Collective Mindfulness: A Dimension of Construction Safety Climate

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Abstract

The construction industry is a high-risk industry known for high fatality rates all over the world. It is quite different from other industries due to its complicated processes, changing work locations, and complex work environments. A wide range of safety management approaches have been introduced and used to manage construction risks, thus advanced methods and approaches are required to further reduce accidents and incidents. High-reliability organising has emerged from research into high hazard industries where collective mindfulness is recognised as a thriving concept that leads these organisations to maintain error free operations. In this study, the Mindfulness Organising Scale is introduced as a safety climate dimension. The five principles of collective mindfulness: preoccupation with failure, reluctance to simplify, sensitivity to operations, commitment to resilience, and deference to expertise can measure the degree of anticipating safety problems and containing them after accidents and incidents occur in a construction organisation. Safety climate is often considered a predictor of safety behaviour. It checks whether the behaviour of people in the organisation matches the rhetoric. The commonly used indicators to measure safety climate in construction are management commitment to safety; safety policies, resources, and training; supervisor commitment to safety; organizational commitment to safety; co-workers' commitment to safety; safety communication; worker involvement in safety; risk appraisal and risk-taking. Along with them, a mindfulness organising scale is recommended to measure the safety climate to identify the pitfalls of current safety management practices in a construction organisation.

Keywords
Collective Mindfulness; Construction Safety; High-Reliability Organising; Mindfulness Organising Scale: Safety Climate

1. Introduction
Construction sites feature numerous moving parts, including heavy machinery, building materials; and various construction professionals trying to get the job done in time and on a budget (Solomon and Esmaeili 2020). Improving safety in construction remains a priority in almost every country because it stands out among all other industries as the main contributor to severe and fatal accidents (Ho et al. 2000). According to International Labour Organisation (2015), thirty percent of all occupational fatal accidents have occurred in construction. These accidents and incidents are not always foreseeable due to the risks associated with construction work, and the conflict of interest between safety and production imposed by project deadlines (Karanikas et al. 2018, Mroszczyk 2015). The trend of construction accidents has decreased gradually, as a result of continuous efforts of researchers and practitioners (Hallowell 2012, Huang and Hinze 2006). Thus, the construction industry is still regarded as one of the most unsafe industries; much needs to be done as existing methods of construction safety management are on a plateau (Perttula et al. 2006, Pinto et al. 2011). In that case, high-reliability organising (HRO) turns out to be useful since its principles are exemplified in high hazard organisations to maintain nearly error free daily operations (Ford 2018).

HRO focuses on how the presence (or lack) of structures, mechanisms, and routines leads to failures and catastrophes in high hazard organisations (Harvey et al. 2019). Its concepts and principles direct an organisation towards increasing performance reliability through anticipation and containment of unwanted events (Scholtenhuis and Doree 2013). Collective mindfulness is a commonly used concept drawn from HRO. It comprises a set of principles that describe how organisations can enhance the reliability of their performance (Weick et al. 1999). The application of collective

mindfulness in daily operations enables organisations to attain high safety standards (Enya et al. 2018). HRO stems from high hazard industries and is relatively new to construction management (Dorée 2014). There is an ample amount of research conducted using HRO and collective mindfulness for the construction industry. Scholtenhuis and Doree (2013) proposed HRO as a theoretical lens to help practitioners anticipate and contain unwanted events in the construction management field. Koh et al. (2013) proposed a mediational framework of social capital, HRO, and safety performance for achieving construction project safety in the microwork process. Høyland et al. (2018) explored HRO safety principles present in the construction industry in Norway. Enya et al. (2018) identified the possibilities and barriers associated with transferring HRO principles to construction activities and how the principles of collective mindfulness can improve construction safety management.

Accident prevention in the construction industry used models and approaches to analyse accident causation and prevention (Harvey et al. 2019). They developed through a series of ages: technical age (Hale and Hovden 1998), engineering/human factor age (Hale and Hovden 1998, Reason 2016), systems age (Hale and Hovden 1998, Hudson 2007), and cultural age (Hudson 2007). Thus, it has not focused on production practices and proactive strategies for safety (Enya et al. 2018). Therefore, this study will identify collective mindfulness as a dimension of safety climate. Safety climate measurements are used to proactively assess an organisation's effectiveness in identifying and remediating work-related hazards to reduce or prevent work-related accidents and incidents (Schwatka et al. 2016). The mindfulness organising scale is introduced as the measurement of collective mindfulness. It was developed by Weick and Sutcliffe (2011) to conduct self-audits within organisations to assess their capabilities for resilient performance. They emphasised that these mindful moments are more important if the work is in contexts that are dynamic, ill-structured, ambiguous, or unpredictable such as in the construction industry.

2. Methods

To present a new perspective on the safety climate in the construction industry, an integrative literature review is undertaken. An integrative literature review is defined as "a form of research that reviews, critiques, and synthesizes representative literature on a topic in an integrated way such that new frameworks and perspectives on the topic are generated" (Torraco 2005). Various databases were used to access literature on high reliability organising and collective mindfulness. These include PubMed, Google Scholar, Scopus, EBSCO, Web of Science, PROQUEST, etc. Using keyword search containing "safety climate"; "safety climate" and "construction"; "high-reliability organising" and "mindfulness"; "high-reliability organising" and "construction"; "mindfulness" and "construction"; "mindfulness" and "construction safety" in each database, related literature was identified, and duplicates were removed after abstract screenings. Important articles to the study were then recognized based on the content of each identified paper. Finally, relevant arguments and findings from the articles were summarized, synthesized, and integrated as appropriate to develop the proposition of this study.

3. Construction Safety

The construction industry dates back to the Palaeolithic Age when humans settled in caves or built structures on even ground (Pérezgonzález 2005). Safety management in construction was first recorded in 2200 B.C. when King Hammurabi of Babylon imposed penalties for houses falling and killing their inhabitants (Zhou et al. 2015). The construction industry is different from other industries due to its unique production process, high mobility of the temporary workforce, fragmented and pervasive subcontracting system, unrepeated and complex project environment, levels of technology used, and individual craft culture (Cheng et al. 2007, Liang et al. 2022, Liang and Zhang 2019, Manu et al. 2013, Meliá et al. 2008, Mohamed 2002, Schwatka et al. 2016). The unpredictable and complex nature of the construction tasks, interaction between workers and equipment, varying degrees of safety awareness and training, and nonstandard behaviours of the workers has made safety a major concern wherever construction activities take place (Bhattacharjee et al. 2011). It often records a high rate of industrial accidents in most countries and regions. According to International Labour Organisation, the fatality rate in the construction sector is five times higher than the general average fatality rate globally (Murie 2007). Table 1 below explains the status of construction accidents in several countries.

The accidents in the construction industry result from the interaction between the work team, workplace, equipment, and materials which lead to about 70% of injuries and fatalities (Enya et al. 2018). The risks inherent in construction activities and accidents cannot be avoided, and sometimes safety affects productivity when it competes with production (Mitropoulos and Cupido 2009). The industry struggles to achieve nearly error-free operation while dealing with limited budgets, tight schedules, demanding stakeholders, and a fragmented supply chain (Buniya et al. 2021).

So, construction professionals have to manoeuvre through complex coordination structures to achieve project objectives (Scholtenhuis and Doree 2013). Many studies have identified a positive correlation between safety performance and safety climate in the construction industry (Cheng et al. 2007, Gao et al. 2016, Hon et al. 2014, Lingard 2013, Lingard et al. 2011, Lingard et al. 2012, McCabe et al. 2017, Panuwatwanich et al. 2017, Zahoor et al. 2015, Zahoor et al. 2017).

Table 1. Status of construction safety

Country	***Construction safety status***
United States	In 2010, a total of 774 workers died from injuries on construction sites, accounting for 16.5% of all industries. The fatality rate is (9.8 per 100,000 full-time equivalent workers) ranked the fourth highest among all industries (Source: U.S. Bureau of Labor Statistics)
United Kingdom	One-third of all workplace fatalities have occurred on construction sites. The fatal injury rate is over four times the average level of all industries (Source: Health and Safety Executive)
China	The number of fatalities was 2538 in the construction industry in 2007 (Source: Zhou et al. (2008))
Singapore	There were 24 fatalities in the construction sector in 2006, which occupied 39% of the total 62 workplace fatalities (Source: Ministry of Manpower)
Australia	There were 30 fatalities recorded in 2012. This number of fatalities equated to three deaths per 100,000 workers, which was the fourth-highest fatality rate of all the industries (Source: Safe Work Australia)
Korea	The construction sector occupied the highest percentage of fatalities among all sectors (Source: Yi et al. (2012))

Adapted from: Zhou et al. (2015)

4. Safety Climate

Safety climate is defined as "a unified set of cognitions regarding the safety aspects of the organisation which reflects employees' shared perceptions about the relative importance of safe conduct in their occupational behaviour" (Zohar 1980). In early research, Cohen (1977) identified management commitment, management-supervisor-worker interactions, workforce stability and industrial relations, housekeeping and environmental control, training and conventional safety practices contribute to successful safety programmes in industrial settings. By comparing 11 pairs of industrial companies, Simonds and Shafai-Sahrai (1977) concluded that factors such as management involvement, selected promotional efforts, workforce characteristics, and physical conditions primarily explained differences in injury frequencies. Moreover, when there is more safety staff, safety committees, and safety training there is a low accident rate (Smith et al. 1978). Schroder (1970) suggested that measuring employee attitudes towards safety could be a useful form of safety measures. Their proposition was unsafe behaviour could be lessened when employees have more mature safety attitudes, thus, they would search for safer environments. Ojanen et al. (1988) argued efforts to improve safety in an organisation need to be perceived by its employees; that perception should be measured, and the measurement is an indication of changes in organisational safety behaviour. Safety climate is often considered a predictor of safety behaviour (Gao et al. 2017). It checks whether the behaviour of people in the organisation matches the rhetoric (Lingard et al. 2010).

Researchers have measured safety climate using diverse and varying sets of questionnaires with different dimensions; the aggregated scores measured perceptions of safety (Alruqi et al. 2018). The dimensions of the first safety climate questionnaire were (1) management commitment to safety; (2) safety training; (3) level of work risk; (4) status of safety officer; (5) work pace; (6) safety committee status; (7) effects of safe conduct on promotion; and (8) effects of safe conduct on social status (Zohar 1980). Mearns et al. (1998) examined the safety climate of 10 offshore installations using a questionnaire with scales measuring work pressure and work clarity, job communication, safety behaviour, risk perception, satisfaction with safety measures, and safety attitudes. Flin et al. (2000) and Guldenmund (2000) identified management, risk, safety arrangements, procedures, training, and work pressure as the most frequently measured dimensions in safety climate studies through a thematic analysis of 18 and 15 studies published respectively. Safety climate scales are developed either based on attitude items or based exclusively upon safety-related perceptions and with both attitudinal and perception items (Glendon and Litherland 2001).

The first construction-specific study measured the safety climate among construction workers using Brown and Holmes (1986) three-factor safety climate model (Dedobbeleer and Béland 1991). They found two-factor model (management commitment and workers involvement) is suitable for the construction industry. Since then, there have been many safety climate studies in the construction industry (Fang et al. 2006, Gao et al. 2016, Gillen et al. 2002, Hon et al. 2014, Lingard et al. 2012, Meliá et al. 2008, Mohamed 2002, Siu et al. 2004, Soraperra et al. 2015, Zhou et al. 2011). Reviewing 56 studies conducted in the construction industry about safety climate Schwatka et al. (2016) identified a majority of the studies adapted and used an instrument developed for construction (Arcury et al. 2012, Gillen et al. 2002, Sparer et al. 2013, Teo and Feng 2011) or a different industry while others developed their own safety climate survey instrument (Kines et al. 2010, Mohamed 2002). Further to their work, management commitment to safety, safety policies, resources, and training, supervisor commitment to safety, organizational commitment to safety, co-workers' commitment to safety, safety communication, worker involvement in safety, risk appraisal, and risk-taking are the commonly used safety climate indicators in the construction industry. However, this research revealed a significant positive association between safety climate and safety performance in the construction industry (Gillen et al. 2002).

5. High-Reliability Organising

High reliability organising was conceptualised after foundational research in the U.S. air traffic control system (La Porte 1988), electrical operations, and power generation at the Pacific Gas and Electric Company (Schulman 1993), and flight operations aboard two U.S. Navy aircraft carriers (Rochlin et al. 1987) by a group of four researchers at UC Berkeley (Saunders 2015). Their operations were relatively high risk in volatile and uncertain environments, yet sustain high levels of safety performance, while meeting highly unpredictable and demanding production tasks (Beyea 2005, Sutcliffe 2011). The study was inspired by Charles Perrow's Normal Accident Theory which provided an alternative explanation of why organisational disasters such as the Three Mile Island nuclear plant explosion were inevitable (Perrow 1984). The processes in HRO have been suggested as possible ways to prevent errors in high hazard and complex organisations (Lekka and Sugden 2011). During the adaptive age of safety management strategies, HRO principles were used to improve safety management in the industrial sector (Borys et al. 2009). Their systematic procedures are applied in managing safety because they operate in a tightly coupled system (Harvey et al. 2019). HRO reflects that accidents are not unavoidable and the term "organising" in HRO suggests safety has to be a continuing and dynamic process (Roberts 1990). These processes allow the organisation to continuously operate under trying conditions, reduce the impacts of accidents, and help with the recovery process (Weick and Sutcliffe 2001). Even though activities in the construction industry are loosely coupled, complexity and uncertainty instigate more advanced and systematic safety approaches such as HRO to safely manage complex projects (Enya et al. 2018, Harvey et al. 2019, Høyland et al. 2018, Mitropoulos and Cupido 2009). HRO is based on group mental processes that improve the quality of an individual's attention through alertness and awareness, allowing them to recognize subtle changes in their environment and respond appropriately (Vogus 2011).

6. Collective Mindfulness

Collective mindfulness was derived from HRO as the strategy that underpins the unique ability of HRO to detect and correct errors and adapt to unexpected events (Weick et al. 1999). It differs from situational awareness as it involves the continual review of existing expectations, continual refinement, and differentiation of expectations based on up-to-date experiences, willingness and ability to devise new differentiated assessment and processing methods, and identification of new dimensions that can improve the current view and functionality of the context (Endsley 1995, Roth et al. 2006). Collective mindfulness entails a set of actions and interactions where members of a team or organization anticipate, prevent, and dynamically respond to errors and unexpected events using five aspects: preoccupation with failure; reluctance to simplify interpretation; sensitivity to operations; commitment to resilience, and deference to expertise (Weick 2005). These principles fall into two clusters: principles of anticipation and principles of containment (Weick and Sutcliffe 2011). Anticipation focuses on identifying and preventing potential unwanted situations (preoccupation with failure, reluctance to simplify, sensitivity to operations), while containment is about reacting to and recovering from such situations (commitment to resilience, deference to expertise) (Scholtenhuis and Doree 2013).

- Preoccupation with failure refers to regularly discussing the various ways in which things can go wrong and collectively analysing early indications of trouble

- Reluctance to simplify is frequently questioning the adequacy of existing procedures and discussing potentially more reliable alternatives
- Sensitivity to operations deals with creating and maintaining an up-to-date, integrated understanding of operations
- Commitment to resilience is committing to recovering quickly from setbacks by thoroughly analysing, discussing, and learning from them
- Deference to expertise refers to accepting expertise rather than authority when resolving problems (Martínez-Córcoles and Vogus 2020).

Weick and Sutcliffe (2001) define mindfulness as "a rich awareness of discriminatory detail." It involves the combination of ongoing scrutiny of existing expectations, continuous refinement and differentiation of expectations based on newer experiences, willingness, and capability to invent new expectations that make sense of unprecedented events, a more nuanced appreciation of context and ways to deal with it, and identification of new dimensions of context that improve foresight and current functioning (Langer 1989). Weick and Sutcliffe (2011) described nine audits to help an organisation to be more alert to the dimension of mindfulness and mindlessness in their work and system. It enhances the awareness of how to institutionalise mindfulness by identifying similarities of the five HRO principles in the organisation. Further, they abstracted these nine audits to one scale known as the Mindfulness Organising Scale for ease of use as shown in Table 2.

Table 2. The Mindfulness Organising Scale

The Mindfulness Organizing Scale				
How well do the following statements describe your work unit, department, or organisation?				
		Always	Sometimes	Never
Preoccupation with Failure				
1	We spend time identifying activities we do not want to go wrong.			
Reluctance to Simplify				
2	We discuss alternatives as to how to go about our normal work activities.			
Sensitivity to Operations				
3	When discussing emerging problems with co-workers, we usually discuss what to look out for.			
Commitment to Resilience				
4	We talk about mistakes and ways to learn from them.			
5	When errors happen, we discuss how we could have prevented them.			
Deference to Expertise				
6	We have a good "map" of each person's talents and skills.			
7	We discuss our unique skills with each other so that we know who has relevant specialized skills and knowledge.			
8	When attempting to resolve a problem, we take advantage of the unique skills of our colleagues.			
9	When a crisis occurs, we rapidly pool our collective expertise to attempt to resolve it.			

Weick and Sutcliffe (2011) used the measurement scale as 1 = never, 2 = sometimes, 3 = always and the numbers are added in the audit conducted in an organisation. If the score is higher than 17, they suggested the mindful organising practices are strong; if the score is between 11 and 17, it is a moderate mindful organising practice and if the score is lower than 11 it suggests that the organisation should be actively thinking of ways to improve its mindful organising practices.

7. Measuring Construction Safety Climate with Collective Mindfulness

The construction work environment is volatile and something unexpected will always happen. So, it is more important to respond according to the situation focusing on operations rather than strategy. Safety climate is the shared

perceptions of members of the organisation about the way safety is managed. Collective mindfulness is about the quality of attention. The mindfulness dimension in the safety climate reveals the extent to which current safety practices incorporate the five principles of mindfulness.

Preoccupation with failure involves continuous attention to anomalies that could be symptoms of larger problems. The construct is forward-looking and relates to methods and risk. It is a complementary characteristic to sensitivity to operations and requires a reluctance to simplify problems and incident causes. Details are obscured by simplification, and this increases the likelihood of unreliable performance. Thoroughly examining and investigating problems and testing solutions before implementation are key to this characteristic. Reluctance to simplify is also connected with deference to expertise. Expertise, rather than authority, takes precedence in an HRO. If both reluctance to simplify and deference to expertise score low on the safety climate scale, it can be concluded that problems/ incidents/ accidents/ issues are explained away, accepting simple diagnoses, instead of conducting root cause analysis because of authority, unavailability (or non-recognition of on-the-ground subject matter experts) and unwillingness to challenge long-held beliefs.

Sensitivity to operations reflects watchfulness for moment-to-moment changes in operating conditions. Such changes are all too common in the construction industry and the changes can have many causes. Changes may be brought about by physical conditions but also by external forces (such as design or specification changes). Commitment to resilience is a dedication to improving the organisation's general capacity to learn and its ability to act during disturbances to mitigate them without losing adaptability. This is about reacting quickly and solving problems with as little disruption to production as possible and embedding learning for future incidents. Deference to expertise refers to respectful yielding to expertise and experience and making use of others' domain-specific knowledge. This requires open and honest discussion to get the whole team on board with a clear understanding of the issues.

Measuring these characteristics provides a benchmark of the organisation against a high-reliability organisation that maintains relatively error-free performance by relying on mindfulness. Based on this benchmark, the organisation can focus on areas lagging and strive for continuous improvement for safety. Further, it will help build a mindful organisational culture where people share their accounts of what went wrong (reporting culture); everyone is treated fairly, acceptable, and unacceptable actions are defined and when something goes wrong, reasons are looked for eliminating blame on each other (just culture); opportunities are provided to everyone to share information (learning culture). Mindful people have the big picture of the moment. When people are aware of context and discriminate among details and deviations from expectations, it helps create readiness for the unexpected by being comfortable imagining them in everyday operations. Therefore, this review proposes to combine the statements of Weick & Sutcliffe's (2011) mindfulness organising scale with other frequently adapted safety climate dimensions with a suitable scale of measurement for safety climate studies in construction and interpret the aggregate results.

8. Conclusion

The construction industry has been adapting various models and strategies for safety management over decades and is still infamous as one of the highest contributors to occupational fatalities. This study reviewed safety climate measurements in the construction industry and collective mindfulness used in HRO. Safety climate is a collective construct of individuals' shared perceptions about how safety is valued in the workplace. It has been identified as a predictor of safety behaviour and safety outcomes. Measuring safety climate provides a focal point to make changes to improve safety. Mindfulness is a mental orientation that continually evaluates the environment. It tracks small failures, resists oversimplification, remains sensitive to the operations in practice, maintains the capability for resilience, and takes advantage of changes in who has expertise. Mindful organising helps organisations to maintain resilience during unexpected events through anticipation and containment. Based on the review this recommends the mindfulness organising scale as a safety climate dimension for the construction industry. Commonly used safety climate indicators such as management safety commitment, communication, competence, supervisory leadership, appreciation of risk, and worker involvement do not closely measure how accidents and incidents are anticipated and contained. It is also an important factor for safety management since accidents and incidents are inevitable in the construction industry. Construction organisations should be ready to accept them and act in ways to minimise the damages. When principles of collective mindfulness are combined with other safety climate dimensions, it measures the proactiveness of safety management strategies in an organisation. This review only presents a conceptual proposition. Further quantitative studies are needed to validate the concept.

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