Safety Science 138 (2021) 105197

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/safety

Enhancing safety in high-risk operations: A multilevel analysis of the role of mindful organising in translating safety climate into individual safety behaviours

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ARTICLE INFO

Keywords:
Mindful organising
Multi-level analysis
Safety performance
Team safety climate
Safety citizenship behaviour

ABSTRACT

Mindful organising is a team level capability that allows teams in high-risk operations to anticipate when something is about to go wrong and quickly act to maintain the stability of the system. The present study aimed to add to our currently limited understanding of the team level conditions that are important for mindful organising to develop as well as broaden our understanding of the impact of mindful organising on individual safety behaviours. To do so, the authors test a multilevel mediation model using data collected from a sample of chemical workers. The model tested whether mindful organising mediates the relationship between team safety climate and individual in-role and extra-role safety behaviour. The findings showed that high levels of priority given to safety over other competing demands in a team is an important prerequisite for mindful organising to develop. The findings also showed that mindful organising leads to increased safety citizenship and compliance with safety protocol.

1. Introduction

Despite rapid advancements in technology and safety management systems, most organisations that operate in high-risk environments still experience errors and accidents that have dire consequences for their workers, customers and their communities. It is estimated that every day more than 960,000 people get injured on the job and around 5330 die due to work related injuries and diseases (Mekkodathil et al., 2016). Traditionally, safety research interested in improving the safety standards of particular industries or organisations would analyse accidents and errors to try to understand how to avoid them. This approach has since been criticized as not enough, as accidents and errors represent an absence of safety. To better manage safety and risk, we also need to uncover models and frameworks that represent the billions of cases where safety is present, and nothing goes wrong (Hollnagel, 2018). From these models and frameworks, we can extrapolate lessons about how to achieve higher safety standards in other settings.

One safety framework which has received rising attention is high-reliability organisation (HRO) theory. High-reliability organisations (such as air traffic control centres or nuclear power plants) operate in trying conditions filled with constant risks and potential for error, and in these environments one error could lead to catastrophic consequences. What makes HROs remarkable is that they manage to operate almost error-free and maintain consistently stable performance (Rochlin et al., 1987). Through analyses of how these organisations managed to achieve such high reliability, researchers found that HROs designed for safety on a systems level and had a very intricate understanding of their operations with highly mapped our procedures and protocols (Schulman, 2004). Beyond that, they exhibited the social and relational infrastructure that allowed them to expertly manage unexpected events (Weick and Roberts, 1993). This social and relational infrastructure meant that teams working in these environments have a collective capability to anticipate, and quickly recover from, unexpected events and small errors to maintain stability within the system (Weick et al., 1999). This team capability has been called “mindful organising”, which is said to underpin the success of HROs (Weick & Sutcliffe, 2007). As our technologies become more sophisticated, modern organisations are experiencing higher levels of uncertainty, complexity and interdependence than ever before, which increases the number of unforeseen events occurring in these organisations. This raises key questions for safety researchers about the new determinants of safety management in organisations (Griffin et al., 2014) as the ability to detect errors and

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https://doi.org/10.1016/j.ssci.2021.105197
Received 12 August 2020; Received in revised form 29 October 2020; Accepted 29 January 2021

unexpected events and quickly recover from them is becoming increasingly more relevant.

Mindful organising appears to have great potential in helping researchers and practitioners to create more resilient teams and organisations. However, a recent special issue on mindful organising highlights that mindful organising theory and empirical research is still limited and is criticized for not being socially embedded enough, being too limited in focus and being too narrow in its level of analysis (Martínez-Córcoles & Vogus, 2020). This makes mindful organising difficult to sustain in practice. Of particular relevance, is the lack of research positioning mindful organising, which is a team level capability, within other important safety related variables, contextual variables (i.e. safety climate) and individual safety behaviours. In fact, the safety behaviours that teams engage in collectively has barely been studied, as most research on safety behaviour looks at individual behaviours such as safety compliance and safety participation (Neal et al, 2000) and individual proactive safety behaviours (e.g. Curcuruto et al., 2019a; Curcuruto et al., 2019b; Neal and Griffin, 2006). Extending our understanding of the safety behaviours that teams engage in together expands our lens to the multilevel factors at play that could be enhancing more reliable performance in high-risk environments.

In a review of safety proactivity in organisations, Curcuruto and Griffin (2016) highlight that the current literature shows that there appear to be positive links between safety climate dimensions (Zohar, 2008), team models such as mindful organising (Vogus & Sutcliffe, 2007; Weick et al., 1999) and individual behaviour models (e.g. Curcuruto et al., 2013; Hofmann et al., 2003; Parker & Collins, 2010). However, there is limited integration of theory across levels due to a lack of clear understanding and empirical investigation into the relationships between these variables (Curcuruto & Griffin, 2016). Therefore, we do not have clear holistic theories that show us how these various components of the organisational system work together to ensure safety yet. Without an integration of theories that show us how to understand, analyse and measure the human behaviour elements of the organisational system that promote or hinder safety, the more granular and one dimensional our studies and enquiries will end up being. Given the complexity of the social and behavioural elements of an organisational system, granular and one-dimensional analyses are unlikely to offer meaningful safety models from a human behaviour perspective. Therefore, it is becoming increasingly valuable to analyse organisational systems from a multi-levelled perspective to have a more holistic picture of these complex behavioural systems. The first step toward meaningful integration of theory is to understand the relationships between these important organisational, team and individual variables to understand whether they are related as well as the strength and direction of these relationships. From here, we can start to pave the road to better integration of these various concepts.

Within the current mindful organising literature, there are major gaps in our understanding of which contextual safety factors relate to mindful organising and how mindful organising may influence individual safety behaviour (Sutcliffe et al., 2016). It is widely accepted that strong organisational safety cultures expressed as strong safety climates are drivers of team and individual safety attitudes and behaviours leading to better safety outcomes (see the systematic review by Kalteh et al., 2019). Originally, early authors positioned mindful organising as "an enactment of safety climate" (Vogus & Sutcliffe, 2007), arguing that mindful organising may help to facilitate the behaviours associated with prioritizing safety on a team level. Since then, it has become apparent that mindful organising fundamentally differs from group safety climate conceptually and empirically (Renecle et al., 2020). However, the notion that mindful organising could facilitate the behaviours associated with prioritizing safety has never been tested empirically. The nature of the relationship between mindful organising and group safety climate is poorly understood, and no study to date has looked at the role of mindful organising in facilitating the relationship between group safety climate and individual safety behaviour. This is interesting because mindful organising has been criticized as "unstable" and in need of constant reinforcement. Building our understanding of contextual factors that may aid in creating and sustaining mindful organising can help in advancing how theoretically robust and practically relevant mindful organising can be (Martínez-Córcoles & Vogus, 2020).

The enactment of mindful organising on a team level has shown to improve objective safety outcomes (e.g. fewer medication errors (Vogus & Sutcliffe, 2007), and lower rates of mortality in patients (Madsen et al., 2006)). Although there is value in analysing the direct impact of mindful organising on these outcomes, these models do not show us which individual safety behaviours are stimulated by team level mindful organising leading to increased reliability and fewer accidents. Models using objective indicators of safety (e.g. medication errors) are also specific to certain environments and industries, not offering much insight to other organisations about the how mindful organising may effect more generalisable, individual behaviours. The recent study conducted by Gracia et al. (2020) is the only research that has looked at the impact of mindful organising on the more general individual safety indicators of participation and compliance.

Yet we still do not know what role mindful organising plays in predicting a more articulated cluster of extra role safety behaviour such as safety citizenship behaviours (SCBs)[1] (Hofmann et al., 2003) and in preventing safety violation (Hansez & Chmiel, 2010). These individual safety behaviours have shown to be crucial for sustaining reliability in increasingly volatile, uncertain and complex environments (Curcuruto et al., 2015). Examining these relationships could help us to better understand the value of mindful organising. It is possible that engaging in mindful organising is not the sole reason certain teams have better safety outcomes, but rather, it could be the extra-role safety behaviours stimulated by mindful organising that also play a big role in organisations achieving better safety outcomes.

The present research aims to position mindful organising as a collective, discursive form of safety related proactivity (Curcuruto & Griffin, 2016) which acts as the mechanism through which a high group safety climate leads to individual safety proactivity (safety citizenship behaviours) and safety compliance. We do so by testing a multilevel mediation model in a sample of chemical workers. By investigating these relationships, we aim to contribute to the current literature in three ways. First, by investigating the impact of team safety climate on mindful organising, we hope to broaden our understanding of which contextual, team level variables are important for fostering mindful organising, to hopefully shed light on the conditions needed to help sustain mindful organising in practice. Second, we hope to show that individuals that engage in the processes of mindful organising with their teams, will be more likely to individually engage in proactive efforts to ensure safety (i.e. safety citizenship behaviours) and comply with already established safety protocol. This could offer insight into positive effects of mindful organising on individual workers, which could play a substantial role in the link between mindful organising's and higher reliability as seen in previous studies (Sutcliffe et al, 2016). Third, by investigating the mediation effect of mindful organising between team safety climate and individual safety citizenship and compliance, we hope to gain some insight into how safety proactivity is manifested in high-risk settings and hopefully show how these multi-levelled psychological and behavioural precursors of safety work together. Through this, we aim to help occupational safety researchers on the path to better theory integration.

[1] From now onwards, we use the word safety citizenship behaviour and extra-role safety behaviour interchangeably.

2. Theoretical background

2.1. Mindful organising

Mindful organising is the collective ability of teams to anticipate, and recover from, unexpected events and errors. It encompasses various behaviours and norms that are seen in the actions and interactions of team members. It was originally discovered by Weick et al. (1999) during field and case study research on the human characteristics that made HROs manage to operate almost error free when the potential for errors and catastrophe is so high. They found that teams exhibited a highly attentive pattern of interrelating that allowed them to quickly detect when something was about to go wrong, and then act to maintain the stability of the organisational system. This ability allows teams, and the organisations in which they operate, to exhibit extreme reliability in their performance. Therefore, mindful organising has also called "the principles of high reliability" (Weick & Sutcliffe, 2007). Mindful organising is a fragile construct, as it is enacted and re-enacted by those on the front line and it is a team level emergent phenomenon (Vogus and Sutcliffe, 2012; Weick & Sutcliffe, 2007). Since its inception, mindful organising has been positioned within high reliability theory and has not been a big feature of mainstream safety behaviour research. This could largely be due to the fact that mindful organising research is still in its infancy, with most studies investigating mindful organising being qualitative in nature, limiting our understanding of mindful organising's nomological network (Martínez-Córcoles & Vogus, 2020; Sutcliffe et al., 2016).

Mindful organising is created and maintained through five interrelated processes, namely: (1) a preoccupation with error, (2) a reluctance to simplify interpretations, (3) sensitivity to operations, (4) a commitment to resilience and (5) deference to expertise (Weick & Sutcliffe, 2007). *A preoccupation with error* means that teams continuously try to anticipate everything that could go wrong and take any small deviation in performance as an indicator of potentially bigger problems (LaPorte & Consolini, 1991). *A reluctance to simplify interpretations* means that teams actively avoid simplifying their interpretations of events happening in their work as it could lead to incorrect conclusions (Schulman, 1993). This is seen in teams questioning assumptions made by others and allowing uncertainty to build up before making a diagnosis of a situation (Weick & Sutcliffe, 2015). *Sensitivity to operations* means teams remain aware of all of the details of current operations at any given moment (Weick et al., 1999). It also means teams keep managers informed of the realities of what is happening on the front line (Weick & Sutcliffe, 2015). *Commitment to resilience* means teams are able to quickly recover from unexpected events and errors, achieving stability of the system (Weick & Sutcliffe, 2007). It also means that teams actively try to develop and enhance their ability to bounce back from unexpected events (e.g. through learning from errors) (Van Dyck et al., 2005). *Deference to expertise* means that when teams are faced with unexpected events, decision making migrates to those with the best expertise or first-hand knowledge of the event, rather than to those with the highest rank (Roberts et al., 1994). It is through the first three processes that teams are able to anticipate when something is amiss or something unexpected is about to happen and it is through the last two processes that teams develop the ability to quickly contain, bounce back, and recover from, unexpected events and errors (Weick & Sutcliffe, 2007). Thus, mindful organising is about collective anticipation and containment.

In the present study, we posit that mindful organising is a form of team level safety proactivity (Curcuruto & Griffin, 2016). Safety proactivity is defined by encompassing three key elements (Parker & Collins, 2010): (1) it is self-initiated, (2) it is anticipatory and future focused, and (3) it is change-orientated. These features differentiate safety proactivity from proficient behaviour and adaptive behaviour (Griffin, Neal & Parker, 2007). Proficient behaviour in a high-risk context entails following rules and procedures to maintain a safe environment and adaptive behaviour entails reactively supporting safety in unpredictable changing environments (Curcuruto & Griffin, 2016). Adaptive behaviour bears more similarity to proactive safety behaviour than proficient behaviour, but it involves less initiative and anticipatory thinking. Mindful organising is an emergent phenomenon created and sustained by teams on the front line (self-initiated) (Sutcliffe et al., 2016), it involves teams initiating actions and communication about possible emerging issues and creating capacity to better respond to unexpected events in future (anticipatory and future focused) (Weick et al., 1999), it also focused on improving safety levels by changing the ways of working and growing team and system wide capabilities to best respond to unexpected events and errors (change-orientated) (Weick & Sutcliffe, 2007).

2.2. Group safety climate and mindful organising

Safety climate is defined as shared perceptions about safety policies, procedures and practices (Zohar, 2008). Employees develop a collective understanding of the priority given to safety through internally consistent patterns of actions concerning safety from management and peers (Zohar & Luria, 2005). From this, employees form a consensus about what is valued. Safety climate has a subjective normative influence on individual and group behaviour (Zohar, 2008). This means that individuals and groups will conform to the group by repeating the patterns of action of others out of a desire to fulfil other's expectations and gain acceptance into the group or organization (Zohar, 2003). Safety climate differs from safety culture as safety culture refers to the underlying assumptions and values about safety that guide behaviour, whereas safety climate is the direct perceptions of the priority given to safety by individuals and groups (Guldenmund, 2007). Safety culture is more difficult to directly measure as it represents implicit processes and intangible values, whereas safety climate is more accessible to conscious evaluation (Zohar, 2008; Griffin & Curcuruto, 2016). Safety climate, therefore, can be conceptualized as a "snapshot" or manifestation of a broader safety culture (Cox & Flin, 1998).

Safety climate is also multileveled in that it can be conceptualized on an organisational level and a group level. Zohar (2008) posits that organisational safety climate is reflective of the safety policies put into practice by senior management. In other words, if senior management consistently implements and enacts policies that prioritize safety above other competing demands, such as efficiency, employees are likely to perceive a high organisational safety climate. Group safety climate, on the other hand, is derived mainly from the safety practices that are executed by lower level leaders and team members, which may differ substantially from the implemented policies by senior management (Zohar, 2008). This is because safety practices at a unit level depend on line managers discretion and interpretation of formal policies and procedures. It is also often the case that the policies and procedures implemented by senior management do not cover all the situations that teams may face in their work as the complexities of high-risk environments result in countless possible situations leaving the evaluation and implementation of practices to be prioritized up to lower level formal (and possibly informal) leaders (Zohar, 2008).

Safety climate has been linked to increased motivation to work safely, engaging in safer behaviour as well as fewer adverse safety outcomes (such as accidents and injury) (Kalteh et al., 2019; Nuhrgang et al., 2011). There are many theories as to why and how a high safety climate positively impacts safety behaviour, motivation and outcomes. The current literature on safety climate has explained the link between safety climate and safety motivation or safety behaviour through arguments using self-determination theory, psychological empowerment, social-exchange theory as well as theories about normative influence (Griffin & Curcuruto, 2016). The utility of each theory depends largely on the context, level of analysis (individual, team or organisational) as well as the safety variables in question.

The current study examines the effect of group safety climate on team mindful organising. Group safety climate was chosen to be

included over organisational safety climate because we believe the team level perception of the priority given to safety will be a more powerful and consistent driver of team safety behaviour. To our knowledge, no study exists that examines the direction and nature of the relationship between team mindful organising and safety climate and almost all safety climate research focuses on individual safety behaviour outcomes or collective objective indicator outcomes. Dahl and Kongsvik, (2018) link safety climate to individual mindful safety practices and found that safety climate explained 31% of the variance in individual mindful safety practices. These authors define mindful safety practices following Skjerve (2008) as the ability of an individual employee to remain aware of critical factors in their work environment and act appropriately when dangers arise. Although this bears some similarity to mindful organising, their construct is represented by an individual, 3-item measure that is mostly concerned with individual attentiveness to safety at work and does not begin to measure the team dynamics and capabilities within the five processes of mindful organising. Still, this study offers us some insight into the power of safety climate in influencing individuals' present moment attentiveness towards safety, which is needed for mindful organising on a team level.

We argue that group safety climate creates the psychosocial platform for teams to engage in the five processes of mindful organising through normative influences. We posit that mindful organising is an emergent, team level phenomenon that needs constant reinforcement in teams. A weak group safety climate is likely to stifle mindful organising, whereas a strong group safety climate will influence team members to prioritize engaging in safer actions and practices over more efficient or quicker actions. The three processes to do with anticipation (preoccupation with error, reluctance to simplify interpretations and sensitivity to operations) require continuous attention and vigilance to detect any anomaly or change within the organization's internal or external system (Vogus, 2011). The anticipatory processes of mindful organising also require constant collective sensemaking as well as quick, real time feedback between team members (Weick & Sutcliffe, 2015). If teams do not believe that pursuing safety is prioritized, expected and rewarded above other competing demands, it is highly unlikely that they will be able to sustain the continuous effort needed to engage in the process of anticipation. The two processes to do with containment (deference to expertise and commitment to resilience) have to do with creating capacity to contain unexpected events by using various team members knowledge and experience in a flexible manner (Vogus, 2011) as well as devoting time and energy towards growing team capabilities for bouncing back (Weick & Sutcliffe, 2007). It is unlikely that teams will take the personal responsibility, time and attention needed for quickly acting to contain unexpected events if they do not believe that pursuing safety is of utmost importance within their workgroup.

2.3. Mindful organising and safety behaviours

Our understanding of safety at work has followed the mainstream organisational behaviour models that distinguish work related behaviour according to: in-role behaviour (task performance) and extra-role behaviour (contextual performance) (Katz & Kahn, 1966). In-role safety behaviours are generally labelled "safety compliance" and refer to the tasks and activities outlined by formal procedures and rules that employees are expected to follow to maintain minimum levels of safety (Neal et al., 2000). Extra-role safety behaviours are generally called "safety participation" and refer to a wider set of behaviours that may contribute to developing an environment that supports safety, such as participating in voluntary safety activities or helping coworkers with safety tasks (Neal & Griffin, 2006). High risk environments are facing more uncertainty and change than ever before, making it difficult to predict and formalize ideal behaviours through setting up procedures and rules (Griffin et al., 2007). It is therefore unsurprising that the available research shows that safety management systems that focus more on stimulating safety participation have better safety outcomes (Curcuruto & Griffin, 2016; Hofmann et al., 2003; Zacharatos et al., 2005) Thus, safety management approaches need to encourage both safety compliance (to ensure reliability in routine situations) and safety participation (to ensure that safety citizenship and initiative grow capacity for reliability in unpredictable situations) (Zohar, 2008).

Within the safety participation paradigm, individuals may also engage in safety citizenship behaviours (SCBs), which are prosocial, discretionary actions carried out by employees that are necessary for managing risk in safety critical industries (Curcuruto et al., 2019b; Hofmann et al., 2003). These SCBs can have various typologies, in that they can be affiliative (prosocial, cooperative behaviours that solidify the relationship with others and the organization) or challenging (behaviours that enact organisational change and challenge the status quo through innovation, problem solving or idea generation) (Curcuruto & Griffin, 2018; Hofmann et al., 2003; Van Dyne et al., 1995). These behaviours can also be either people-targeted (aimed at improving the quality of work experiences of the performance of people) or organization targeted (aimed at improving the organization itself) (Laurent et al., 2020; Organ et al., 2005; Williams and Anderson, 1991). Another distinction made, is whether the SCB is either protection/prevention focused (aims to mitigate risks in order to avoid the potential negative consequences of these risks) or promotion focused (aims to enhance safety to increase positive outcomes for the organization) (Curcuruto et al., 2019b; Van Dyne et al., 1995).

Mindful organising has been attributed to higher reliability and better safety outcomes in various studies (e.g. Bigley & Roberts, 2001; Dierynck et al., 2017; Madsen et al., 2006; Mitropoulos and Cupido, 2009; Vogus & Sutcliffe, 2007) These studies all look at safety outcomes (such as the number of medication errors. There have been some investigations into the impact of mindful practiceon safety behaviours in other industries. For example, Leung, Liang and Yu (2016) link individual mindfulness to safety behaviour in the construction industry. Although the conceptual underpinnings of these individual mindfulness models differ substantially from the team-level mindful organising construct under investigation in the present study, these findings offer initial evidence that the capability to display ongoing present moment attentiveness is crucial for safety, instead of blind compliance to safety protocol.

Of the limited quantitative studies into mindful organising and general safety performance that exist, there is only one study linking mindful organising to more general indicators of safety behaviour (Gracia et al., 2020). This study showed that empowering leadership created the context for mindful organising which in turn predicted individual safety compliance but did not predict general individual safety participation. No study to date has looked at the impact of team mindful organising on individual safety citizenship behaviours. This limits our understanding of which individual safety behaviours are stimulated by team mindful organising, helping to achieve better safety outcomes and higher reliability. The present research wanted to investigate the impact of mindful organising on a variety of safety behaviours on the individual level, within the context of a high group safety climate. In other words, we wanted to investigate whether mindful organising mediates the impact of a strong group safety climate on individual safety behaviour, and if so, which safety behaviours?

We posit that group safety climate creates the necessary psychosocial platform to create and sustain the five processes of mindful organising by reinforcing expectancy-value perceptions of safety priorities (Parker et al., 2010). Therefore, we believe that in a context where team members perceive that safety is a priority above other competing demands, mindful organising is likely to develop.

Mindful organising represents a set of safety proactivity principles and norms that help teams to anticipate and contain risks and unexpected events. Consistently engaging in these behaviours and norms are likely to encourage further individual safety proactivity, such as SCBs. Therefore, the present study examines whether a high safety climate in teams leads to higher mindful organising and whether mindful

organising, in turn, leads to SCBs such as helping, initiative and voice. Helping refers to behaviours that help others with safety related responsibilities; it is an affiliative, promotive, and people-targeted SCB (Curcuruto et al., 2019a). Voice refers to raising safety concerns to others; it is a challenging, promotive, and people-targeted SCB (Curcuruto et al., 2019a). Initiative refers to making changes to ways of working to make it safer; it is a challenging, promotive, and organization-targeted SCB (Curcuruto et al., 2019a). We posit that the norms established through collectively engaging in the behaviours required for the anticipation (preoccupation with error, reluctance to simplify, sensitivity to operations) and the containment (commitment to resilience and deference to expertise) processes of mindful organising will increase an individual's propensity to engage in SCBs. This is because consistently engaging in team level proactivity towards safety enacted through mindful organising is likely to influence individuals to be more proactive in enhancing individual capacities for safety by raising safety concerns they see to their colleagues and leaders (voice), independently make changes to their ways of working to make it safer (initiative) as well as helping others with safety related issues (helping). We argue that although a high safety climate may set the foundation for encouraging individual SCBs such as voice, initiative and helping, it is through the influence of team mindful organising that these individual behaviours are likely to be enacted. Therefore, the following is hypothesized:

Hypothesis 1: Mindful organising mediates the relationship between group safety climate and voice(1a), initiative (1b), helping (1c) so that the relationship is positive and significant.

Engaging in team level mindful organising will then increase individual's propensity to adhere to general safety rules and procedures and discourage them from going against these rules, especially for routine tasks. Thus, the present study wanted to examine whether mindful organising mediated the relationship between safety climate and safety compliance. We believe that the heightened attention to safety risks and possible errors and mishaps or "heedful interrelating" that comes from engaging in the processes of mindful organising (Weick et al., 1999), is likely to reduce slip-ups and lack of adherence to safety rules and procedures. Similarly, it is likely that teams with a high safety climate that engage in the five processes of mindful organising create a norm of a high commitment to safety and safety behaviours. It is highly unlikely that individuals working within units will actively go against formalized safety rules. Therefore, the following is hypothesized:

Hypothesis 2: Mindful organising mediates the relationship between group safety climate and safety compliance so that the relationship is positive and significant(see Fig. 1).

Hypothesis 3: Mindful organising mediates the relationship between group safety climate and safety violation so that the relationship is negative and significant (see Fig. 1).

3. Method

3.1. Sample and procedure

The data used in this research was collected within a sample of Russian-based chemical plant workers (N = 1112) comprising of 98 teams. Participation was voluntary and all workers were informed that the data would be used for scientific research and to gain insight into safety culture improvements. The cover page of every questionnaire copy included information which pointed out the purpose of the survey. It was made clear to participants that the information provided by them would be used primarily for scientific research advancements. The cover page also explained that some of the findings would be made available to top management and the entire workforce in the form of a general report of the main results, with insight into how to improve safety culture in the plant. The administration of the questionnaires to the workforce was managed by an external consultancy following the instructions provided by the research team.

The average length of tenure was 4.7 years (SD = 9.58). Participants were employed in production (49%), chemical treatment (25%), packaging (22%) or maintenance (4%). Employees in the sample worked in various departments within the plant such as secondary production (42%), primary production (18%), filter making (17%), in the warehouse (14%), quality assurance (4%), engineering (3%) or other areas (2%). In terms of safety roles, 12% of respondents were either a team safety head or manager and the majority of participants were ordinary workers (88%). The questionnaire was administered in Russian and the scales below were translated from English (the original versions) to Russian using the back-translation methods. First, a certified translator with a psychological behavioural background translated the scales from English to Russian. Thereafter, bilingual industry managers who are experts in occupational safety back translated the scale back to English. The original and back translation version were then compared, and no translation issues were detected.

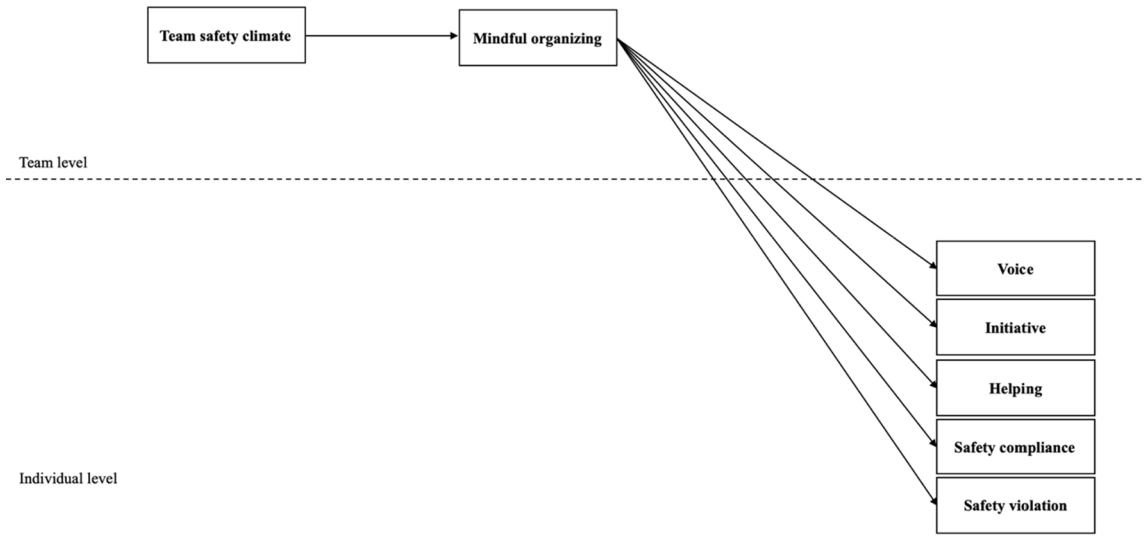

Fig. 1. The hypothesized model.

3.2. Measures

All of the following scales were measured using 5-point Likert scales, with 5 indicating the highest score in the dimension studied and 1 being the lowest score in the dimension studied.

3.2.1. Group safety climate

Group safety climate is the perceived level of importance given to safety at the group level. Group safety climate was measured using a 16-item scale (α = 0.94) taken from Zohar and Luria (2005). An example item is "My direct line manager frequently tells us about the hazards in our work".

3.2.2. Mindful organizing

Mindful organising is a team's collective capability to anticipate and contain errors and unexpected events. Mindful organising was measured using a 9-item scale (α = 0.93) taken from Vogus and Sutcliffe (2007). An example item is "We talk about mistakes and ways to learn from them."

3.2.3. Safety citizenship behaviours

Safety citizenship behaviours are discretionary and prosocial activities essential for managing risk in safety critical industries (Curcuruto et al., 2019b). For the present study, we analysed three SCBs, namely: voice, initiative and helping. Voice was measured using a 4-item scale (α = 0.91), an example item is "rate the extent to which you voluntarily raise safety concerns in planning sessions" Initiative was measured using a 4-item scale (α = 0.84), an example item is "rate the extent to which you voluntarily try to make policies and procedures safer". Helping was measured using a 6-item scale (α = 0.90), an example item is "rate the extent to which you voluntarily help teach safety procedures to new crew members".

3.2.4. Safety compliance

In order to analyse safety compliance, we measured whether individuals comply with the safety protocol of the chemical plant and whether individuals violate safety protocol. Two scales were taken from Hansez and Chmiel (2010) measuring safety compliance and safety violation. Following the literature on human error (Reason, 2000), Hansez and Chmiel (2010) distinguish between these two constructs (safety compliance and violation) as they argue that they reflect two different underlying mechanisms that may lead individuals toward effective safety compliance. According to these authors, the safety compliance scale measures employees' general propensity to comply with safety standards across different work situations, except for exceptional organisational "failings with regard to the site, tools or equipment, cause a deviation from the safest possible way of working in order to get the job done" (Hansez & Chmiel, 2010; p.268). The safety violation scale, on the other hand, assesses the employees' tendency to take shortcuts when performing certain familiar work activities. Examples of these violations are deliberately "taking the path of least effort or corner-cutting" (Hansez & Chmiel, 2010; p.268). The two authors suggest that these "short cuts" could eventually become habitual and are not driven by exceptional failures within an organization. For the scope of the present research, and following Hansez and Chmiel (2010), we treated the two scales as complementary indicators of the behavioural adhesion with the safety protocols in place in the workplace. Safety compliance was measured using a 5-item scale (α = 0.81), an example item is "rate the extent to which you voluntarily use protection, even if it is hard to find." Safety violation was measured using a 5-item scale (α = 0.91) and is inversely scored, an example item is "rate the extent to which you neglect some safety rules when performing familiar or routine work."

3.3. Analyses

To test our proposed model, we ran a multilevel structural equation model (MSEM). Group safety climate and mindful organising were analysed on the team level and safety compliance, routine violation and the SCBs were analysed on the individual level.

First, confirmatory factor analyses (CFA) of the seven scales (group safety climate, mindful organising, voice, initiative, helping, safety compliance and safety violation) were carried out in order to gain evidence of the discriminant validity of these measures. A seven-factor model with all the items loading onto seven separate factors using individual level data was run with Mplus (Muthén and Muthén, 2007). Thereafter, five alternative CFA models were conducted, and the fit of these models was compared with the seven-factor model. The alternative models are: (1) a model with all the items of the seven scales loading onto one single factor, (2) a six factor model with all items loading onto their corresponding factor but with group safety climate and mindful organising loading onto one single factor, (3) a five factor model with all items loading onto their corresponding factor and the three SCBs (helping, initiative and voice) loading onto one single factor, (4) a six factor model with all items loading onto their corresponding factor but with safety compliance and safety violation loading onto one single factor, (5) a four factor model with group safety climate and mindful organising loading onto their corresponding factor, the three SCBs (helping, initiative and voice) loading onto one single factor and the two compliance variables loading onto one single factor.

Model fit was evaluated by calculating the chi-squared statistic, the root mean square error of approximation (RMSEA; Steiger, 1990), the comparative fit index (CFI) (Bentler, 1990) and the Tucker Lewis index (TLI; Tucker & Lewis, 1973). RMSEA values below 0.05 indicate good fit, values of between 0.08 and 0.05 show a reasonable error of approximation and values of 0.10 or more indicate poor fit, (Browne & Cudeck, 1993; Browne & Du Toit, 1992). For the CFI values, values above 0.90 are considered acceptable fit and values close to 1 indicate good fit (Hu & Bentler, 1999). TLI values near 1 indicate good fit, with the conventional cut off being 0.90 for acceptable fit (Tucker & Lewis, 1973). When comparing alternative models, we used the following criteria: (1) whether the differences between TLI and CFI values of the competing models were larger than 0.01 (Cheung & Rensvold, 2002; Widaman, 1985), and (2) whether the differences between RMSEA values were larger than 0.015 (Chen et al., 2008). These criteria indicate whether there is a notable disparity between the models and when these differences in practical fit indices are detected, the model showing better fit will be selected. Complementarily, the difference in chi-squared statistics along with the difference in degrees of freedom was also used to check for statistically significant differences among competing models, using a $\chi 2$ table. If the difference is significant, the model with the smaller chi-square value is argued to have a better fit to data (Schermelleh-Engel et al., 2003).

Second, to evaluate the within group agreement and between group discrimination for group safety climate and mindful organising, we calculated aggregation indices and ANOVA, respectively. Therefore, we calculated different aggregation indices (average deviation index (ADIs), Rwg values, intraclass correlation statistics), and ANOVAs.

Third, we ran a multilevel structural equation model to assess our proposed mediation model and the pathways between our variables. Monte Carlo (MC) confidence intervals were used for testing the significance of the indirect effects, as it is argued to be a more viable and robust method for calculating confidence intervals for complex and simple indirect effects when working with a multilevel model (Preacher & Selig, 2012).

4. Results

4.1. Confirmatory factor analysis

Table 1 shows the goodness of fit indices of the CFA with all seven variables included in the study loading onto seven separate factors, and four alternative models.

The differences between the 7-factor model and the alternative model 1 (ΔRMSEA = 0.097, ΔCFI = 0.267, ΔTLI = 0.278), alternative model 2 (ΔRMSEA = 0.019, ΔCFI = 0.040, ΔTLI = 0.042), alternative model 4 (ΔRMSEA = 0.016, ΔCFI = 0.030, ΔTLI = 0.028) and alternative model 5 (ΔRMSEA = 0.019, ΔCFI = 0.036, ΔTLI = 0.034) were notable, indicating that the study model had a better fit to the data. However, the differences between the 7-factor model and alternative model 3 (where initiative, voice and helping loaded onto a single factor) were negligible (ΔRMSEA = 0.004 0, ΔCFI = 0.007, ΔTLI = 0.007). Therefore, we examined the difference in chi-square statistics of the 7-factor model and alternative model 3, and found that the difference between the chi-square statistics were statistically significant ($\Delta\chi^2$ = 629.15, $\Delta df = 11$, $p < .001$). Given that the 7-factor model has a smaller chi-square value, it is considered to have a better fit to the data. Thus, the evidence above supports the discriminant validity of the seven scales.

4.2. Aggregation indices

The results of the within-team agreement and inter-rater reliability analyses for group safety climate and mindful organising provided adequate justification for aggregating the data to the team level. The ADI values were 0.66 (SD = 0.19) for group safety climate and 0.62 for (SD = 0.21) for mindful organising, both were below the 0.83 cut off indicated for 5-point Likert response scales (Burke & Dunlap, 2002). The $r_{wg(J)}$ values were 0.91 for group safety climate and 0.90 for mindful organising, both indicating acceptable agreement (LeBreton & Senter, 2008; Brown & Hauenstein, 2005). The ICC(1) values were 0.06 for both variables, thus above the recommended 0.05 cut-off (Bliese, 2000). ANOVA results for group safety climate ($F(98,1013) = 1.78$, $p < .001$) and mindful organising ($F(98,1010) = 1.68$, $p < .001$) indicated adequate between-team discrimination.

4.3. Descriptive statistics and correlations among study variables

Descriptive statistics and the correlations between the study variables can be found below in Table 2.

4.4. Multilevel SEM analysis

The results of the MSEM analysis indicated that the hypothesized multilevel mediation model showed a satisfactory fit ($\chi^2 = 21.73$, df = 15, $p > .05$; RMSEA = 0.02 ; CFI = 1.00; TLI = 1.00; SRMR-within = 0.01; SRMR-between = 0.06). All hypothesized pathways were significant (see Fig. 2).

The pathway from group safety climate to mindful organising was positive and statistically significant (b = 0.73, $p < .001$). In addition, the pathways from mindful organising to voice (b = 0.86, $p < .001$), initiative (b = 0.78, $p < .001$), helping (b = 0.824, $p < .001$), safety compliance (b = 0.54, $p < .001$) and safety violation (b = -0.49, $p < .001$) were all statistically significant. Moreover, regarding the indirect effects (mediation effects), none of the 95% Monte Carlo (MC) confidence intervals (CI) include the zero value. Group safety climate had a positive statistically significant indirect effect on voice (IE = 0.63, 95% MC CI = 0.40, 0.91), initiative (IE = 0.57, 95% MC CI = 0.36, 0.82), helping (IE = 0.60, 95% MC CI = 0.40, 0.84) and safety compliance (IE = 0.40, 95% MC CI = 0.27, 0.53) through mindful organising. As expected the indirect between relationship of group safety climate on safety violation through mindful organising was negative and significant

Table 1
Confirmatory factor analysis results for the study model and alternative models for comparison.

Model	χ^2 (df)	p	RMSEA	CFI	TLI	SRMR
7-factor model: *the seven study variables loaded onto seven separate factors*	4167.47 (1106)	0.000	0.050	0.966	0.964	0.039
Alternative model 1: *the seven study variables loaded onto a single factor*	28160.41 (1127)	0.000	0.147	0.699	0.686	0.159
Alternative model 2: *six factor model with mindful organising and group safety climate loading onto the same single factor and initiative, helping, voice, safety compliance and safety violation each loading onto separate factors.*	7757.74 (1112)	0.000	0.073	0.926	0.922	0.065
Alternative model 3: *five factor model with the SCBs (initiative, helping, voice) loading onto the same single factor and mindful organising, group safety climate, safety compliance and safety violation each loading onto separate factors*	4796.62 (1117)	0.000	0.054	0.959	0.957	0.043
Alternative model 4: *five factor model with safety compliance and safety violation loading onto the same single factor and mindful organising, group safety climate, initiative, helping and voice each loading onto separate factors.*	6548.45 (1112)	0.000	0.066	0.939	0.936	0.057
Alternative model 5: *four factor model with group safety climate and mindful organising loading onto their corresponding factor, the three SCBs (helping, initiative and voice) loading onto one single factor and the two compliance variables loading onto one single factor*	7005.23 (1121)	0.000	0.069	0.934	0.931	0.060

Table 2
Descriptive statistics and correlations among study variables.

Variable	*M*	*SD*	1	2	3	4	5	6	7
1. Group safety climate	4.08	0.76	–						
2. Mindful organising	3.97	0.75	0.64**	–					
3. Safety Compliance	4.35	0.67	0.41**	0.44**	–				
4. Safety Violation	1.56	0.78	–22**	−0.24**	−0.47**	–			
5. Voice (SCB)	3.08	1.02	0.31**	0.44**	0.43**	−0.12**	–		
6. Initiative (SCB)	3.09	0.92	0.31**	0.44**	0.40**	−0.11**	0.70**	–	
7. Helping (SCB)	3.35	0.98	0.38**	0.49**	0.48**	−0.15**	0.68**	0.62**	–

Note. * p < .05, **p < .001.

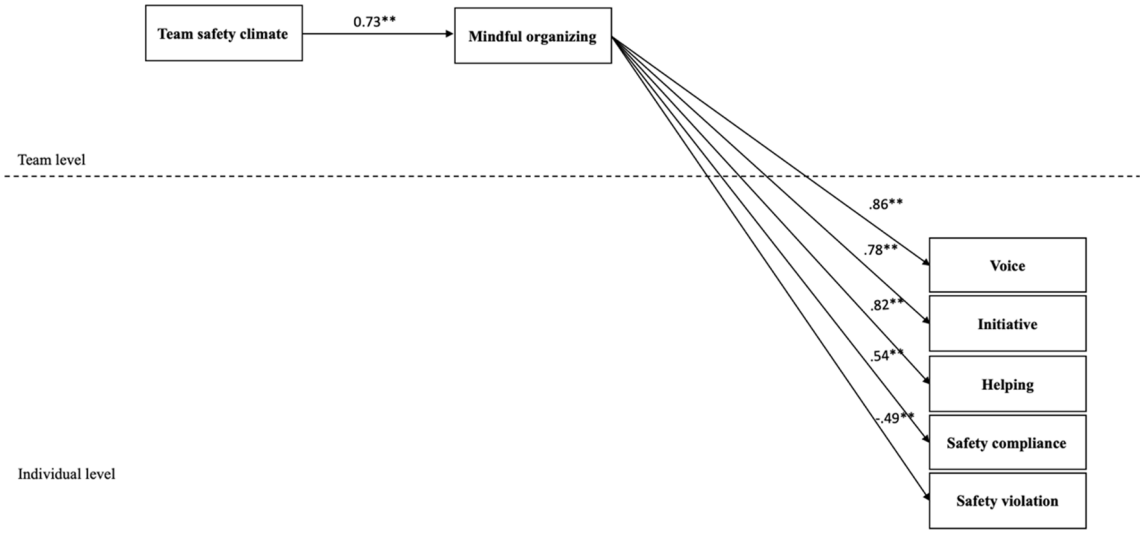

Fig. 2. Unstandardized parameter estimates for the hypothesized model. *$p < .05$, **$p < .001$.

(IE = -0.36, 95% MC CI = −0.53, −0.21).

To further examine full vs partial mediation, we tested an alternative model that included the direct paths from group safety climate to the five outcomes. The extra paths were not statistically significant (p > .05) and the partial mediation model did not improve model fit ($\chi^2 = 32.87$, $df = 10$, p > .001; RMSEA = 0.05; CFI = 0.99; TLI = 0.98; SRMR-within = 0.01; SRMR-between = 0.05).

5. Discussion

It is argued that engaging in mindful organising underpins the success of highly reliable organisations, however, as it stands the applicability and usefulness of mindful organising in safety management theory and practice is limited. As recently reported by Martínez-Córcoles and Vogus (2020) existing mindful organising studies have been criticised as being too narrow in focus, not socially embedded enough and one-dimensional in their level of analysis. The present research set out to expand our understanding of mindful organising's nomological network and in doing so, position mindful organising within other important contextual factors and individual dimensions of safety behaviours. Therefore, we wanted to answer the following research question: Does mindful organising mediate the relationship between group safety climate and individual safety behaviours? If so, which individual safety behaviours? The results shed light on the team climate conditions that may be important for creating safer workplaces in high risk environments.

The results obtained were in line with the hypothesized model in that mindful organising fully mediated the relationship between group safety climate and all five individual safety behaviours included in our analysis (voice, initiative, helping, safety compliance and safety violation), so that the relationship was significant and positive for safety compliance and the SCBs (initiative, voice, helping), and the relationship was negative and significant for safety violation. These results confirm hypotheses 1, 2 and 3.

Our results show that in a safety critical work environment such as a chemical plant, where work is somewhat interdependent, team safety climate leads to mindful organising which in turn leads to individuals engaging in extra-role and in-role safety behaviours. Operationally, this means that when a workgroup collectively perceives that safety is prioritized over other work demands (i.e. production pressure) by their supervisor and teammates, this shared perception of safety prioritization will lead to team members collectively cooperating to achieve higher levels of safety in their work by engaging in the processes of mindful organising. This suggests that establishing a high priority for safety on a team level is likely to create the right conditions needed for teams to engage in group forms of safety proactivity that focus their attention on anticipating when something will go wrong and quickly acting to contain this potential problem (Curcuruto & Griffin, 2016). Furthermore, engaging in mindful organising in a team where safety is perceived to be a major priority increases compliance to safety rules and procedures and leads to less violation of these rules and procedures. At the same time, engaging in group safety proactivity like mindful organising leads to individuals engaging in extra-role safety behaviours, such as helping others with safety related tasks and issues, initiating changes in ways of working to make them safer as well as voicing safety concerns and issues to others, all these behaviours are not required of employees in their contract or by law.

5.1. Theoretical and practical contributions

The present research attempts to position mindful organising within the broader, more mainstream safety literature. We attempt to connect

mindful organising literature with the literature on safety proactivity (Curcuruto & Griffin, 2016), and through doing so, we hope to contribute to narrowing the gap between these two separate research streams.

Previous studies speculate that there could be a reciprocal relationship between mindful organising and safety climate (Vogus, 2011). Our research findings show that when teams perceive that safety is prioritised by their supervisor and team members, mindful organising is stimulated and acts as a collective regulatory mechanism which translates the perceived group safety priorities to team members safety behaviours, sustaining not only compliance with prescribed safety standards but also team members engagement in extra-role behaviours (voice, initiative and helping). This shows us that a high safety climate could be an important driver in creating and sustaining mindful organising, which appears to need constant reinforcement as it is enacted and re-enacted by those on the front-line (Vogus & Suctliffe, 2012). Although the lack of a longitudinal research design did not allow us to include the hypothesis of the 'reverse effect' (i.e. the influence of mindful organising on safety climate), we believe that it is more likely that a strong sense for prioritising safety above other demands will be an important prerequisite of mindful organising rather than the other way around. We speculate that teams engaging in mindful organising could strengthen and solidify a high group safety climate, but mindful organising is unlikely to develop if there is not a strong safety climate to begin with. This is because the processes of mindful organising require ongoing attention, effort and commitment toward anticipating and containing errors, which requires continuously choosing the action to ensure safer practices and minimising error over any other action to pursue other goals (efficiency and speed). Without the perception that safety is prioritised, rewarded and expected above competing demands, we believe that mindful organising would be stifled. By showing the relationship between safety climate and mindful organising quantitatively, we offer some insight into the team level conditions needed to create and perhaps sustain mindful organising. This is especially relevant given that mindful organising has proven difficult to create and sustain in practice (Martinez-Corcoles & Vogus, 2020) and our limited understanding of antecedents of mindful organising have not focused on team climate conditions, which are likely to be powerful drivers of this team propensity to engage in safety proactivity together.

Our findings suggest that mindful organising (which we posit is a form of team safety proactivity and should be treated as such theoretically) is likely to encourage individual initiative to promote proactive anticipation of risks. For instance, voice safety concerns (Curcuruto et al., 2020), periodically revising safety systems and showing initiative in providing constructive suggestions for the improvement of the safety of work procedures and practices (Curcuruto et al., 2019b). When teams engage in self-initiated, future-focused and change orientated safety actions such as the processes of mindful organising (actively anticipating and containing errors and unexpected events together), our findings show that the members of these teams are more likely to take it upon themselves to do specific tasks and actions to ensure their safety and their colleagues' safety, even if these behaviours are not within their job description. We speculate that this link between group safety proactivity and individual safety proactivity could be explained by the subject-normative influence of safety climate (Zohar, 2008). That is, engaging in mindful organising on a team level may send the message to individuals that they should be proactive about safety in order to be accepted by the group, thus encouraging them to engage in these behaviours on their own.

The present findings also added to the growing empirical evidence that mindful organising is a shared, team construct as the aggregation indices for mindful organising showed adequate within team agreement and between team discrimination. The findings of the study also expand our current understanding about the interplay between group normative influences (safety climate), mindful organising, and extra role and in-role safety behaviours. We see that group safety climate and mindful organising are important for creating the context for increasing key safety behaviours. This insight broadens our understanding of how social norms and group behaviours influence individual safety proactivity and adherence to safety rules.

Practically, leaders in high-risk organisations face a complex and multifaceted challenge when it comes to managing safety, therefore leaders in this setting must balance their focus across individual, team and organisational levels (Curcuruto & Griffin, 2016); Griffin & Curcuruto, 2016). Our findings offer leaders and practitioners in safety–critical contexts with some insight into which factors are important to focus on when attempting to increase individual safety citizenship behaviours and adherence to safety rules and procedures (which have shown to directly result in better safety outcomes) (Christian et al., 2009; Curcuruto et al., 2015). It shows that on an organisational level, leaders must ensure that they put into practice policies and procedures that highlight the importance of vigilance and caution above competing demands for efficiency and high performance. Thereafter, they should measure and ensure that lower level leaders are enacting these policies and processes and that this priority of safety above other demands is felt and practised on a team level so that they may have strong group safety climates. Along with this, leaders could train workers and lower level leaders on the principles of mindful organising, knowing that the strong group safety climates will provide the context to enhance and sustain these team level processes. From this, safety citizenship and higher adherence to safety will be stimulated.

5.2. Limitations and implications for future research

Although this study offers valuable advancement of our current understanding of mindful organising and safety proactivity on various levels of analysis, the present study is not without its limitations. Firstly, the study was conducted in a sample of chemical plant workers, which is a unique organisational context and therefore the study findings should be applied to other high risk settings with caution. That being said, these chemical plants are high-risk settings that face many of the same challenges as other high risk settings (small errors leading to accidents and unexpected events leading to failures in the system), meaning the lessons in safety behaviour models may still be useful for other industries with similar challenges. Future research should build on this model in other high risk environments to show the replicability of the study and test the generalisability of the study findings. Another major drawback of the present study is that it relies on self-report measures of behaviour. This opens up the possibility of inaccurate responses due to social desirability bias as workers operating in safety–critical units may be less inclined to respond honestly to questions about safety as they know that they ought to be taking safety seriously. We did, however, ensure anonymity and confidentiality and allowed employees to withdraw their responses at any time. Future research should consider including additional sources or other more objective indicators of safety behaviour and compliance such as peer and supervisor ratings of safety citizenship and compliance or incident reports.

As previously mentioned, we did not look at the reciprocal relationship between mindful organising and safety climate over time, which could have added greater insight and depth into our understanding of these important organisational phenomena, especially given the claims of mindful organising being a transient, unstable characteristic. Future research should look at the reciprocal relationship between these two variables over time. Our study also did not look at the possible motivational drivers that could mediate the relationship between mindful organising and individual SCBs and safety compliance. There is much work on proactive-motivation and how it drives safety behaviour (e.g. Parker et al., 2010; Parker & Collins, 2010; Curcuruto et al., 2019b), future research should look into the impact of team mindful organising on various individual cognitive-motivation states. This would broaden our current understanding of how and why mindful organising may be so impactful for achieving higher reliability in safety critical

contexts. Another limitation of our study is that our measure of mindful organising is a nine item, one-dimensional scale that does not comprehensively measure the five processes of mindful organising, this limits our enquiry into which factors of mindful organising may more strongly affect various individual behaviours. However, the nine item measure does encompass all five processes of mindful organising and has been successfully validated in various contexts (e.g. Renecle et al., 2020; Vogus & Sutcliffe, 2007). Future research should consider validating a broader measure of mindful organising that allows for more granular measurement of mindful organising to more clearly see how the five dimensions may differently relate to specific safety behaviours enacted by the individuals.

6. Conclusions

Understanding safe systems from a human behaviour perspective is a major feat, not only because human beings are fallible and somewhat unpredictable, but because human behaviour is so complex and multifaceted that we cannot begin to measure every element at play. What we can do, is create models that synthesize and measure some of the major factors and conditions known in research on safer systems and see how these major factors relate to one another and try to understand why. That is what we tried to achieve in this study. The study findings offer a multifaceted, multileveled safety behaviour model that enhances our current understanding of mindful organising as a construct and the multilevel factors affecting safety proactivity. Although much work still needs to be done before mindful organising can be theoretically and practically relevant within safety management research and practice, this study offers an interesting insight into how mindful organising may lead to higher reliability and under which conditions.

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