

Developing a Model of Construction Safety Culture

Rafiq M. Choudhry¹; Dongping Fang²; and Sherif Mohamed³

Abstract: The concept of safety culture is relatively new in the construction industry; however, it is gaining popularity due to its ability to embrace all perceptual, psychological, behavioral, and managerial factors. To address the lack of a verifiable process to analyze construction safety culture, this technical note presents a robust conceptual model that has its roots firmly entrenched in pertinent academic and applied literature. It provides a critical review of the term “safety culture”; along with distinct yet related concepts (i.e., safety climate, behavior-based safety, and safety system). It also compares the proposed model with available safety culture models in order to demonstrate its applicability in construction site environments.

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Introduction

Improving site safety is a top priority for construction companies throughout the world. Having a positive and mature safety culture is becoming crucially important to facilitate such improvement as anecdotal evidence suggests that in many major accidents, the safety management system’s defenses broke down because of the prevailing safety culture in which safety management activities were carried out (ACSNI 1993). Although it is not clear how safety culture shapes and influences safety behaviors and safety program effectiveness, it is important to define and understand what is meant by safety culture. To gain a better understanding of the concept, this technical note gives an overview of the term “safety culture,” followed by a discussion of the highly related concepts of safety climate, safety system, and behavior-based safety—all of which represent the main components of the proposed conceptual model of safety culture. The proposed model is then compared to other safety culture models, reported in the literature, to demonstrate its applicability. The paper concludes with offering insights into construction safety culture research activities at Tsinghua University, China.

¹Ph.D. Candidate, Tsinghua-Gammon, Construction Safety Research Center, School of Civil Engineering, Tsinghua Univ., Beijing 100084, China; and, Faculty Member, National Univ. of Sciences and Technology, Rawalpindi, Pakistan. E-mail: choudhry03@gmail.com

²Professor and Director, Tsinghua-Gammon Construction Safety Research Center, School of Civil Engineering, Tsinghua Univ., Beijing 100084, China. E-mail: fangdp@tsinghua.edu.cn

³Professor and Director, Center for Infrastructure Engineering and Management, Griffith Univ., Queensland 9726, Australia. E-mail: s.mohamed@griffith.edu.au

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Safety Culture

The term safety culture was first introduced in INSAG’s Summary Report on the Post-Accident Review Meeting on the Chernobyl Accident in April 1986, published by the IAEA as *Safety Series No. 75-INSAG-1* in 1986, and further expanded on in *Basic Safety Principles for Nuclear Power Plants, Safety Series No. 75-INSAG-3*, issued in 1988 (IAEA 1991). INSAG-3 (INSAG 1988) explains that safety culture refers to a very general matter, the personal dedication and accountability of all individuals engaged in any activity. Nevertheless, the meaning of the term was left open to interpretation, with guidance lacking on how safety culture could be assessed.

The Advisory Committee on the Safety of Nuclear Installations (ACSNI 1993) provides the definition that “the safety culture of an organization is the product of *individual and group values, attitudes perceptions, competencies, and patterns of behavior* that determine the *commitment* to and the *style and proficiency* of an organization’s health and safety management.” Numerous definitions of safety culture exist in the academic literature. Examples of a few selected definitions are tabulated in Table 1; these definitions have resulted in the research carried out from 1998 (Choudhry and Fang 2005). Most of the definitions are relatively similar in their belief perspectives, with each focused, to varying degrees, on the way people think and/or behave in relation to safety. The definitions tend to reflect the view that safety culture “is” rather than that “has” something. Though definitions vary, there is a consensus of safety culture being a *proactive* stance towards safety. This now has been almost universally accepted if not always practiced (Lee and Harrison 2000).

Related Concepts

Safety Climate

Zohar (1980) introduced “safety climate” as “a summary of molar perceptions that employees share about their work environment.” Researchers considered it as a subcomponent of the safety culture (Cooper 2000; Neal et al. 2000; Choudhry and Fang 2005) and

Table 1. Selected Safety Culture Definitions

Reference	Definition of safety culture
Hale (2000)	Safety culture refers to “the attitudes, beliefs and perceptions shared by natural groups as defining norms and values, which determine how they act and react in relation to risks and risk control systems.”
Guldenmund (2000)	Safety culture is defined as those aspects of the organizational culture that will impact on attitudes and behavior related to increasing or decreasing risk.
Cooper (2000)	Culture is “the product of multiple goal-directed interactions between people (psychological), jobs (behavioral) and the organization (situational); while safety culture is ‘that observable degree of effort by which all organizational members direct their attention and actions toward improving safety on a daily basis.’”
Mohamed (2003)	Safety culture is a subfacet of organizational culture that affects workers’ attitudes and behavior in relation to an organization’s on going safety performance.

a reflection of actual safety culture (Lee and Harrison 2000; Flin et al. 2000; Guldenmund 2000). In construction, Mohamed (2003) suggested that safety culture is concerned with the determinants of the ability to manage safety (top-down organizational approach); whereas, safety climate is concerned with the workers’ perceptions of the role safety plays in the workplace (bottom-up perceptual approach). He further stated that safety climate is largely a product of the safety culture, and the two terms should not be viewed as alternatives.

The writers, therefore, postulate that “safety climate reflects employees’ perceptions about the organization’s safety management system, including policies, practices, and procedures that

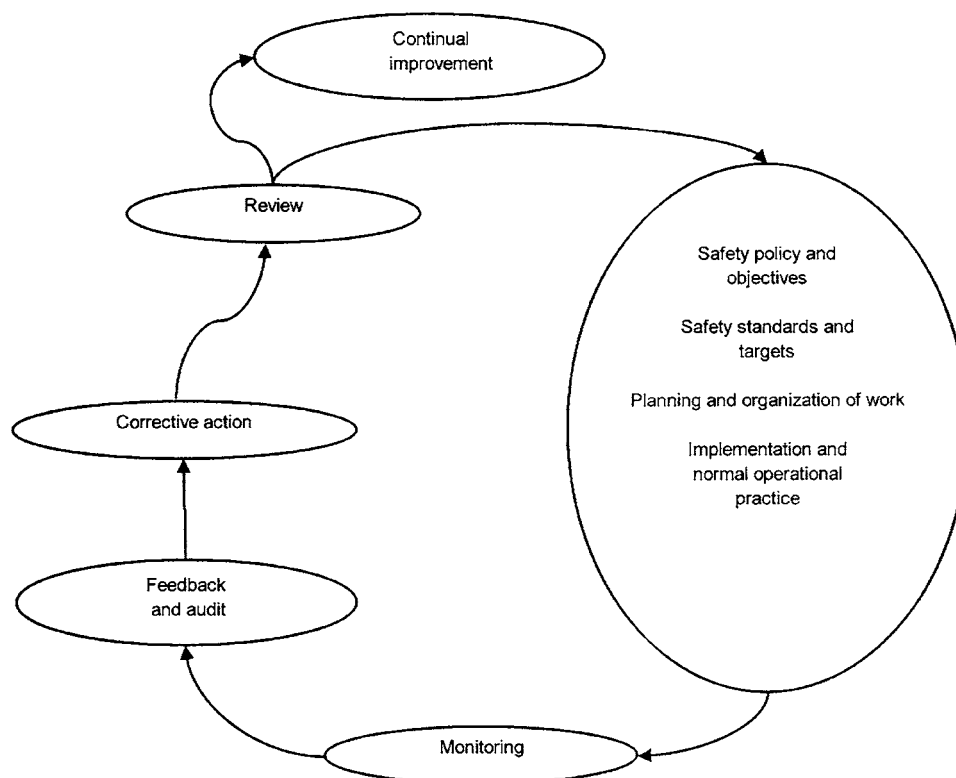
show how safety is implemented within the working environment.” It is exactly the “snapshot” that describes “the way we do things around here now.”

Behavior-Based Safety

Behavior-based safety (BBS) refers to the systematic application of psychological research on human behavior. It is an analytic or data-driven approach, where critical behaviors get identified and targeted for change. In BBS, primary attention is directed at specific safety-related behaviors that are, typically, performed by workers (Krause et al. 1984). Workers’ performance gets systematically observed to know base-period scores. Using these scores, goal-setting meetings are arranged, with the participation of workers, to set realistic and attainable targets of performance. Workers are encouraged to practice safe behaviors. Providing feedback is essential to reinforce desired safety behaviors, thus fostering continuous improvement. It is noteworthy that more than 80% of all workplace accidents and incidents are attributed to unsafe behaviors (HSE 2002).

Safety System

The safety system label term that has been widely reported in the literature (Flin et al. 2000) encompasses all aspects of the organization’s safety management system including safety policies, procedures, committees, etc. This system provides a systematic process for planning, implementing, monitoring, and reviewing safety performance. The system is not just documentation, but is the actual implementation of processes, operational control procedures and practices. Fig. 1 presents elements of the construction safety system that include safety policy and objectives, safety standards and targets, planning and organization of work, implementation and normal operational practice, monitoring, feedback and audit, corrective action, review, and continual improvement.

**Fig. 1.** Basic elements of a safety management system model

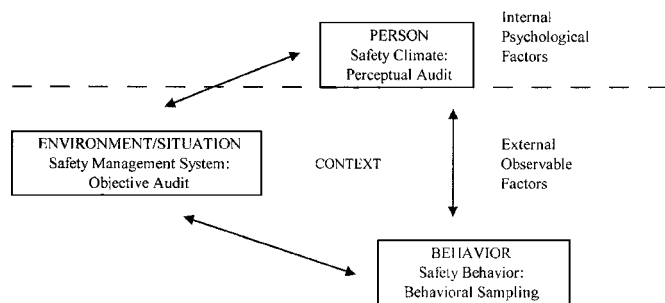


Fig. 2. Cooper's model for safety culture (2000) [Cooper (2000), with permission]

mentation and normal operational practice, monitoring, feedback and audits, corrective action, review, and continual improvement.

The writers take the view that a "safety system comprises all policies, objectives, roles, responsibilities, accountabilities, codes, standards, communications, processes, procedures, tools, data, and documents for safely managing site operations."

Safety Performance Measures

Traditional measures of safety are after-the-fact measures; namely, that safety is measured after injuries have already occurred. These measures are labeled reactive, trailing, downstream, or lagging indicators because they rely on retrospective data. Focusing on these measures (e.g., accident rates and compensation costs) often means that the success of safety is measured by the levels of system failure (Cohen 2002). Recognizing such shortcomings, many advocate a shift to using proactive, upstream, or leading indicators (Flin et al. 2000; Cooper 2000; Mohamed 2002; Choudhry and Fang 2005; Hinze 2005).

Model Development

The strong agreement concerning safety culture being a proactive stance towards safety, coupled with the need for adopting proactive safety performance measures has led to the development of a conceptual model that embraces all of perceptual, psychological, behavioral, and managerial safety-related factors. This robust model, described below, aims towards facilitating objective analysis of construction safety culture to enhance and improve safety.

Accident causation models recognize the presence of an interactive relationship between psychological, situational, and behavioral factors (Cooper 2000). Maloney and Smith (2003), revealing that human behavior is an element of a triad consisting of the *person*, *environment (situation)* in which the person functions, and *behavior* in which the person chooses to engage. Bandura (1986) described this triad as one of reciprocal determinism, where reciprocal means mutual action between causal factors, and determinism simply meant the production of effects by certain factors. The reciprocal influences do not operate simultaneously nor are they necessarily of equal strength; however, there is a process of action and reaction, or one of "perpetual dynamic interplay" (Cooper 2000).

Fig. 2 presents the model of reciprocal determinism for safety culture adopted from Cooper (2000) with slight modifications. The model also reflects Bandura (1986) model, derived from the social cognitive theory, which implies that people are both prod-

ucts and producers of their environment. In this model, the person (safety climate) construct reflects employee's perceptions, which can be assessed by way of safety climate questionnaires; the behavior (safe or unsafe) construct, which is concerned with actual safety-related behaviors can be assessed by checklists developed as part of BBS initiatives; and the environment/situation construct can be assessed through audits or inspections of safety systems. By incorporating the safety climate, behavior-based safety and safety systems, and building upon previous works by Cooper (2000), Neal et al. (2000), HSE (2002), and Marosszeky (2005), the proposed conceptual model (see Fig. 3) of construction safety culture recognizes the presence of interactive relationships between psychological and perceptual, environmental and situational, and behavioral constructs, thus having the potential to analyze safety culture as the three constructs can be measured independently or in combination on any construction site. Details of each construct and its potential utilization are illustrated in the following subsections.

Person Construct

Management commitment has a great influence on safety and could be communicated through various initiatives. Nevertheless, to investigate whether a positive safety climate exists, management commitment must be perceived as valid and important by everyone, and this could be assessed through safety climate surveys, which measure employee perceptions.

A safety climate survey would increase safety knowledge and provide motivation to employees ensuring their compliance (i.e., adhering to standard work procedures) and participation in safety activities. This is supported by a previous study that if safety climate improvements are to have any impact on safety performance, then the survey must first produce changes in employee knowledge and motivation (Neal et al. 2000). Survey results would also reveal the strengths and weaknesses in current safety management practices for remedial actions to be taken.

Behavior Construct

The behavioral aspects of safety culture could be measured by peer observations through the design and implementation of appropriate BBS programs (Krause et al. 1984; Choudhry et al. 2006). In a typical BBS program, a behavioral safety assessment survey is conducted to check the readiness of participants and site conditions, and also to identify weaknesses. Management and workforce support must be sought to ensure "buy-in" of the BBS program (Cooper 2000). Behavioral observation checklists for safe/unsafe behaviors could be prepared from available incident records, risk assessment documents, standard operating procedures, and by group discussion. Trained observers would then measure the safe and unsafe behaviors periodically to establish the base-period safety scores. Based on these scores, site environment, or condition, construction equipment and systems are to be rectified where necessary.

The workforce must be informed about what is being measured, and goal-setting sessions are to be arranged for them to participate in setting achievable safety performance targets. Measurement of behavioral safety performance continues for an agreed-upon period of time where checklists of behavioral safety get regularly reviewed and updated. This type of BBS program can also be developed for different levels of management. An important feature of this program is the mathematical nature of its output. A score of 86 or 95%, for example, would give every

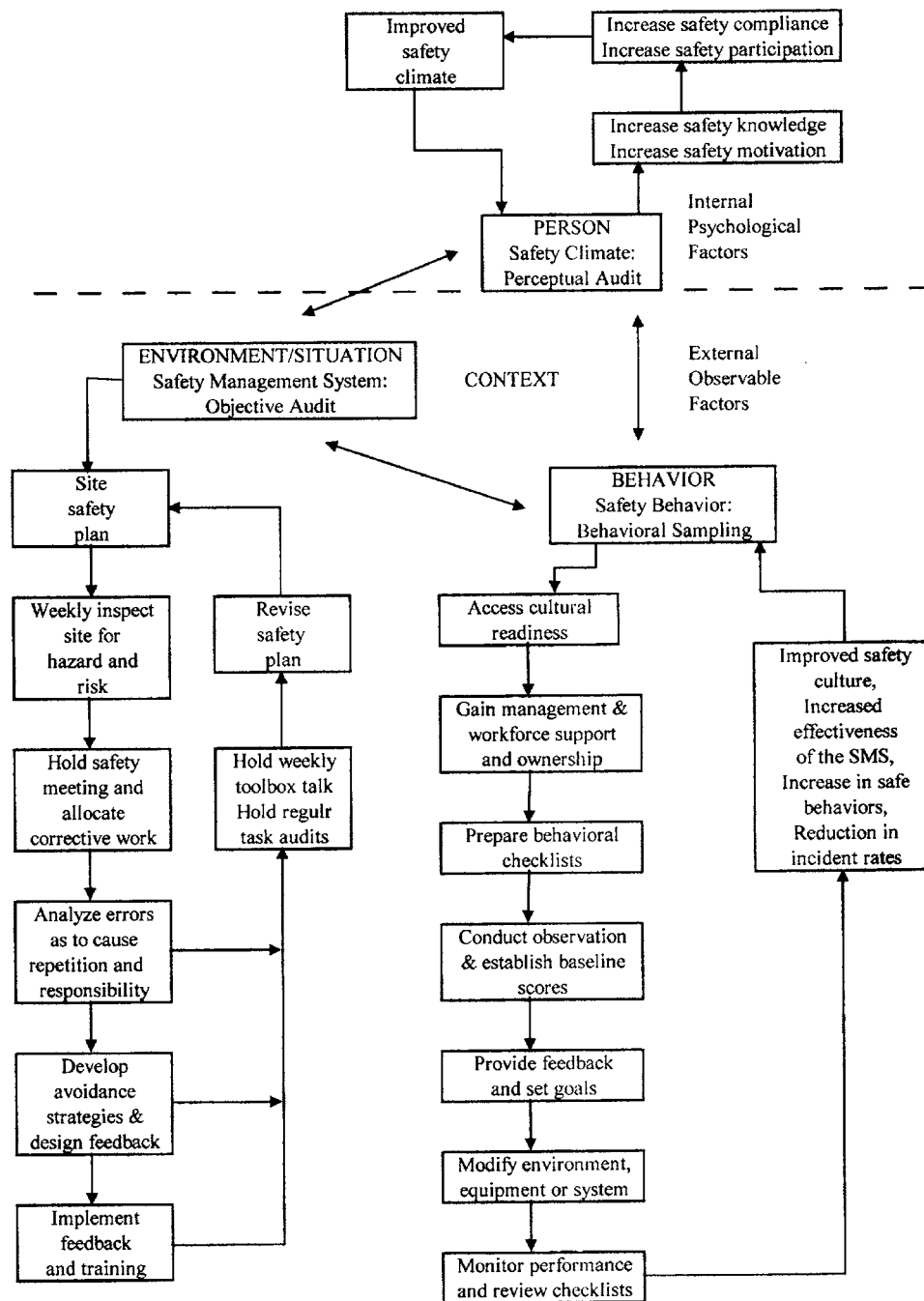


Fig. 3. Model of construction safety culture

employee a clear indication of the status of safe behavior on site. Anecdotal evidence (HSE 2002) suggests that the output of a behavioral-safety program will ultimately lead to improving the safety culture.

Environment/Situation Construct

Given that the safety system encompasses all aspects of the organization's safety management system (SMS), one would expect that the environmental and situational aspects of the safety culture are reflected in the operational SMS. On a typical construction project, systematic hazard identification and control provides an objective and empirical process for proactively dealing with environmental and situational problems. A project-specific site

safety plan is a necessary tool for facilitating such a task. Unfortunately, often site safety plans are too general in nature and do not address the project's specific needs. Primarily, a safety plan is developed by carefully examining project activities, and identifying and dealing with associated hazards. Marosszeky (2005) has outlined a safety management approach based on a project site safety plan that has the following common elements:

1. Weekly inspections/audits to identify hazards;
2. Regular safety meetings to discuss inspection reports, design, and allocate corrective work;
3. Rigorous error analysis to identify root causes, repetitions (if any), and responsibility;
4. Effective avoidance strategies and timely feedback;

5. Improved guideline documents incorporating the received feedback;
6. Regular toolbox meetings at the trade level; and
7. Regular audits of and revision of site safety plans.

Comparison and Key Model Features

This section provides a brief description of safety culture models as reported in the literature in an attempt to highlight key features of the proposed model. Grote and Kunzler (2000) presented a sociotechnical model of safety culture that links the safety management system and safety culture to the general organizational design. However, the model is more schematic and lacks any mechanism to improve and assess safety culture. Geller (1994) puts forward a model distinguishing three dynamic and interactive factors, namely, person, behavior, and environment. Three years later, a total safety culture model, which includes this safety triad and recognizes the dynamic and interactive relationship between them, was proposed (Geller 1997).

Cooper (2000) argued that organizational culture is the product of multiple goal-directed interactions between people, jobs, and the organization, and presented a model recognizing the presence of an interactive or reciprocal relationship between psychological, situational, and behavioral factors. Building upon Geller's model, Cooper's argument, and broadening the organization construct into an environmental/situational construct to incorporate the safety system concept, the model presented in this technical note has the following key features:

1. It integrates three related concepts, namely, safety climate, behavior-based safety, and safety system, thus allowing different dimensions of construction safety culture to be measured individually or in combination.
2. It does not rely on a single type of measurement tool. In contrast, it accommodates a variety of tools including surveys, audits, focus groups, document analysis, etc.
3. The environment/situation construct is concerned not only with the situational aspects of the organization, but also with the specific conditions of the project.
4. The three constructs complement each other in a way that offers a triangulated method of measurement, thus allowing for a multilevel analysis of construction safety culture.

In sum, construction safety culture could be defined as: the product of individual and group behaviors, attitudes, norms and values, perceptions, and thoughts that determine the commitment to, and style and proficiency of, an organization's system and how its personnel act and react in terms of the company's on-going safety performance in construction site environments. This comprehensive definition relates safety culture to personal and workgroup behaviors, attitudes, and thoughts, as well as to safety performance through the organization's safety management system. It also relates safety to commitment, management style, and ability to act and react to safety concerns.

Current Research at Tsinghua University

The conceptual model presented above offers an integrative framework to explore the holistic, multifaceted nature of construction safety culture. Applying this model in a research project at Tsinghua University, behavioral checklists were used to measure safety-related behaviors. Employee perception was measured via safety climate perceptions' surveys. Also, safety audits and

interviews were periodically conducted to examine safety management systems, policies, and standards. Initial results indicate that the model is successful in improving the overall understanding of safety culture on construction projects. Specifically, questionnaire surveys were helpful in increasing safety awareness among employees, thus improving safety climate; site safety audits facilitated enhancing safety on site, and an increase in safe behavior was observed due to the implementation of a designed BBS program (Choudhry et al. 2006). Overall, the three components of the model provided a valid instrument to offer guidance to all employees to regard safety as being an issue concerning every one.

Concluding Remarks

In light of the hitherto lack of a systematic approach to objectively analyze safety culture in construction site environments, this technical note proposed a conceptual model that recognizes human, technical, situational, and organizational elements as well as their interactions. The theoretical grounding for the proposed model comes from an extensive review of pertinent literature, but more specifically the works of Geller (1997) and Cooper (2000). The model is anchored in three fundamental conceptual categories, namely, safety climate, behavior-based safety, and safety system. The model serves as the logical basis for determining what and how to analyze and assess the different aspects of construction safety culture. It offers the opportunity to adopt a goal-setting paradigm by pursuing multiple subgoals. Employee perceptions, safety behaviors, and environmental or situational features could be assessed through safety climate surveys, peer observations, and systems audits/inspections, respectively.

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