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Understanding Safety Culture and Safety Climate in Construction: Existing Evidence and a Path Forward

Literature Review Summary for
Safety Culture/Climate Workshop
June 11-12, 2013
Washington, DC

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Prepared by

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Man is an animal suspended in webs of significance he himself has spun; I take culture to be those webs. (Geertz 1973)

Understanding Safety Culture and Safety Climate in Construction: Existing Evidence and a Path Forward

Definitions and Historical Framework

Safety culture and safety climate are constructs that evolved in the 1980s from the broader concepts of organizational culture and organizational climate. Organizational culture and climate have different meanings including when the focus is more specifically on safety. Unfortunately, neither the research literature nor the practical application of these concepts has offered clear or consistent distinctions, which has resulted in considerable definitional confusion.

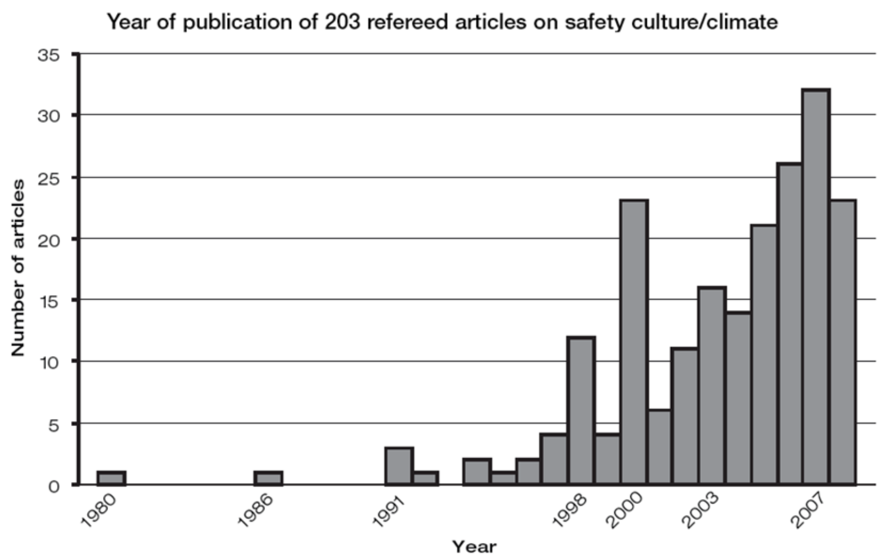
For this review, we have chosen just a few definitions that we believe capture the essence of safety culture and safety climate and help address the cause and effect debate. Some authors (Guldenmund 2000; Schein, 1992) present a model of culture and climate as a layered phenomenon where the core of culture (the inner layers) comprise constructs such as basic values, assumptions, principles, or convictions and the more visible expressions of culture like rituals, artifacts, and heroes, are located in the outer layers   Another way authors attempt to clarify these concepts is by analogy with the study of personality as in: *culture* is analogous to the relatively fixed *personality trait*, while *climate* corresponds to the more variable *mood state* (Cox & Flin 1998), or through other familiar terminology:

> …climate is commonly associated with terms such as “superficial” … “snapshot,” “quantitative,” and “state,” whereas culture with “deep,” “stable,” “qualitative,” and “trait.” (Seo et al. 2004).

Safety Culture

The origin of the safety culture concept is easily traced. The International Atomic Energy Agency (IAEA) and OECD Nuclear Agency identified “poor safety culture” as a prominent factor in the 1986 Chernobyl nuclear disaster in the former Soviet Union (Cox & Flin, 1998). Soon thereafter the safety culture theme was also applied to major disasters in transportation (Kings Cross underground fire- London 1987; Clapham Junction rail crash- London 1988), and offshore oil production (Piper Alpha platform explosion- North Sea 1988), among others (Cox & Flin 1998). A UK nuclear safety panel developed a definition of safety culture that became the “market standard” in that country:

> The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation’s health and safety management (HSC 1993, 23).



(Glendon 2008)

The above figure illustrates the degree to which research on safety culture and safety climate took off in the 1990s and beyond. A great deal of the early research took place in the so-called high reliability industries of nuclear power, offshore oil extraction, and commercial aviation, and this is where many concepts of safety culture were developed. The high reliability organization (HRO) designation has subsequently penetrated health care and other sectors, but construction, despite its many risks, is not generally considered an HRO industry, except when construction services intersect with an HRO sector such as in nuclear reactor and petrochemical turnarounds and semiconductor fab construction and maintenance. This intersection has likely increased, particularly during the recent health care construction boom, and will probably continue to do so, but only for certain segments of the construction market.

Safety Climate

Zohar published the first safety climate study in 1980, where he developed and tested a model of safety climate using a 40-item questionnaire, which he administered to workers in 20 Israeli factories across a variety of industries. He defined safety climate as "a summary of molar perceptions that employees share about their work environment" (Zohar 1980). This study established what has become the common way to assess safety climate: a questionnaire whose items (questions) measure a set of factors or constructs that reveal shared perceptions of the organization's safety climate. Zohar's original set of factors were:

- Importance of safety training
- Effects of required work pace on safety
- Status of safety committee
- Status of safety officer
- Effects of safe conduct on promotion
- Level of risk at work place
- Management attitudes toward safety
- Effect of safe conduct on social status (Zohar 1980).

Many subsequent studies began from this list, but methodological and population differences have been a barrier to identifying a consistent core set of factors and definitions (Flin et al 2000). That said, Seo and colleagues (2004) concluded that the set of critical factors in subsequent literature had not significantly diverged from Zohar's original set, finding that the themes clustered into five core constructs of safety climate: *management commitment to safety, supervisory safety support, coworker (safety) support, employee (safety) participation*, and *competence level*.

More on Measuring Safety Culture and Safety Climate

Disciplinary Approaches

Organizational and occupational psychologists have sought to uncover the structure of organizational climate and culture by developing questionnaires designed to measure and characterize it. The questionnaire is administered to employees of an organization and quantitative results are psychometrically analyzed to reveal dimensions of the organization's climate or culture. (Psychometrics is the study of the theory and techniques of psychological measurement).

The ethnographic method associated with anthropology is the qualitative counterpart to the psychological approach. It typically uses time- and resource-intensive interview and observational methods to uncover a group's strongly held, and perhaps not so apparent, core values to provide a better understanding of its culture. It is important to note that the term 'organizational culture' may give a false impression of a single integrated culture, while many organizations may be characterized by multiple cultures or subcultures. Referring to a single organizational culture in construction may be particularly misleading since workers may be influenced more by acculturation into their trade, particularly through apprenticeship training, than by the organization for whom they work (Gherardi & Nicolini 2002). Furthermore, construction is also conducted on a project-by-project basis whereby numerous organizations come together for a period from weeks to years, bringing with them a variety of company, trade, and sometimes national or ethnic cultures and subcultures.

Collecting and analyzing data via questionnaires is much less expensive and less time-consuming than conducting in-depth interviews and observations. This may partly explain why, practically speaking, safety climate questionnaires have become the accepted method for measuring safety climate in a company or on a site as well as a proxy for an organization's safety culture. This should not obscure the fact that organizational and safety culture and climate remain distinct concepts,

Value of Safety Culture and Safety Climate Measurement

A major appeal of the safety culture and climate constructs is their potential to act as *leading indicators* for safety outcomes like injuries and incidents. Shannon et al. (1996, 1997), and Hunt et al. (1993) among others, identified organizational and management practices (leading indicators) that correlated with lower rates of workers' compensation claims or improved disability management (lagging indicators). Some of the scales identified in these studies, for example "active safety leadership" and "people oriented culture," (Amick 2012) correspond quite closely with common safety climate factors found in many climate instruments.

As safety culture and climate research expanded several key questions arose:

1. What is the full scope of safety culture and safety climate and how do these concepts overlap, interact, or integrate with formal safety management systems?
2. What are the most effective measurement tools for each of these elements of organizational safety?
3. What are the levers for change and improvement of safety culture and climate?

Parker et al. (2006) conducted a qualitative research study with a purposive sample of 26 oil company executives with HSE expertise. She provided them with a modified safety culture typology (based on Westrum's framework (2004) with additional categories from Reason (1997)) She asked them to populate a rubric of 18 aspects of organizational culture, 11 of which were considered tangible, including audits, incident reporting, and training. The remaining seven were characterized as abstract and included who causes accidents in the eyes of management, balance between HSE and profits, and how do safety meetings feel (Parker et al. 2006). Their proposed expanded safety culture typology with brief descriptions of each are:

- Pathological; Who cares about safety as long as we are not caught?
- Reactive; Safety is important: we do a lot every time we have an accident.
- Calculative; We have systems in place to manage all hazards.
- Proactive; We try to anticipate safety problems before.
- Generative; HSE is how we do business round here. (Parker et al. 2006)

The managers found the matrix to be a useful adjunct to their companies' HSE self-assessments. A companion study tested a sample of seven of the aspects in the form of a typical safety climate survey administered to employees with items generated as statements from the matrix. The validity of the constructs was largely supported, though some more so than others (Lawrie et al. 2006).

Several recent studies have examined the predictive value of safety climate metrics for safety outcomes. Nahrgang et al. (2010) and Christian et al. (2009) conducted meta-analyses to test hypothesized pathways between safety climate and related constructs and safety behaviors, injuries, and incidents. Nahrgang found that risks and hazards were the job demands most predictive of accidents, injuries, and adverse events (especially in construction), while a supportive environment, including safety climate, was the strongest inverse predictor of adverse safety outcomes. Christian et al. (2009) found that group and organizational safety climate were significantly correlated with safety performance (safety behaviors) and safety outcomes. Many of the studies included in both meta-analyses relied on self-reported outcome data, while some used observational or administrative data.

Most safety climate studies are cross-sectional so that causal relationships cannot be assessed. However, a few longitudinal studies have shown significant or near-significant correlations between safety climate measures and subsequent safety behavior and injury severity measures (Johnson 2007). Recently, however Bergen et al. (2013) examined the leading and lagging relationships between safety climate and four types of safety incidents, suggesting that safety climate has a varying "shelf life" depending on the type of incidents being considered. Furthermore, they noted that the relationships were bi-directional. That is, safety climate in some cases predicted incidents, while in other cases incidents predicted safety climate.

Behavior Based Safety and Safety Culture

The ongoing quest to define and measure safety culture and climate has inevitably become intertwined with the hundred-year-old debate about the management's responsibility to create safe conditions on the one hand and workers to behave properly on the other to reduce accidents. While more sophisticated and multi-factorial models of incident causation have been developed in recent decades, (the "New View of human error" in Dekker's (2006) words), the "Old View" remains strong in many occupational safety and health circles. The "old view" is best represented by H.W. Heinrich's two "theories": 1) The 88-10-2 ratio of accident causation, i.e. 88% unsafe acts of persons, 10 percent unsafe mechanical or physical conditions, 2 percent unpreventable; and 2) the pyramid which holds that for every one major injury 29 minor injuries and 300 no-injury accidents would have occurred. Manuele (2011) details the fallacies and misuse of Heinrich's data, but the point is that many of these ideas still have great currency in the world of occupational safety and health practice.

Given this, it is not surprising then that critics of the burgeoning attention to safety culture, particularly in the context of high risk/high reliability industries, warn that

> Although invocation of safety culture seems to recognize and acknowledge systemic processes and effects, it is often conceptualized to be measurable and malleable in terms of the attitudes and behaviors of individual actors, often the lowest-level actors, with least authority, in the organizational hierarchy. (Silbey 2009, 343)

The risk of conceptualizing safety culture/climate this way is most clearly illustrated by the investigation of the catastrophic explosion at the BP Texas City refinery in 2005. BP's reliance on individual injuries, i.e. recordable injury rate, as an indicator that process safety was being adequately managed and that a healthy safety culture was maintained proved to be deadly (CSB 2007).

This is not to suggest that behavior is off limits when defining or studying safety culture. It is essential to understand human behavior and human error for preventing adverse safety events and organizational accidents (Dekker 2006, Reason 1997). Indeed, behavior is included in most models that describe accident causation and workplace safety, including those encompassing safety culture. Cooper (2000) proposed a model called "reciprocal determinism" with the three primary variables of person (internal psychological), situation, and behavior interacting in dynamic ways. The balance of how these three pillars interact varies depending on the situation. Choudhry et al. (2007) applied Cooper's model to construction by including three measurement techniques: safety audits for the environment/situation, perceptual audit of safety climate for the person, and behavioral sampling for behavior.

The difficulty arises when certain elements or causal factors are overemphasized in these models without having credible evidence for doing so. Examples of this are unfortunately common in the safety culture literature (see for example Choudhry et al. 2007b). The oft-cited UK Keil Report acknowledges four categories of critical health and safety behaviors- frontline behaviors, risk control behaviors, management actions, and leadership and direction (Fleming & Lardner 2002). However, it is only the first that is generally observed in behavior based safety (BBS) programs in part because measuring the latter three categories is more difficult. This is reflected in the fact that the majority of safety culture/climate related intervention studies are directed toward changing frontline and line supervisory behavior, typically under the heading of leadership training or coaching (Barling et al. 2002, Zohar 2002). While these may be valuable for improving culture, climate, and performance, it is important to recognize that this emphasis may be prompted more by convenience or political feasibility rather than by evidence of where change is truly needed (i.e. organizations are willing to expose their frontline workers and supervisors to safety culture interventions but are less likely to agree to do this at higher management levels).

DeJoy (2005) sees a complementarity in behavioral and cultural approaches, conceiving of behavior based safety as a bottom-up approach and culture change as top down (i.e. the overemphasis on immediate causes and worker actions in behavioral programs is balanced by an organizational and systemic approach by culture change advocates.). Also, he states that the more qualitative and sometime vague measures of safety culture are balanced by quantitative measurement of very specific behaviors in behavioral programs, concluding:

> … the behavior-based approach to safety could be expanded up the causal chain to identify and reinforce the key safety-related behaviors of supervisors and managers. (DeJoy 2005, 121-122)

DeJoy's integrative model of safety management proposes that if behavior based programs are indeed effective at targeting frontline behaviors, why not apply the same process to target critical environmental conditions at the sharp end and track them upstream as well. The model does seem to offer a comprehensive approach that unites safety culture with safety management practices and the key inputs of management commitment and employee involvement. However, DeJoy's view and model have been challenged. For one, rarely are BBS programs initiated at the bottom, and the implicit and embedded nature of many components of culture argues that real cultural change must emerge from below as well as above (Tharaldson & Haukelid 2009). These critics also note that the model doesn't include the role of power differentials in the workplace (Antonsen 2008, Tharaldson & Haukelid 2009). Actually, the assumption in much of the safety culture research is that all members of an organization share the same safety-related beliefs, perceptions, and practices. And while achieving agreement about the attribution of accidents is a noble ideal, it may not be realistic given the different positions of organizational members. Differing opinions and perceptions are not necessarily bad, and indeed discussing and negotiating on them may result in a greater degree of worker safety.

To conclude this section on behavior based safety, perhaps two guiding principles could be adopted to alleviate some of the tension between behavioral and systemic approaches to incident prevention: 1) Unsafe behavior is the symptom, not the disease; 2) Behaviors at all levels of the organization are subject to equal scrutiny.

Construction-Specific Safety Culture and Climate Research

Earlier we noted some of the characteristics that set construction apart from many other HRO and non-HRO industries: the distinct cultures or subcultures of different trades, the multi-organizational project structure by which most projects are built, the constantly changing work environment, and the transient workforce. Construction culture and safety culture received particular attention in a series of ethnographic sociological articles (Gherardi et al 1998, Gherardi & Nicolini 2000, 2002), but oddly these are rarely cited or acknowledged in subsequent safety climate studies of the industry.

Quantitative Surveys

The earliest application of a safety climate instrument to construction was Dedobbeleer and Beland's (1991) effort to replicate Zohar's factor structure using a nine-item survey tool. Their analyses yielded a two-factor model- management commitment and worker involvement- and the investigators proposed that construction workers may view safety as more of a joint management-worker responsibility than do workers in other industries (Dedobbeleer & Beland 1991). This instrument has subsequently been used with other construction populations where Gillen et al. (2003) found differences between union and nonunion workers in safety climate measures and Dennerlein and Murphy (2012) found no correlation between safety climate measured by the Dedobbeleer questionnaire and contractor safety performance measured by a third party assessment program.

Published construction safety culture/climate research have appeared more frequently in recent years, but for this review two characteristics are notable: 1) Most of the construction-specific studies are from non-US locations, especially Hong Kong and Taiwan, UK, Scandinavia, and Australia; and 2) The survey instruments used are largely generic or developed from pre-existing general industry instruments.

Mohammed (2002) administered an 82-item safety climate questionnaire to Australian construction workers that was based on several existing general industry instruments. The questionnaire comprised ten constructs, roughly similar to Zohar and subsequent studies. Management, risk, and safety systems, including management commitment; a nonpunitive approach to safety; and open flow of safety information correlated with more positive safety climate scores, and self-reported safe behaviors, a two-item scale (1. I follow safety procedures, and 2. My coworkers follow safety procedures). The author argued that percentage of safe behaviors is a superior measure to accident data because accidents are either too rare or too variable from site to site in construction. Work pressure was not confirmed as a significant correlate with safety climate.

Choudhry et al's (2007) safety culture model is based on Cooper (2000), Neal et al. (2000), Geller (1994), and others, with items added to address important aspects of construction including extending the environment/situation construct to examine both the organization and the project level. They used multiple measurement tools specific to the model constructs that allow for triangulation of data.

A Swedish research group has been conducting a longitudinal study of tunnel construction workers to test the reliability of earlier scales and to assess the degree to which their safety climate measures predict safety outcome variables (Pousette et al. 2008). For example, a previous factor structure reported by Cheyne et al. (1998) in British and French manufacturing populations was replicated in the tunnel workers with three different but overlapping samples. The findings supported a narrowing set of core dimensions for safety climate- management safety priority, safety management, safety communication, and workgroup safety involvement- as suggested by Seo (2004) among others. The longitudinal design supported the predictive value of safety climate for safety behavior, but again the latter was self-reported so this study could not establish correlation with actual safety outcomes.

The "sharedness" of safety climate as a measure was supported by the findings of Pousette as well. Workgroup members showed significantly greater agreement regarding safety climate *perceptions* than they did on individual safety *attitudes* (Pousette et al. 2008), supporting the Zohar and Luria's (2004) view of group safety climate.

The fragmented and transient nature of most construction work raises the question of whether workgroups are sufficiently established and homogeneous to yield reliable safety climate measures. A number of studies have examined this issue. Cigularov et al. (2011) analyzed data collected using a 19-item safety climate survey, from a sample of 4725 construction workers, representing 10 trade categories, on a massive US commercial construction site that had encountered significant safety problems, including multiple fatalities. They found good measurement equivalence (ME) of the climate instrument, including similar factor loadings for all four factors: management commitment, safety practices, supervisory support, and work pressure for the 10 trades, suggesting that surveys don't need to be tailored to each individual trade. They did, however, observe significant mean differences in climate perceptions across the trades. Likely explanations included differing intensity of tasks and risks, autonomy, and resources provided to different trades. Since employer information was not captured, this study was not able to address the possible impact of variations across employers (Cigularov et al 2011, Gittleman et al. 2010).

Level of aggregation of safety climate data may be particularly important in construction. In a study of Australian road construction and maintenance crews, Lingard et al (2009) found high levels of within workgroup homogeneity on safety climate dimensions, but significant between-group differences in perception of supervisory leadership and co-workers' actual safety behavior. This suggests an important role for supervisors who may have a great deal of influence on, for instance, implementation of safety culture/climate improvement initiatives. The authors point out that aggregating safety climate data at the organizational level will, in such cases, mask important differences, and that workgroup size and within-group interaction should be considered in future group-level safety climate studies (Lingard et al 2009).

The effect of organizational safety climate on injury reporting was investigated among a group of subcontractors on a large industrial construction project. Probst et al. (2007) found that safety communication and management responsiveness on safety, measured via a survey, were associated with lower rates of injury underreporting; a more positive safety climate correlated with more accurate injury reporting based on two independent injury data sources.

Qualitative Research

As noted earlier, not all construction safety culture and climate research is survey-based. Törner and Pousette (2009) conducted in-depth interviews with six worker safety representatives and 19 first-line supervisors on a tunneling project to determine the preconditions and elements of high safety standards from the perspective of experienced construction workers and field managers. The categories and subcategories identified were:

1. Project characteristics and nature of work
2. Organization and structures
    a. Planning
    b. Roles
    c. Procedures
    d. Resources
3. Collective values, norms, and behaviors
    a. Climate and culture
    b. Interaction and cooperation
4. Individual competence and attitudes
    a. Competence
    b. Individual attitudes.

The findings indicate that safety management practices, management attitudes, collective values, site conditions, and individual attitudes interact and mutually reinforce one another. Open and trusting relationships within the contractor organization and between the contractor and other parties are key to developing and maintaining high safety standards (Törner & Pousette 2009).

Construction Case Studies

Two recent megaprojects with very different safety profiles provide lessons for the value of safety culture/climate assessments and the potential for addressing findings using tailored interventions. Las Vegas City Center/Cosmopolitan, adjoining sites that constituted the largest commercial construction project in US history, took place from 2006-2009. The London 2012 Olympic Park construction work took place under the auspices of the Olympic Delivery Authority (ODA). Both are extensively documented, Las Vegas because of a great deal of negative attention it attracted due to eight worker fatalities over the course of the project (Gittleman 2010), London because of the Learning Legacy project that carried out extensive research and documentation to develop lessons for the industry and government.

Las Vegas City Center/Cosmopolitan

This massive commercial project consisted of two adjacent sites totaling 24 buildings on 45 acres. By the end of 2008 7000 workers were on the site. In the course of 18 months eight fatalities had occurred on the project, leading to a walkout by workers and their unions to protest safety conditions and intense media attention on the owner and general contractor for the project. These concerns led to a third party intervention including a safety needs assessment survey. Different safety perception surveys were administered to four groups with the following number of respondents: craft workers (5,268), foremen (134), superintendents (61), and executives (17). The surveys included an open-ended section in addition to roughly 40 questions with Likert scale responses. Three categories of questions made up each survey: 1) General Contractor (e.g. management commitment), 2) Subcontractor (safety program, foreman safety management), and 3) individual perceptions (safety practices, behaviors, and knowledge) (Gittleman et al. 2010).

Survey results indicated that management groups, particularly at the highest levels, perceived safety climate more positively than workers. Management also attributed mistakes and accidents to worker fatigue more than workers themselves did. Safety climate measurements did predict safety outcomes but inconsistently across levels (Gittleman et al. 2010). Specific issues were identified that related to safety on the site including schedule pressures, overcrowding and trade stacking in work areas, and language barriers between English- and Spanish-speaking workers. Quantitative and qualitative data led the investigators to recommendations for improvement in four areas:

1. Management commitment and active safety problem solving
2. Increased involvement of senior and mid-level managers in safety communication, and accountability for safety through managers' performance reviews
3. Proactive safety leadership by foremen including frequent feedback and more open communication about accidents and near misses
4. Empowerment of workers to become more active in safety. (Gittleman et al. 2010)

This intervention demonstrated the value of multiple data sources in assessing safety climate and safety needs and the value of identifying perception gaps between frontline workers and management. The results suggested that insufficient planning and failure to anticipate the challenges of the schedule, steep manpower ramp, and workforce demographics contributed to eight tragic fatalities and numerous other safety problems.

London Olympic Delivery Authority

Whereas the Las Vegas safety needs assessment and safety climate effort was conducted in response to poor safety performance, the research and assessment of the London Olympic construction was planned as the construction projects themselves were being planned and executed. The safety aspects of the ODA were documented as part of the Learning Legacy program with numerous reports available online (http://learninglegacy.independent.gov.uk/themes/health-and-safety/research-summaries.php). Reports cover multiple aspects of the project including leadership and worker involvement, communication and action, prevention through design, and supply chain management. This brief case summary focuses on the safety culture findings (Healy & Sugden 2012).

Safety culture and climate assessment for the ODA projects was conducted using a modified version of the UK Safety Climate Tool (SCT), originally developed for the UK offshore oil industry (Cox & Cheyne 2000). The SCT is an eight-factor scale including:

1. Organisational commitment
2. Health and safety oriented behaviours
3. Health and safety trust
4. Usability of procedures
5. Engagement in health and safety
6. Peer group attitude
7. Resources for health and safety
8. Accident and near miss reporting.

The Olympic Park site employed a peak workforce of 12,000 with 30,000 workers thought to have cycled through the site over its lifetime. The construction work was organized through prime contractors (Tier 1) who had overall responsibility for given projects with lower tier subcontractors worked through the primes.

The accident frequency rate over 62 million man-hours was 0.17 per 100,000 hours through June 2011. SCT scores for companies across the park were higher than the highest in the all-industry dataset for every factor. The data showed a negative relationship between SCT scores and accident rates but coefficients were small (Healy & Sugden 2012). A number of reasons are suggested for the superior safety performance on this project:

- The strong owner role of ODA, with safety as a priority and integrated into the business through standards and requirements from the outset.
- Clarity of standards and requirements and cultural alignment throughout the supply chain.
- ODA empowerment of Tier 1 contractors to develop their own processes and systems rather than adopting 'client-decreed' methods.
- Recognition of the prestige of working on the Olympic Park and striving for excellence in all activities, including health and safety.
- The scale and duration of the project meant that initiatives had time to embed, and could be tailored to ensure their efficacy and success. Workers believed in the genuine commitment within organizations, as the message was consistent and reiterated across the Park over time. (Healy & Sugden 2012)

Many specific examples of promotion of positive safety culture are provided in the Learning Legacy report, but one unusual instance provides a flavor. To establish the principle of empowerment of workers to stop work for safety one company implemented a one-month reward and recognition scheme solely to reward those who stopped work because of safety concerns. Workers thus gained confidence that it was truly okay to exercise the stop work authority (Healy & Sugden 2012). Although the Olympic construction was clearly larger, more visible, more complex, and better resourced than most, construction researchers and stakeholders found many lessons that are applicable to the broader industry (Cheyne et al. 2011).

Unfortunately, the safety performance of the Olympic project has been potentially tainted by allegations of contractors blacklisting construction workers for union and political activity, including safety and health advocacy (Boffa 2013). Prime contractors involved in Olympic construction have admitted participation in the blacklisting, and while much of the activity took place prior to the Olympic project, some appears to have carried over into the Olympics. While this doesn't nullify the strong statistical safety performance and other accomplishments of the ODA projects, it certainly has implications for safety culture and climate. The apologies and disavowal of the blacklisting process by a number of major contractors suggests that they understand the damage and erosion of trust such practices engender.

Conclusions and Recommendations

- Safety culture and safety climate are distinct though related concepts. Culture reflects deeper values and assumptions while climate refers to shared perceptions among a relatively homogeneous group. As the two constructs are often conflated it is important to recognize that most efforts at measurement, typically through workplace surveys, are assessing climate. Safety climate data can tell us something about the underlying culture, particularly where gaps in perceptions exist within an organization.

- Major factors identified safety climate in the research literature include management commitment, employee involvement and/or empowerment, safety communication, safety competence, balance of safety and production, and supervisory and coworker safety support, among others. An important question is how these factors overlap with and relate to safety management systems including hazard identification, site audits, incident reporting, subcontractor management, etc. Schemes and models that integrate the more concrete safety management practices and the less tangible culture/climate constructs can enhance our understanding of these relationships (Parker et al. 2006, Choudhry et al. 2007, DeJoy, 2005).

- Whether culture is seen as a thing or a process, every organization has a culture and a safety culture. Reason (1997) suggests where leverage lies for improving safety culture by delineating the components of a positive safety culture as:
  - An **informed** culture, relying on good information
  - A **reporting** culture
  - A **just** culture that generates trust
  - A **flexible** culture, and
  - A **learning** culture.

- The existence of multiple cultures or subcultures within organizations or projects is particularly germane to construction where trade acculturation and multi-employer projects are the norm.

- Construction is a highly segmented industry. Efforts at improving the factors associated with safety climate and safety culture may require different paths for smaller contractors with fewer resources, but improvements can be made at all levels. Additional leverage may be gained by linking to other ongoing improvement efforts, including prevention through design, green building, and safety prequalification.

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