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# Safety climate and mindful safety practices in the oil and gas industry

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ABSTRACT

*Introduction:* The existence of a positive association between safety climate and the safety behavior of sharp-end workers in high-risk organizations is supported by a considerable body of research. Previous research has primarily analyzed two components of safety behavior, namely safety compliance and safety participation. The present study extends previous research by looking into the relationship between safety climate and another component of safety behavior, namely mindful safety practices. Mindful safety practices are defined as the ability to be aware of critical factors in the environment and to act appropriately when dangers arise. *Method:* Regression analysis was used to examine whether mindful safety practices are, like compliance and participation, promoted by a positive safety climate, in a questionnaire-based study of 5712 sharp-end workers in the oil and gas industry. *Results:* The analysis revealed that a positive safety climate promotes mindful safety practices. *Conclusions:* The regression model accounted for roughly 31% of the variance in mindful safety practices. The most important safety climate factor was safety leadership. *Practical applications:* The findings clearly demonstrate that mindful safety practices are highly context-dependent, hence, manageable and susceptible to change. In order to improve safety climate in a direction which is favorable for mindful safety practices, the results demonstrate that it is important to give the fundamental features of safety climate high priority and in particular that of safety leadership.



## 1. Introduction

Over the last three decades the existence of a positive relationship between safety climate and the safety behavior of employees in high-risk organizations has been confirmed by a large number of studies (e.g., Agnew, Flin, & Mearns, 2013; Clarke, 2006; Clarke & Ward, 2006; Cooper & Phillips, 2004; Griffin & Neal, 2000; Guo, Yiu, & González, 2016; Sinclair, Martin, & Sears, 2010; Thompson, Hilton, & Witt, 1998). Research within the oil and gas industry is no exception from this (e.g. Dahl, Fenstad, & Kongsvik, 2014). In brief, this body of research demonstrates that employees who perceive that safety is valued and prioritized within their organization display more positive safety behavior than employees who perceive that their organization places less value on safety.

The well-established empirical relationship between safety climate and safety behavior has significant theoretical and practical implications. First, it contributes significantly to our understanding of the causal relationship between organizational, social and cultural factors on the one side and human safety behavior on the other. Second, it demonstrates that variation in safety behavior is causally related to factors that are in the hands of management. From a practical point of view this is encouraging, because it demonstrates that variation in safety behavior is not attributable solely to individual psychological variables or chance, but is in fact manageable and susceptible to influence.

Previous studies of the relationship between safety climate and safety behavior have primarily analyzed safety behavior in terms of safety compliance (adherence to rules and procedures) and safety participation (voluntary efforts to improve safety, such as promoting safety campaigns; Neal & Griffin, 2004). Both safety compliance and safety participation are important aspects of the human contribution to safety, and several studies have observed a negative causal relationship between these aspects of safety behavior and the frequency of accidents and injuries (e.g. Christian, Bradley, Wallace, & Burke, 2009; Goldenhar, Williams, & Swanson, 2003; Jiang, Yu, Li, & Li, 2010; Liu et al., 2015). However, research on high reliability organizations (HROs), such as nuclear power plants, naval aircraft carriers and offshore petroleum platforms, has led to emphasis on another type of behavior that is important to the safe operation of high-risk industries, namely mindful safety practices.

The term 'mindfulness' was first introduced to the HRO literature by Weick, Sutcliffe, and Obstfeld (1999), but they did not use it to describe an individual's mental state nor as an extension of the overarching term 'safety behavior.' Instead the term was applied to an organizational level characteristic (i.e., an organization's ability to notice and manage the unexpected and hence Weick et al. preferred the term 'collective mindfulness;' see also Weick & Sutcliffe, 2006, 2007).

In the aftermath of Weick et al.'s introduction of the term 'collective mindfulness' into the HRO literature, safety researchers have begun to

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recognize the importance of mindfulness to the individual's safety behavior repertoire (Aase, Skjerve, & Rosness, 2005; Hopkins, 2002; Reason, 2008). For example, Skjerve (2008, p. 1004) referred to individual mindfulness as 'mindful safety practices' and described them as practices where the 'employee must rely on his or her own ability to be aware of critical factors in the environment and to act appropriately when dangers arise.' Thus, mindful safety practices, which are based on knowledge-based reasoning (to use the terms of Rasmussen, 1983) were contrasted with compliance, which is based on rule-based reasoning. In other words, mindful safety practices are not based on following procedures, but on a 'subjective, real-time evaluation of the situation at hand' (Skjerve, 2008, p. 1004).

The objective of this study was to examine whether mindful safety practices, like safety compliance and safety participation, can be promoted by a positive safety climate. To do this we analyzed quantitative data on the behavior of sharp-end workers within the Norwegian oil and gas industry. Research on this topic may yield insight into the broader relationship between safety climate and employees' safety behavior. Such insight is believed to be important, not only within the oil and gas industry, but in high-risk industries in general where human behavior constitutes a vital factor in the safety performance of the organization.

## 2. Theoretical background

### 2.1. Mindfulness and mindful safety practices

The interest in the organizational dimension accelerated in safety science in the late 1980s, supplementing the earlier focus on technical safety and human factors (Hale & Hovden, 1998). The relevance of the organizational level became apparent when investigations into several major accidents (e.g. Chernobyl; Piper Alpha; Texas City) highlighted the role of management, communication and competence and noted that the interaction of such factors was pivotal to the tragic outcome. On a more general level, the interest in organizational factors in the safety field can be seen as a reflection of the increasing complexity in industry, which is related to technological developments, acquisitions and mergers and more integration and couplings of systems, which introduces new vulnerabilities (Rasmussen, 1997; Rosness et al., 2010). Major accidents have been attributed to increasingly complex environments and by deficiencies in the capabilities to adapt to complexity, in line with the classical argument about 'requisite variety' (Ashby, 1956). For example, the theory of 'normal accidents' (NAT) (Perrow, 1999) regards major accidents as more or less inevitable in socio-technological systems that are both tightly coupled (failures spread fast) and interactively complex (failures spread in unforeseeable ways), such as nuclear power plants, chemical plants, offshore petroleum installations etc.

Another strand of research, developed partly as a response to the fatalistic perspective of NAT, focuses on organizations that seem to have high operational reliability and very few accidents despite being tightly coupled and interactively complex. Identifying the processes underlying this reliability 'against the odds' has been an important research area. From the early 1990s, Weick and co-researchers have linked the reliable functioning of organizations to collective mental processes (Weick & Roberts, 1993), arguing that heedfulness arises when the actions of single actors are based on an understanding of how they are related to the actions of others and when actions are collectively aligned. Weick and Roberts (1993) argued that heedful interrelation of actions and mindful comprehension were important preconditions for the safe operation of complex systems such as aircraft carriers. They extended their framework by describing mindfulness in relation to reliability, defined as 'a rich awareness of discriminatory detail' (Weick & Sutcliffe, 2007, p. 32). It was argued that mindfulness was related to five cognitive processes (Weick et al., 1999): (a) Preoccupation with failure (i.e., a propensity to treat all failures as signals of potential larger, underlying problems); (b) Reluctance to simplify interpretations. HROs cultivate requisite variety and view simplification as increasing the probability of surprise; (c) Sensitivity to operations (i.e., creating awareness about what is really going on); this depends on integration of information from different sources to construct the 'big picture' of ongoing operations, which enables continuous adjustments to be made and can thus prevent errors accumulating in complex systems; (d) Commitment to resilience (i.e., the capacity to handle unanticipated dangers successfully and 'bounce back' to a normal state of operations). Resilience implies the ability to cope with surprises and improvise when needed, as well as being prepared for and expecting that something unforeseen might occur. (e) Deference to expertise (i.e., accepting that potentially dangerous situations should be handled by the people most competent to do so, independent of their place in the organizational hierarchy). Deference to expertise thus entails a willingness to redistribute power when necessary.

According to Skjerve (2008), collective mindfulness can lead to a certain kind of behavior. *Mindful safety practices* are safety-promoting work practices that may prevent or interrupt unwanted and unanticipated event sequences (Aase et al., 2005; Skjerve, 2008), for example by warning colleagues if they are in danger or putting work operations on hold if there is uncertainty about safety. Barton and Sutcliffe (2009) underscore that such micro-level social processes are at the core of organizational safety. In their study, voicing concern and creating space for re-evaluation of a chosen course of action was central for maintaining safety. In some instances, mindful safety practices may be incorporated into formal process rules, or made a mandatory part of operations (Hale & Borys, 2013), for example, evaluation of risk before commencing tasks. However, mindful safety practice includes behaviors and traits that cannot be formalized, such as safety awareness and use of judgment and the ability to respond appropriately to dangerous or potentially dangerous situations. Use of mindful safety practices often implies redundancy, as it involves a control function and different, and sometimes an outside perspective on unfolding events (Skjerve, 2008).

### 2.2. Safety climate and mindful safety practices

The safety climate in a work community involves the shared perceptions about safety policies, procedures and practices (Zohar, 2003). The safety climate construct is rooted in the psychometric tradition and questionnaire surveys are often used to provide indications of the culture for safety at a given point in time. There is no consensus on the factorial structure of safety climate, but a review of 18 factorial models of safety climate (Flin, Mearns, O'Connor, & Bryden, 2000) described four underlying themes or factors that are often included in assessments: (a) safety system, (b) work pressure, (c) safety competence and (d) leadership or supervision. The review also identified a fifth factor, risk, but risk is commonly defined and analyzed in terms of unsafe or safe behavior and is, in such instances, not considered an aspect of safety climate (Kvalheim & Dahl, 2016).

Safety climate has been linked to different safety related outcomes, safety performance, and also different subjective attitudes and other work-related issues (Nahrgang, Morgeson, & Hofman, 2011). This includes concepts such as job satisfaction and work engagement and also turnover rates (Huang et al., 2016). A poor safety climate has been considered a stressor that may be associated with physical symptoms and musculoskeletal complaints (Golubovich, Chang, & Eatough, 2014).

The causal link between safety climate and safety behavior has frequently been explored, and meta-analyses of the relationship show that variation in safety behavior can be explained by variation in safety climate. In a review of 32 studies, Clarke (2006) found that safety climate was correlated with both safety compliance and safety participation and a later review of 90 studies (Christian et al., 2009) reported similar associations.



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