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Safety climate: Leading or lagging indicator of safety outcomes?

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ABSTRACT

This paper theorizes how and why safety climate can be conceived as both a leading and a lagging indicator of safety events (i.e., accidents, injuries). When safety climate is conceived as a leading indicator, a prospective design is utilized and safety climate data are correlated with accidents/injuries that occur in the future. When safety climate is conceived as a lagging indicator, retrospective designs are used in which safety climate data are correlated with prior accidents/injuries. We examine the research literature to reveal that safety climate has been investigated as both a leading and a lagging indicator, but it is usually only examined as one or the other within a given study and has been examined as a lagging indicator most frequently. Consistent with our theorizing, prospective designs yield stronger relationships than retrospective designs, suggesting that safety climate is a better leading indicator than lagging indicator; however, it is clearly both. Implications for safety climate research and study design are discussed.

The economic impact of workplace accidents on the U.S. is approximately $142.2 billion each year, and production loss due to injuries is equivalent to 80 million days lost each year (National Safety Council, 2009). In 2007 alone, more than four million nonfatal injuries and 5600 fatalities from workplace accidents were recorded (Bureau of Labor Statistics, 2009). In an effort to identify leading and lagging indicators of workplace accidents and injuries, safety researchers have turned to the organizational science research literature for constructs that capture various aspects of the workplace such as organizational culture and climate.

Organizational culture is defined as the underlying values and assumptions about the organization that organizational members hold (Ostroff, Kinicki, & Tamkins, 2003), whereas organizational climate is the overall meaning organizational members assign to a particular aspect of the workplace. Organizational culture is considered an antecedent of organizational climate (Ostroff et al., 2003). That is, the values, assumptions, and traditions espoused and perpetuated by organizational members (i.e., organizational culture) lead to the adoption of particular organizational policies, procedures, and practices. Consequently, collective employee perceptions of enacted policies and procedures form various types of organizational climates. For example, employee perceptions of the policies, procedures, and practices concerning safety is called *safety climate* (Zohar, 2003).

To further elaborate on the meaning of safety climate, policies describe organizational goals and means for goal attainment, whereas procedures provide tactical guidelines for actions related to these goals and means. Both of these are created and maintained at the organizational level. Practices are the implementation of policies and procedures by managers within each work group; thus, practices can vary across workgroups. It is these practices that seem especially important because not only do they guide everyday behavior of employees as supervisors structure the day-to-day work, but also because practices highlight any disconnect between what the organization claims is important (i.e., policies and procedures) and what organizational agents (i.e., supervisors) model as important. These disconnects between the organization's claims about appropriate behavior (i.e., policies and procedures) and what employees are managed to do (i.e., practices) can send powerful messages about what appropriate activities really are. Safety climate can be understood by examining employees' perceptions of the types of safety behaviors that are rewarded, supported, and expected (O'Reilly, 1989; Reichers & Schneider, 1990).

Operationally, safety climate is assessed via employee surveys because safety climate is, by definition, employee perceptions. No single safety climate measure has been identified as most valid, and many have been used throughout the literature (for reviews, see Flin, Mearns, O'Connor, & Bryden, 2000; Guldenmund, 2000; and Mueller, DaSilva, Townsend, & Tetrick, 1999). Sample items used to

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assess safety climate include "My supervisor approaches workers during work to discuss safety issues" (Zohar, 2000), "My commander strictly follows regular safety procedures even during a difficult week out in the field" (Zohar & Luria, 2004), and "Safety is given a high priority by management" (Neal & Griffin, 2006). Most safety climate researchers propose safety climate as a multidimensional construct, although the number and content of these dimensions remain debated (Brown & Holmes, 1986; Dedobbeleer & Beland, 1991; Zohar, 1980).

Two research designs have primarily been used to study the relationship between safety climate and safety outcomes: (1) prospective and (2) retrospective.[1] In prospective designs, safety outcomes are measured for a period of time *after* safety climate is measured. In this design, safety climate is a leading indicator of safety outcomes. In retrospective designs, safety-related events are recorded for a period of time *before* safety climate is measured. In this design, safety climate is a lagging indicator of safety outcomes. As we will describe below, both of these perspectives are useful and indicate important information about safety climate. The purpose of this paper is to review the literature regarding the relationship between safety climate and safety-related events (i.e., accidents, injuries) in order to determine if there is more theoretical and empirical support for safety climate as a leading or a lagging indicator.

1. Safety climate as a leading indicator

When safety climate is a leading indicator of safety outcomes, a prior measure of safety climate is related to a later measure of safety outcomes. In other words, safety climate is conceptualized as the antecedent or cause and safety outcomes are conceptualized as the consequences or effects. This does not necessarily mean that safety climate is conceptualized as having a *direct* effect on accidents/injuries in the workplace. Instead, safety climate may be a more distal antecedent of accidents/injuries, having a direct effect on safety-related behaviors which in turn have a direct effect on accidents/injuries (Zohar, 2003). Historically, organizational climate is conceived to be a critical determinant of individual behavior in organizations (Campbell, Dunnette, Lawler, & Weick, 1970; James & Jones, 1974, 1976; Kopelman, Brief, & Guzzo, 1990; O'Reilly, 1989). Because climate reflects the behaviors that are rewarded, supported, and expected (O'Reilly, 1989; Reichers & Schneider, 1990), and individual behavior tends to align with rewards (both instrumental, such as pay, and interpersonal, such as respect or belongingness; Deci & Ryan, 1985), then individuals should act in ways that are consistent with the climate.

Thus, building on more general models of the influence of organizational climate on behavior, the primary theoretical model underlying leading relationships of safety climate on safety outcomes is one in which safety climate affects employee behavior which in turn affects accidents and injuries (Neal, Griffin, & Hart, 2000; Zohar, 2003; see Fig. 1). For instance, Griffin and Neal (2000) described a framework for linking safety climate to various proximal safety outcomes including safety motivation and safety knowledge, which were subsequently related to safety behavior. Likewise, Zohar (2003) proposed that safety climate perceptions influence behavior-outcome expectancies, expectancies influence prevalence of safety behavior, and behavioral safety influences company safety records.

[1] A third study design, cross-sectional, involves the collection of data for all variables at the same time. When studying safety outcomes, this design would most likely involve employees *self*-reporting *past* behavior and accidents, because organizational records are not as cross-sectional as a survey is and employees can only record what has occurred in the past.

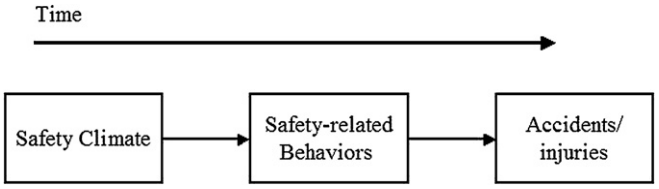

Fig. 1. Safety climate as a leading indicator of accidents/injuries (Prospective design).

Other mechanisms of the safety climate-safety outcomes relationship can be seen as additional factors that influence safety-related behaviors. These include transformational leadership (Barling, Loughlin, & Kelloway, 2002), work context (Hofmann & Stetzer, 1996), production pressures (Brown, Willis, & Prussia, 2000; Prussia, Brown, & Willis, 2003), and employee safety control (Huang, Ho, Smith, & Chen, 2006). The overriding message from these disparate views is that climate is not a "cause" such that a poor climate directly makes accidents/injuries happen, but that climate is a contributing factor (one of many causes); it is the context in which all safety-related activity occurs in a workplace.

It is important to note that a number of factors make it difficult to demonstrate safety climate as a leading indicator. First, in the prospective research design, after the safety climate survey is conducted, the researchers must wait several months for safety records—whether it is reports of accidents and injuries or lack thereof—to accumulate. In addition to the need for time to pass, other events can intervene (e.g., corporate mergers, changes in leadership) that either attenuate the eventual relationship or lead the organization to abandon the research. Additionally, there is an ethical dilemma: if a researcher becomes aware that the safety climate is low, an intervention designed to enhance this climate and ideally prevent accidents/injuries would be warranted. If an intervention is implemented, then the prospective relationship between safety climate and accidents/injuries becomes contaminated by the intervention. Finally, survey administration and communication of survey results could be interventions in and of themselves. Completing a safety climate survey could communicate something about safety policies, procedures, and practices to employees; providing feedback (or not) about the survey to employees could also send messages about the safety climate.

2. Safety climate as a lagging indicator

When safety climate is a lagging indicator of safety outcomes, prior measures of safety outcomes are related to more recent measures of safety climate (see Fig. 2). In other words, safety outcomes are conceptualized as the antecedent or cause and safety climate is conceptualized as the consequence or the effect. Again, this does not necessarily mean that safety-related events are the *direct* cause of safety climate. A number of researchers have compared employees who experienced an accident in the workplace with those who did not experience an accident within the

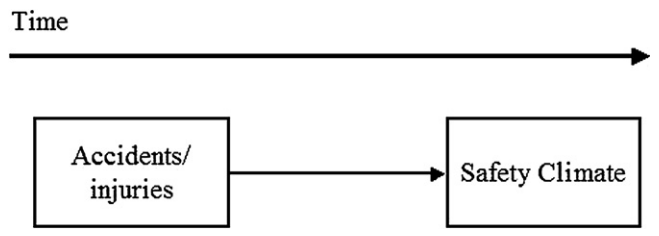

Fig. 2. Safety climate as a lagging indicator of accidents/injuries (Retrospective design).

same time frame (e.g., Mearns, Flin, Gordon, & Fleming, 1998). For example, Brown and Holmes (1986) found that the group of workers who had experienced an accident reported significantly lower levels of management concern and management action (lower levels of safety climate) than employees who had not experienced an accident. Such studies provide indirect support for safety climate as a lagging indicator of accidents, as they show differences in safety climate between groups of individuals based on accident history, but they do not directly relate safety climate assessments to accident and injury records.

Past behavior and outcomes, both for the individual and for the organization, contribute to current perceptions of safety (cf. Huang et al., 2006). Considering that climate reflects what is rewarded, supported, and expected in the organization (Reichers & Schneider, 1990), the prior pattern of rewards and punishments regarding safety-related behavior should influence current perceptions of climate. Additionally, employees are likely to consider their own and the organization's relevant safety history when describing safety climate. This is through a process of sensemaking, in which employees attempt to align information from multiple sources (Ostroff et al., 2003; Weick, 1995). When very few accidents and injuries occur, employees are likely to perceive that the individuals directly involved in the events were the direct, proximal contributors to the cause of these events either through their own bad behavior or through sheer bad luck. However, as more "accidents" accumulate over time, individuals will perceive that there is a single underlying cause for these events that occur repeatedly in this organization, and that the organization is this cause, because it is the common denominator.

Beyond past accidents and injuries, how the organization responded to these events also influences safety climate. The organization's reactions to accidents would potentially be even more related to employees' perceptions of safety than the accident itself. There is a wide range of responses an organization can make following an incident. On the negative side, the organization could ignore the accident completely, make external attributions (e.g., blame the worker or attribute the incident to bad luck), or debrief only the individuals directly involved rather than all the employees in the organization. More positive responses might include investigating to determine root cause(s), fixing or altering work environment characteristics, revising policies and procedures, providing needed training, and educating all employees by treating the incident as a lesson to learn from and to avoid in the future.

The logistical advantages of a retrospective design compared to a prospective design are not trivial. Most organizations maintain records of workplace accidents, so it is relatively easy to conduct a retrospective study as the researcher does not have to wait a certain period of time before gathering outcome data. Additionally, even when a prospective study is planned, because organizational safety records already exist, it should be relatively easy to also incorporate retrospective information into a prospective study design.

On the other hand, retrospective designs are not without their limitations. For example, retrospective self-reports are subject to memory errors, including telescoping effects (i.e., a bias toward remembering events as recent based on their vividness), inability to recall events that on the surface seem to have little contribution to later events, and difficulty in estimating where one stood on a continuous process at any point in time that is not tied to a specific event (Janson, 1996). As an example, employees could spend years perceiving that the organization's policies, procedures, and practices all advocate safety, yet a single, recent accident could lead the employees to rationalize that the safety climate is not very good and that they should attenuate their ratings of safety climate perception items accordingly. This is not to suggest that accidents should not affect ratings, but rather that memory biases, limited knowledge about events, and other cognitive distortions could taint the lagging relationship between safety-related events and safety climate. Additionally, it is not only the incident itself but also organizational responses to the incident (which are not directly included in climate-accident relationships) that safety climate reflects. The organizational response to the incident provides employees with considerable information about resources and concern that the organization has for the specific incident and employee safety more broadly; these can be seen as interventions between the accidents/injuries and safety climate in the retrospective design.

3. Safety climate research

After a thorough review of the psychology and safety literatures, we compiled all the published studies we could locate that examined the safety climate-accident/injury relationship. As shown in Table 1, retrospective studies greatly outnumber prospective studies. This is likely due to the ease of conducting a retrospective study in comparison to a prospective study. It is also apparent that safety climate is usually studied as either a leading or a lagging indicator within a given study, rather than both. To our knowledge, only Neal and Griffin (2006) gathered safety event data both prior to and after a safety climate survey. They examined relationships between group safety climate and accidents among hospital workers over a five-year period and included both retrospective and prospective accident data. They found near zero relationships between safety climate and accidents both retrospectively and prospectively. However, this may be attributable to the fact that their aggregated final sample consisted of only 33 groups with a total of 135 individuals, which did not provide them with enough power to find the small to moderate effect sizes that have typically

Table 1
Studies examining safety climate and accidents/injuries.

Study #	Authors (date)	Design
1	Brown and Holmes (1986)	Retrospective
2	Clarke (2006b)	Retrospective
3	Cree and Kelloway (1997)	Retrospective
4	Donald and Cantor (1994)	Retrospective
5	Evans, Michael, Wiedenbeck, and Ray (2004)	Retrospective
6	Garavan and O'Brien (2001)	Retrospective
7	Gillen, Baltz, Gassel, Kirsch, and Vaccaro (2002)	Retrospective
8	Goldenhar, Williams, and Swanson (2003)	Retrospective
9	Hayes, Peranda, and Trask (1998)	Retrospective
10	Hofmann and Mark (2006)	*Prospective*
11	Hofmann and Stetzer (1996)	Retrospective
12	Huang et al. (2006)	Retrospective
13	Johnson (2007)	*Prospective*
14	Kelloway, Mullen, and Francis (2006)	Retrospective
15	Lee (1998)	Retrospective
16	Lee and Harrison (2000)	Retrospective
17	Mearns et al. (1998)	Retrospective
18	Mearns, Whitaker, and Flin (2003)	Retrospective
19	Michael, Evans, Jansen, and Haight (2005)	Retrospective
20	Morrow and Crum (2004)	Retrospective
21	Neal and Griffin (2006)	Retrospective
22	Oliver, Cheyne, Tomas, and Cox (2002)	Retrospective
23	Probst (2004)	Retrospective
24	Probst and Extrada (2008)	Retrospective
25	Siu, Phillips, and Leung (2004)	Retrospective
26	Smith, Huang, Ho, and Chen (2006)	Retrospective
27	Wallace, Popp, and Mondore (2006)	*Prospective*
28	Willamson, Feyer, Cairns, and Biancotti (1997)	Retrospective
29	Zacharatos, Barling, and Iverson (2005)	Retrospective
30	Zohar (2000)	*Prospective*
31	Zohar (2002)	*Prospective*
32	Zohar and Luria (2004)	*Prospective*

been found between safety climate and accidents (Probst, 2004; Zohar & Luria, 2004).

Clarke (2006a) recently conducted a meta-analysis[2] on the relationships between safety climate and two organizational outcomes: workplace accidents/injuries and safety compliance/participation (i.e., doing safety-related behaviors that are required by the job and being engaged in workplace safety beyond job requirements, respectively). After performing meta-analytic corrections for sampling and measurement error, she concluded that the true relationship between safety climate and accidents/injuries is −.22. Clarke also revealed study design as an important moderator of this relationship, such that prospective designs ($\rho = -.35$, $k = 6$) yielded stronger relationships than retrospective designs ($\rho = -.22$; $k = 25$). Although the prospective studies tended to yield stronger relationships between safety climate and safety outcomes, it is important to note that this is based on a small number of studies. Thus more research is still needed to substantiate the safety climate-safety outcome relationship prospectively.

Clarke's (2006a) results are consistent with our arguments regarding safety climate as a leading and a lagging indicator of workplace accidents and injuries. As we suggested above, Clarke demonstrated that safety climate is both a leading and a lagging indicator of accidents/injuries. Also, consistent with our theoretical arguments about how accidents/injuries and safety climate are related retrospectively and prospectively, the meta-analytic relationship is stronger prospectively. Practically, this is useful because a prospective relationship between safety climate and accidents/injuries helps in the prediction of future unsafe events and the possibility of warding them off.

4. Conclusions

In this paper, we have conceptualized safety climate as both a leading and a lagging indicator of safety outcomes. We have also briefly reviewed the literature and shown that there is empirical support for both relationships. Although there is more practical interest in safety climate as a leading indicator than as a lagging indicator, both are important to our understanding of the relationship between safety climate and accidents/injuries. This is because employees' perceptions of safety climate should be based, in part, on the previous accidents/injuries in the organization. Additionally, safety climate sends messages to workers about the appropriate and expected behaviors in the workplace; thus, safety climate should also influence workplace accidents/injuries.

In addition to the practical interest in the leading effect of safety climate, the prospective safety climate-safety outcomes relationship should be less contaminated than the retrospective safety events-safety climate relationship. The events that intervene between retrospective behaviors/outcomes and a measurement of safety climate, such as organizational responses, also influence the later measures of safety climate. In contrast, in prospective designs, most events that intervene between the current safety climate and future measures of behavior/outcomes are not contaminating the climate-behavior relationship. Instead, intervening events are factors that rely in part on the current safety climate and contribute in part to future behavior/outcomes. This is why we believe Clarke (2006a) found studies using prospective designs yielded stronger relationships than retrospective designs.

This is not to suggest that retrospective designs are useless. To the contrary, it is important that safety climate be a lagging indicator of accidents and injuries. If safety climate were not related to retrospective accidents/injuries, it would suggest that employees are not made aware of safety-related events or that they are not paying attention when they are made aware. Both of these are dangerous situations for organizations. If the organization is not communicating the risks of the job to its workers and not using previous unsafe incidents as learning opportunities, or if the employees are not attending to this information, then employees will not be able to develop skills to act safely, recognize and report dangers, and correct problems as they arise. It is essential that safety climate is a lagging indicator of accidents and injuries, as this indicates that employees are invested in their own safety as well as the safety of the organization as a whole.

Prospective designs have received less attention in the literature, and this is where research is especially needed in the future. Although safety climate researchers commonly posit that safety climate affects the future occurrence of accidents/injuries, relatively few studies have examined this relationship prospectively. Thus, it is important for future safety climate research to substantiate safety climate's hypothesized effect on accidents/injuries by using prospective designs. Additionally, the prospective studies that been conducted have only shown that there is a relationship in the aggregate; they are unable to indicate a particular time or place where unsafe events will occur. Although it is unlikely, given the myriad causes of any single event, that safety climate assessments could pinpoint a precise time and/or place where accidents/injuries occur, safety climate assessments might be able to narrow the window. It is important to not develop tunnel vision around safety climate assessments, because unsafe events are multiply determined. But safety climate assessments might be able to highlight where the greatest dangers lie in an organization, allowing businesses to strategically target their limited resources to produce maximal safety for the organization.

In sum, researchers should make an effort to examine both retrospective and prospective accident/injury data when studying safety climate. The prospective relationship has received less attention, yet from a practical standpoint it is more important. However, the retrospective relationship is also essential, as it indicates the continuity of understanding that employees have regarding safety in the workplace. Safety climate is both a leading and a lagging indicator of safety-related events, which should continue to be recognized in the safety literature.

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