and organization have taken to ensure high safety standards (Zhou, Goh & Li, 2015). The safety culture is a result of the climate that exists in the working environment. This explains the workers' views and perceptions on the safety of the working site. Therefore, for most researchers, safety climate and culture could be used interchangeably to explain the safety issues within a construction site. In this paper, there is an exploration of the factors that explain the performance of safety culture and climate in the construction industry.

4.2 Safety Culture and Climate is Little Searched in the Field of Construction

Although the concepts of safety culture and climate are significant in understanding the idea of construction safety, little research has been completed. Past studies have focused on the risk factors in the construction with interests in areas such as near misses and factors that cause injuries to workers at the construction sites. The neglect of safety climate and safety culture is perhaps linked to the complexity of the concepts and researchers' perceptions of their insignificance in explaining construction safety (McCabe et al., 2016). Despite the little interest in exploring the areas, different scholars have made notable efforts towards promoting construction safety (Zhou, Goh & Li, 2015). These efforts have resulted in a significant decline in fatalities. According to the researchers, the creation of a standard safety culture and climate is a function of the industry regulators and workers such that no extent of research would help improve the safety standards if the managers in such industries do not appreciate the importance. This partly explains why there has been little research in safety culture and climate in the field of construction.

The fact that there are no standard guidelines on the safety culture and climate and that these aspects are defined by the specific environment lowers the researchers' interests in the area. Safety culture and climate are relative concepts that have a unique understanding depending on the environment (McCabe et al., 2016). As a dynamic field, it becomes complex to fully explore; thus, the limited research on the concepts. Therefore, the little research on safety culture and climate form the basis of the current study. It targets to improve the understanding of the concepts with an aim of improving safety standards.

5 CONCLUSION

Although safety culture and safety climate has been searched since 1986, there still is vagueness about their distinct meanings and elements in the construction industry. The main goal of this study is to assist in clarifying this vagueness. By conducting a thorough review on construction-related papers, the study has identified the performance indicators. The performance indicators for construction safety culture and climate are vital elements in the evaluation of a company's progress in ensuring that the workers are safe. As mentioned above, exploring the literature and latest studies have revealed the importance of more efforts towards safety culture and safety climate in the field of construction. Specifically, the construction industry needs to focus on clarifying and unifying the definitions and elements of safety culture and climate. The fact that researchers use the two terms interchangeably and the fact that this topic is little searched in the construction industry make it necessary for the industry's efforts to be towards addressing these issues. In summary, researchers in the field of construction industry need to reflect the unique nature of construction sites and exert more effort toward unifying the definitions and elements of safety culture and safety climate which will help in developing metrics that mirror the distinct nature of construction sites.

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