Safety Culture

Effects of Environment, Behavior & Person

By Ruoyu Jin and Qian Chen

IN BRIEF

- **An integrated safety culture model was adopted as a holistic assessment framework for evaluating a contractor's safety culture after the implementation of a new safety program.**
- **The calculated safety violation rates confirmed the reduction of unsafe behaviors among workers on the contractor's job sites.**
- **Results from multilevel safety climate surveys showed overall positive employee perceptions of the safety program in terms of awareness, acceptance, accountability and other dimensions.**

During the investigation of several notable disasters (e.g., 1986 Chernobyl nuclear release, Continental Express Flight 2574 crash in 1991), the lack of positive corporate safety culture was identified as a major contributing factor to these incidents (IAEA, 1986, as cited in Cox & Flin, 1998; NTSB/AAR-92/04 1992, p. 54, as cited by Meshkati, 1997). For example, as pointed out by National Transportation Safety Board (NTSB), "the failure of Continental Express management to establish a corporate culture which encouraged and enforced adherence to approved maintenance and quality assurance procedures" was a potential cause of the crash (NTSB/AAR-92/04 1992, p. 54, as cited by Meshkati, 1997).

Since then, safety culture assessment has been frequently used to identify root causes of system failures or incidents (Cox & Flin, 1998; Gordon, Flin, Mearns, et al., 1996; Pidgeon, 1998; Wilpert, 2000). Accordingly, building a positive corporate safety culture has been an interest in nuclear energy, offshore and other high-risk industries to improve safety awareness and prevent incidents (Cox & Cheyne, 2000; Fleming, 1999; INSAG, 1999).

Construction is well known as a high-risk field. According to Bureau of Labor Statistics (BLS, 2011), in 2009, construction accounted for 18.3% of all fatal work injuries in the U.S. The industry's fatality rate (9.9 per 100,000 full-time equivalent workers) was the third highest among all industries. The emphasis on building a positive safety culture has proven to enhance contractors' safety awareness and performance. For example, the 1-Hour for Safety Management program, providing safety education for top management, successfully increased safety awareness, interest and commitment (Hakkinen, 1995). Job-site incidents were also reduced after a cultural intervention program was launched in the Netherlands' concrete industry (Oh & Sol, 2008). Corporate safety culture has gradually become a primary safety performance indicator (Mohamed, 2003; Reiman & Pietikeinen, 2010).

This research's objective was two-fold: 1) study a safety program launched by a regional general contractor (GC), Messer Construction Co. (hereafter called "the GC"), in the U.S. building construction industry; and 2) examine the program's effectiveness in building a positive safety culture based on a holistic assessment framework. This article presents an example of best safety management practices and offers an assessment tool that can be used to evaluate safety culture and safety program effectiveness.

Concept of Safety Culture & Assessment Tools

The literature contains several definitions for *safety culture.* For example, Guldenmund (2000) defines safety culture as the aspects of the organizational culture that will influence attitudes and behavior related to increasing or decreasing risk. Mohamed (2003) relates safety culture to safety management using a top-down organizational attribute approach. In its National Occupational Research Agenda, NIOSH (2008) defines safety culture as the underlying organizational principles, norms, commitments and values related to the operation of safety and health, as well as its importance compared with other workplace goals.

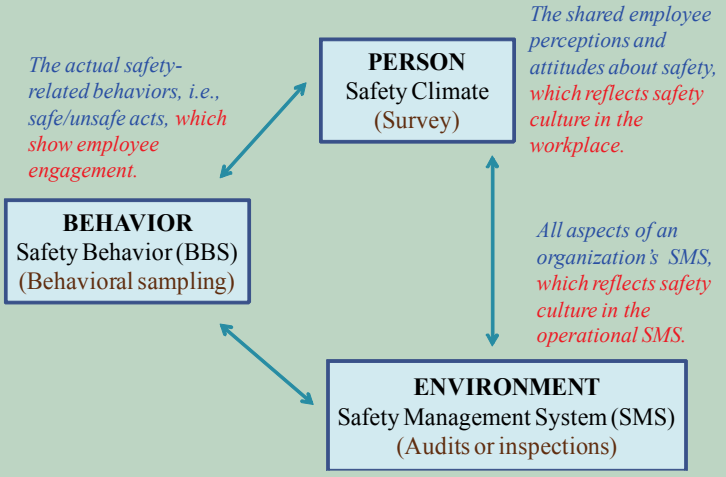
Safety culture can be assessed using both qualitative (e.g., observations, focus group discussions, case studies) and quantitative methods (e.g., interviews, surveys, Q-sorts in which participants can assess a statement using a subjective weighed approach) (Donner, 2001; Wreathall, 1995). So far, questionnaire surveys have been the most widely used assessment tool due to their practicality in time, cost and ease of implementation (Dedobbeleer & Beland, 1991; McDonald, Corrigan, Daly, et al., 2000; Mearns, Whitaker & Flin, 2003; Zohar, 2000). Survey questions are usually categorized into multiple safety culture dimensions such as management attitude toward safety, perceived importance of safety training, safety communication and worker involvement (Dedobbeleer & Beland; Mearns, et al.; Zohar, 2000).

Ruoyu Jin holds an M.S. in Construction Engineering and Management from University of New Mexico. He is currently a Ph.D. candidate in the Construction Systems Management program at Ohio State University.

Qian Chen, Ph.D., is an assistant professor in the Construction Systems Management program at Ohio State University. She holds a Ph.D. in Building Construction from Virginia Tech. Her work focuses on interface management, information technology applications in construction, safety management and green/sustainable buildings.

A safety culture model with three interdependent dimensions (environment, person, behavior) was proposed by Cooper (2000). Figure 1 illustrates the model and provides further information on how the three dimensions are defined (in blue text), measured (in brown text) and related to safety culture (in red text). Specifically, safety climate, the shared employee perceptions and attitudes about safety, reflects safety culture in the workplace and can be measured by a questionnaire. Safety behavior (safe or unsafe), representing employee engagement in safety, can be evaluated through behavioral sampling. Environment, including all aspects of an organization's safety management system (SMS), can be assessed by audits or inspections (Choudhry, Fang & Mohamed, 2007; Cooper, 2000). Overall, the integrated model and various measurement tools would allow for a multilevel, holistic analysis of construction safety culture.

Figure 1
A Safety Culture Model



Note. *Adapted from "Towards a Model of Safety Culture," by M.D. Cooper, 2000,* Safety Science, 36*(2), pp. 111-136; and "Developing a Model of Construction Safety Culture," by R.M. Choudhry, D. Fang and S. Mohamed, 2007,* Journal of Management in Engineering, 23*(4), pp. 207-212.*

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Types of Existing Safety Programs

Safety programs are usually a core part of contractors' SMS. They can improve job-site safety performance by reducing incidents/injuries, enhance safety culture or climate, prevent project delays and build positive company image (Abdelhamid & Everett, 2000; Aksorn & Hadikusumo, 2008; Anton, 1989; Findley, Smith, Kress, et al., 2004; Michaud, 1995; Rowlinson, 2003)

Companies can take many approaches to developing and implementing safety programs. Some programs focus more on enforcing safety rules through an accountability system. For example, behavior-based safety management programs have been used to measure employees' safety performance by identifying and observing specific, job-related safe or unsafe behavior in the workplace. Through the monitoring and feedback process, employees' safety behavior can be improved (Duff, Robertson, Phillips, et al., 1994; Lingard & Rowlinson, 1997; Mattila & Hyödynmaa, 1988;). Other programs provide safety education/training to enhance employees' safety awareness, attitude and commitment through a cultural intervention (Hakkinen, 1995; Oh & Sol, 2008). Other approaches integrate both aspects (Chen & Jin, 2012a).

In practice, a behavior-based safety management program implemented at seven public housing construction sites in Hong Kong improved site housekeeping (Lingard & Rowlinson, 1997). However, improvements in access to heights were found to be inconsistent in this study due to factors such as management commitment and diminished initial enthusiasm. In that study, behavior-based safety management was limited to focusing attention solely on individual workers while ignoring fundamental, social and organizational factors.

Therefore, it was not always effective in improving safety performance if a basic safety infrastructure was not in place. In contrast, a national policy program, Improving Occupational Safety, implemented in the Netherlands to increase the business community's knowledge and awareness of job site hazards, not only reduced job site incidents, but also enhanced enthusiasm and safety responsibility among both employers and employees (Oh & Sol, 2008).

Chen and Jin (2012b) introduced an integrated safety program to a U.S. commercial building contractor to reduce workers' unsafe behaviors and improve employees' safety awareness and attitude. They found decreased incidence rates and safety violations after 17 months of implementation, but did not assess how effective this program was in enhancing safety awareness and attitude among the contractor's employees.

Methodology

This research aimed to evaluate the effectiveness of the GC's safety program in building a positive corporate safety culture based on a holistic assessment framework such as Cooper's (2000) safety culture model and its three dimensions: environment, behavior and person. To evaluate the environment dimension, researchers audited the GC's SMS by reviewing the materials provided by the GC, including safety documents, educational materials and videos about the company's safety policies, requirements, procedures, management techniques and account-

Higher accountability for the 20 nonnegotiables did not impose means and methods on subcontractor work. The 20 identified work behaviors were all OSHA violations.

Figure 2

20 Nonnegotiable Behaviors Identified in the Safety Program




Fall	Struck-by	Caught-in-between	Electrical
•Working 6 ft above the ground or higher with no approved fall protection; •Exposed holes that are large enough for a human to pass through and 6 ft or greater in depth, left unprotected or improperly protected; •Blatant, clear or intentional misuse of fall protection equipment/systems; •Altering or disabling any component of a fall protection system that exposes oneself or others to a fall hazard; •Improperly using a stepladder.	•Disregarding red danger tape or barrier/crossing without proper authorization; •Dropping debris off buildings without proper chutes or approved alternate procedures; •Riding on equipment not designed for multiple passengers; •Using damaged equipment that may inadvertently fire or altering the equipment where the safety is bypassed; •Exposing others to overhead struck-by hazards by not barricading the area on lower levels.	•Working in unprotected trenches or excavations (5 ft or greater); •Not surveying for utilities before digging; •Operator not barricading/protecting swing radius or pinch points; •Operator exposing employees to an overhead load while working in an excavation; •Reckless operation of equipment.	•Working within 10 ft of power lines; •Exposing oneself or others to live bare electrical conductors (> 50 V); •Working on live electric without proper PPE and procedures; •Unauthorized altering, bypassing or removing of any guards, locks, tags or other safety device protecting persons from live electricity; •Not using a ground fault circuit interrupter when using temporary wiring (including extension cords) for construction or maintenance purposes on active construction sites.

ability systems. Then, the main components of the SMS were summarized and compared with those identified through the literature review.

In terms of the behavior dimension, safety behavioral violation reports were reviewed to analyze: 1) the distribution of safety violations among the predefined behavior categories; 2) employee involvement in the accountability system; and 3) violation rates. Specifically, employee involvement was measured by tracking who (by job classification such as manager, safety representative, craft employee) reported safety violations. A quantitative measurement, in this case the safety violation rate, was used to evaluate the GC's yearly safety behavioral violation, subcontractors working on the GC's job sites and the combined rate since the program's launch.

To study the person dimension of safety culture, researchers conducted three individual safety climate questionnaire surveys at three hierarchical levels: the GC's top executives, middle management personnel on job sites and workers. The purpose was to gather their perceptions on the safety program and the GC's safety efforts. In each questionnaire, similar types of questions were asked about respondents' awareness, accountability, program acceptance, their general perceptions on safety risks, and safety attitudes and involvement. Questions were given in multiple-choice, Likert scale and open-ended formats. The GC's safety director was deeply involved in questionnaire development, providing feedback on questionnaire structure as well as on the relevance and accuracy of individual questions.

After the questionnaires were reviewed and approved by the university's Institutional Review Board, anonymous surveys were administered in six of the GC's nine regions across four states (Ohio, Indiana, Kentucky, Tennessee) from November 2010 to February 2011. It has been recognized that conducting a perception survey is not an easy task, and uncertain/low response rates and sample selection, as well as site administration and permission, are common problems (Jin, 2010; Mohamed, et al., 2008). In this study, workers from both the GC and subcontractors were surveyed face-to-face during site visits, which boosted the response rates and helped obtain more insightful feedback.

On the other hand, top executives (senior managers and higher) and site management personnel (project managers, superintendents, engineers, safety coordinators, foremen, trade leaders) were given some flexibility to be surveyed either via online questionnaires or face-to-face interviews if their time allowed. All visits to the GC's regional offices and job sites were closely coordinated by its regional safety coordinators. This facilitated the survey process and minimized interruptions to participants' regular duties.

In this study, researchers collected 650 completed questionnaires from 71 top executives, 229 site management personnel and 350 workers. Each questionnaire was analyzed separately to determine how the select group viewed the safety program and what its attitude was toward safety. In addition to counting response rates to specific answers to survey questions, this study also used the statistical method of inference concerning proportions, known as a one-tailed z-test (Johnson, 2008), to check the consistency of perceptions from different groups or from the same group but for different questions. A p value of less than 0.05 was used to indicate a statistically significant difference.

The analyses conducted from environment, behavior and person perspectives provided a more holistic assessment of the GC's safety culture and the effect of the safety program. The results are presented later in this article.

The GC's New Safety Program

The GC's safety program was launched at the end of May 2008. It was designed to reduce injuries and worker exposure to OSHA's (2011) Focus 4 Hazards (falls, struck-by, caught-in or -between, and elec-

trocution). The program focuses on increasing safety awareness among and accountability of the GC's employees, all subcontractors and material suppliers of all tiers, while achieving positive safety culture and attitude. It consists of three key elements:

1) 100% eye protection with safety glasses required for all workers on the project;

2) daily huddle (toolbox) meetings for the GC's and subcontractors' project teams;

3) employee accountability of the 20 nonnegotiable unsafe behaviors in the Focus 4 Hazard categories (Figure 2).

Before the program was launched, multilevel training was provided to the GC's employees and to subcontractor employees working on the GC's job sites. Training included: 1) 3-hour manager implementation training delivered to approximately 450 of the GC's managers; 2) 4-hour OSHA Focus 4 Hazard training for approximately 450 management staff and 450 craftspeople; and 3) training to all subcontractors' employees through huddle meetings, contractor orientations and other project meetings.

Through this process, subcontractors' commitment to the program was obtained, an important step since most crafts working on the GC's job sites were subcontractor workers. Although subcontractors were allowed to adopt their own safety and health management systems, they had to abide by the safety program's rules. The details about how the safety program was implemented can be found in Chen and Jin (2012b).

Safety Risk Transfer Between GC & Subcontractors

As the safety program was developed, feedback was widely solicited from foremen and craftspeople hired by the GC across regions. No one expressed concerns that the program would create new hazards or increase worker exposure to existing or potential hazards. Actually, the safety program's three main elements (100% eye protection, huddle meeting, higher accountability for 20 nonnegotiables) did not impose means and methods on subcontractor work. The 20 identified work behaviors were all OSHA violations.

In addition, all subcontractors were clearly informed that besides following the program's rules, they had to comply with all federal, state and local occupational safety and health laws. While program implementation could reduce workers' exposure to the Focus 4 Hazards and help subcontractors to better enforce safety, it might not completely eliminate safety risks. Therefore, the GC made it clear to subcontractors that they would be fully responsible for any incidents caused by their workers.

Table 1
SMS Components Identified From the Literature & the GC's SMS

	SMS components														
References	Site safety plan/emergency preparedness	Site inspection and hazard analysis	Safety meeting/feedback	Assignment of accountability	Safety training/orientation	Safety policy/manual	Incentives for worker participation	Safety communication	Safety resources[a]	Safe work practices	Incident investigation/analysis	Safety rules/regulations	Procurement and control of subcontractors	Performance monitoring	Self-assessment/improvement
Hale, et al. (1997)		*	*	*	*			*	*	*	*	*			*
Basso, et al. (2004)	*	*							*		*			*	
Teo and Ling (2006)		*	*		*	*	*		*	*	*	*	*		
Choudhry, et al. (2007)	*	*	*	*	*										*
Fernandez-Muniz, et al. (2007)	*	*			*	*	*	*			*				*
Bottani, et al. (2009)					*	*		*	*	*	*				*
Ismail, et al. (2012)		*	*	*	*		*	*	*	*					
The GC	*	*	*	*	*	*		*	*	*	*	*	*	*	*

Note. [a]*Safety resources include PPE, first-aid supplies, and other medical and health care equipment/facilities.*

This contractor's safety management system was comprehensive in that it included nearly all components reported in the literature except incentives for worker participation.

Assessment of the GC's Safety Culture

The safety program's effectiveness in building a positive safety culture was evaluated using the the three dimensions of Cooper's safety culture model: environment, behavior and person.

Environment

The environment dimension of safety culture mainly relates to a contractor's SMS (Choudhry, et al., 2007). According to Federal Aviation Administration (FAA, 2010), SMS is a systematic and comprehensive business approach to managing safety risks. It includes organizational structures, accountabilities, policies, procedures and other workplace safety elements. Containing multiple safety components, an SMS usually has a broader scope than a safety management program.

Table 1 (p. 63) presents previously identified

The safety program strengthens various aspects of the SMS, such as safety rules, safety meetings and other means of safety communication. In turn, this provides the environment or platform to facilitate safety program implementation.

Table 2

Detailed Audit of the GC's SMS

SMS components	Detailed SMS elements	Safety program related
Site safety plan/ emergency preparedness	Emergency response plan; Warning systems and emergency team leaders; Planning and preparation for a pandemic outbreak.	
Site inspection and hazard analysis	A standard job safety analysis (JSA) form/checklist; Daily huddle meetings prior to every work shift; Safety plan of action and subject matter experts for nonroutine tasks; Preconstruction meetings for major tasks.	 X
Safety meetings	Project-specific preconstruction safety meetings; Preconstruction meetings for major tasks.	X X
Accountability	Accountability in the safety program; Progressive discipline ranging from verbal warning to termination of jobs; Retraining workers if their violations are associated with specific equipment.	X
Safety and health training	OSHA 10-hour course; The 4-hour Focus 4 orientation program; 3-hour new employee safety orientation; Additional training (weekly toolbox talks, operator training, PPE training); Update of safety policies and annual reorientation; Education program for safety communication; Linkage with the National Center for Construction Education and Research.	 X
Safety policy	Written SH&E program in three different formats (manual, condensed and pocket version) at each of the GC's locations.	X
Safety communication	Written programs; Daily huddle meetings; Preconstruction meetings; Weekly toolbox talks; Education programs; Visuals (safety banners, flags, posters, signs, hardhat stickers, tapes, etc.).	X X X X X
Safety resources	Emergency contact sticker; Certifications required for first aid, CPR and bloodborne pathogens; First-aid supplies and emergency medical equipment; Triage training for project leaders; Occupational medical facilities identified in all regions of the GC.	
Safe work practices	Administrative and engineering control methods (e.g., wet-cut); 65 standard work practices for routinely performed activities.	
Incident investigation	Using CMiC software to report accidents, incidents, near misses, etc.; Incidents reviewed biweekly by the GC's safety team; Safety alerts generated to summarize incidents and provide corrective measures.	
Safety rules	A few safety requirements that are more stringent than OSHA; Elements from the safety program (100% eye protection; daily huddle meetings) and 20 non-negotiable unsafe behaviors.	 X
Procurement and control of subcontracts	Prequalifying subs by evaluating their safety performance history; Requiring subs' participation in project-specific preconstruction safety meetings; Observing and tracking subs' safety behaviors (a prequalifier for future projects); Correction plan, additional safety specialist/competent person, or termination of contracts.	 X X X
Performance monitoring	Monthly review of data from CMiC reports; Mid-year and year-end comprehensive reports (including history of accidents/incidents, 20 nonnegotiable violations, etc.).	 X
Self-assessment/ improvement	Using SafetyNet software to identify, track and trend safe and unsafe behaviors; Weekly inspection and documentation of job sites; Informal daily job site inspection by safety coordinator and a representative from the project management team.	X

Note. *X indicates that this SMS element is more or less related to the safety program.*

SMS components and compares them with those included in the SMS. Obviously, the SMS was comprehensive in that it included nearly all components reported in the literature except incentives for worker participation. Table 2 displays the details of this SMS and how the safety program related to those components. It can be concluded that the safety program strengthens various aspects of the SMS, such as safety rules, safety meetings and other means of safety communication. In turn, this provides the environment or platform to facilitate safety program implementation.

One key feature in the SMS is safety communication with all project participants and individuals through preconstruction meetings, daily huddle meetings, weekly toolbox talks and similar activities. This helps communicate safety expectations and requirements to all the subcontractors and workers, who are also encouraged to participate in the planning process to help identify and assess potentially unsafe conditions related to specific trades. Realizing that subcontractors may not have a strong safety culture, the GC evaluates their safety records and performance as a prequalification for them to have more access to its projects.

Behavior

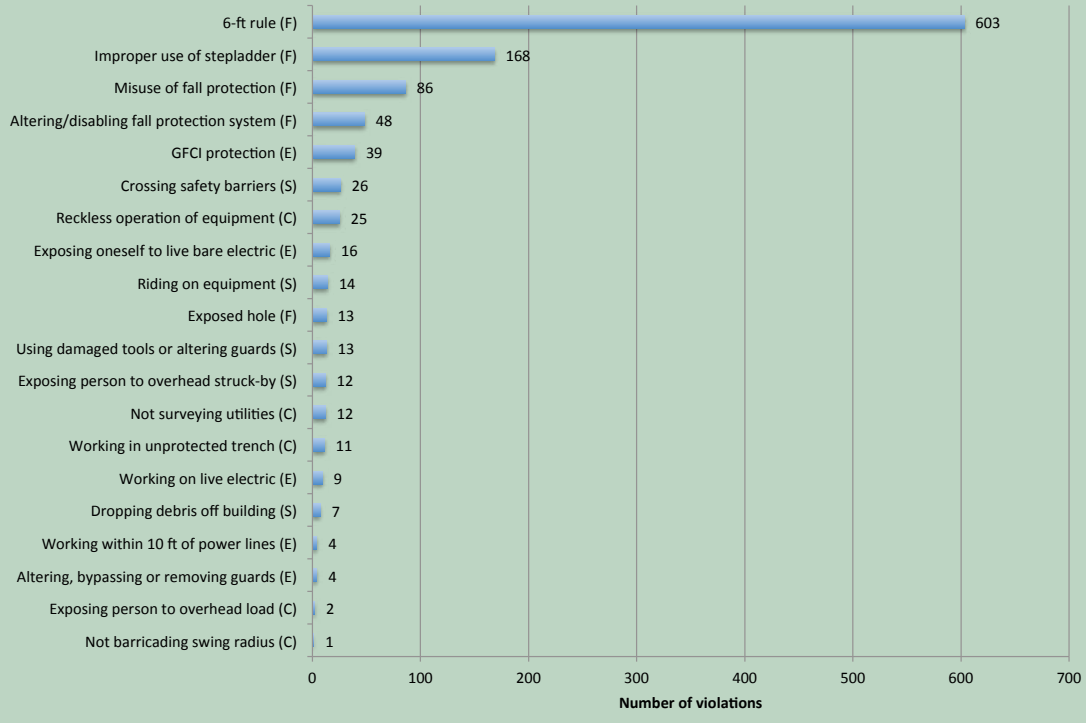
The safety program's accountability system, which is associated with 20 nonnegotiable unsafe behaviors, has been applied to both the GC's and subcontractors' employees. Safety representatives, project managers, field workers and other professionals on job sites were required or encouraged to report any nonnegotiable violations they observed. Workers who committed such violations for the first time were immediately removed from the job site for 1 day, but were allowed to return to work the next day after leading the morning huddle meeting and signing the program's engagement letter. Second violations carried larger penalties: 30 days separated from work without pay and benefits for the GC's workers and 1-year suspension from the GC's projects for subcontractors' workers. Subcontractors with a higher number of violations had to implement a correction plan and hire an additional safety specialist/competent person for the project at their cost.

From May 2008 to December 2011 (a study period of 44 months), 1,113 violations were reported and documented on the GC's job sites. Figure 3 depicts their distribution among the 20 nonnegotiables. The top four violations (81% of total violations) were related to the fall hazard. Among them, the 6-ft rule (working 6 ft above the ground or higher with no approved fall protection) was the most violated item, constituting 54% of total violations. This indicates the significant effect of the safety program on the potential reduction of fall-related incidents and injuries on job sites.

Figure 4 (p. 66) illustrates who reported the vio-

Figure 3

Distribution of Safety Violations Related to the 20 Nonnegotiables



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lations. While safety coordinators witnessed 35% of violations during their site visits, the GC's managers reported another 61%. This is a positive indicator of strong management commitment to the program because a manager's traditional role is not safety supervision. With managers' active involvement, safety responsibility was shared among middle management personnel and a greater number of unsafe behaviors were identified quickly to prevent subsequent incidents or injuries. Although only a small portion of violations (approximately 2% or slightly more than 20 instances) was reported by workers, this showed that workers could take responsibility for their peers' safety.

The safety violation rate (SVR) was first introduced by Chen and Jin (2012b) to properly assess the reduction in unsafe behaviors by eliminating the influence of varied employee hours. Similar to the incident rate, SVR measures the number of violations based on the annual working hours of 100 full-time workers. It is calculated as SVR = (number of violations/employee hours) x 200,000.

For this research, annual SVRs for the three study groups (GC, subcontractors, GC and subcontractors combined) were calculated and compared (Figure 5). Apparently, the overall trend of SVRs dropped for all three study groups from 2008 to 2011. It should be noted that subcontractors' annual SVRs (ranging from 15.35 to 11.32) were much higher than the GC's (falling between 2.69 to 0.90). However, after staying high for around 3 years, subcontractors' SVR eventually dropped in 2011 by 31% compared to their annual SVR in 2010.

The inconsistency of SVRs between the GC and subcontractors could be due to the frequent change of subcontractors for the GC's jobs. Unlike the GC's own employees, who worked on the same company job sites and were constantly exposed to the safety program, a higher percentage of subcontractor employees could be new to the GC's job sites. It would take them time to become familiar with the program and specific safety rules.

However, after continuous implementation, it was more likely that most subcontractors working for the GC had experience with the program and were able to make positive progress. This suggests that continuous program education and enforcement among subcontractors, and building long-term business relationships with them would be helpful and will eventually have a positive effect on their safety performance.

Figure 4
Observations Captured by Job Classification

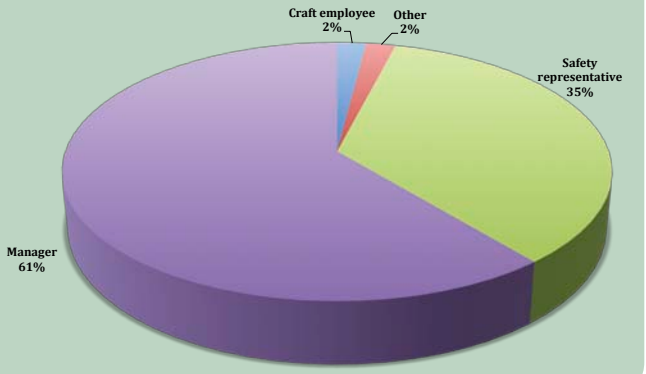

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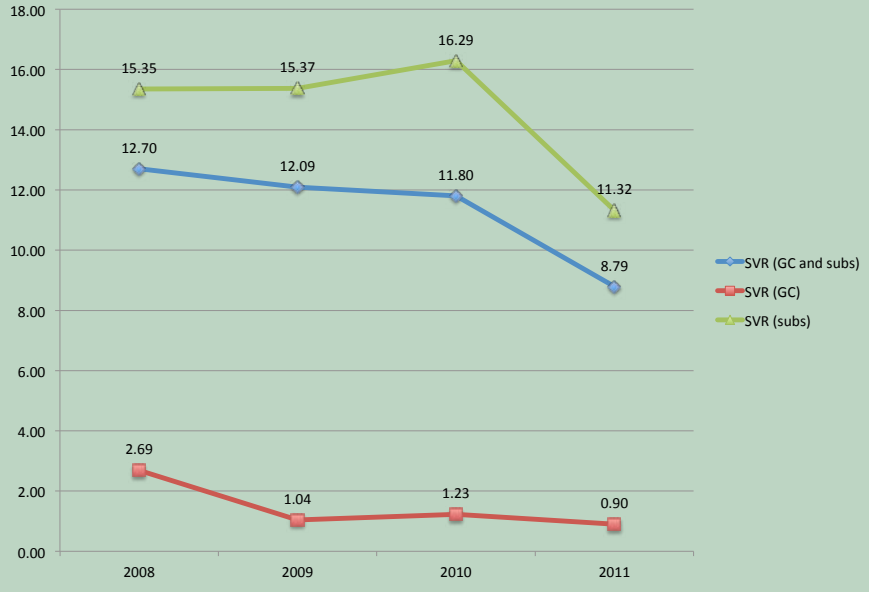
Figure 5
Safety Violation Rates, 2008-11



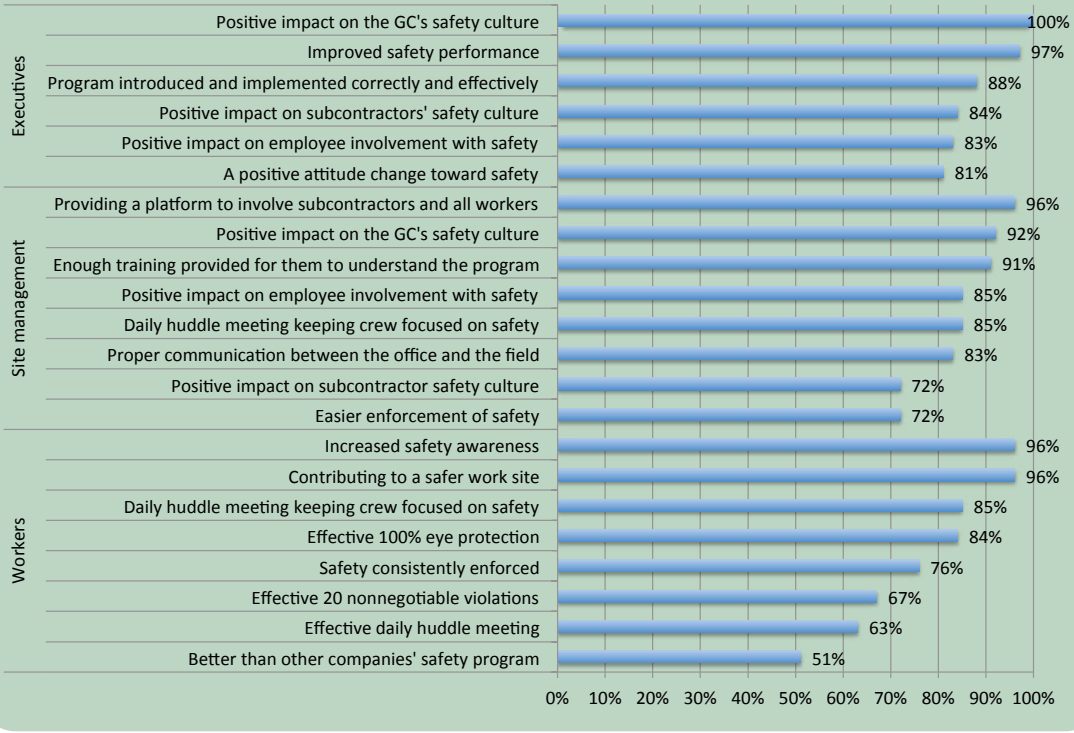
Person

Worker involvement is a necessity when building an effective SMS (Fernandez-Muniz, Montes-Peon & Vazquez-Ordas, 2007). For the program to succeed, employees must perceive organizational safety culture as valid and important (Cooper, 2000). The three safety climate questionnaires developed for three individual groups contained 66 questions in total. Due to space limitations, the major findings from the three questionnaire surveys regarding employee perception of the program are summarized here. Detailed survey questions and more statistical analysis results can be found in Chen and Jin (2012a).

Awareness. Workers were asked about their awareness of the safety program, its basic elements and the 20 nonnegotiables. Results showed that 99% of all workers surveyed (30% from the GC and 69% from subcontractors) were aware of

Figure 6

Percentage of Survey Participants Having Positive Acceptance of the Program



Most participants had positive views. These included improved safety awareness, attitudes, culture, performance, and better involvement of subcontractor employees and all workers.

the safety program in general. However, their levels of awareness of the three basic elements and 20 nonnegotiable behaviors significantly decreased to 74% and 33%, respectively. This suggests that although workers had some understanding of the program, their knowledge of its detailed safety requirements was limited and needs to be improved through continuing education. The early statistical study (Chen & Jin, 2012a) found that the following factors had affected workers' learning outcomes related to the 20 nonnegotiables:

- The joint use of training (classroom and/or orientation video) and visuals (e.g., posters, handouts) was statistically more effective than using training or visuals alone.
- Older workers (above age 50) were more effective in learning nonnegotiables, suggesting safety training for young and middle-aged workers should need to be strengthened.
- Those who had previously worked for the GC or had committed a prior violation showed greater awareness, indicating that constant exposure to the program and personal experience had a positive effect on workers' learning outcome.

Acceptance. All participants were surveyed to assess their acceptance of the safety program. Questions included "Do you agree that the safety program has improved your company's safety performance?"; and "Do you feel that the safety program contributes to a safer work site?" Figure 6 summarizes the percentage of respondents who claimed the program's positive effect on each of the acceptance items given in the questionnaires.

For each item, the remaining participants gave either a neutral or negative response. As shown in Figure 6, most participants had positive views. These included improved safety awareness, attitudes, culture, performance, and better involvement of subcontractor employees and all workers. In particular, top executives and site managers had more consistent perceptions for all items, with positive response rates ranging from 81% to 100%, and 72% to 96%, respectively. Workers' positive response rates for all items had greater variations, ranging from 51% to 96%.

It is worth noting that a higher percentage of top executives and site management personnel had positive perception of the program's effect on the GC's safety culture than on the subcontractors. This is evidenced by p values of less than 0.01. The program's higher positive effect on the GC's safety culture might be a contributing factor to the lower annual SVRs achieved by the GC's workers.

When workers were asked whether the program was better than other safety programs they had experienced, 51% answered *yes* while 43% answered *the same.* Only 6% thought that the program was less effective than those implemented by other companies. Employees indicated that some companies had already implemented or were considering implementing the same or a similar safety program.

Enhanced safety awareness, attitude and accountability builds a more positive safety culture in the long run.

Accountability. The study found increased safety accountability among survey participants from all three groups. For example, 55% of executives surveyed answered positively to the question, "Do you agree that the responsibilities associated with your job have increased due to the implementation of the safety program?" Furthermore, a high percentage (94%) of the GC's executives claimed that they also held their managers accountable for safety enforcement.

On the other hand, a similar percentage (56%) of site management personnel felt increased safety accountability. This is a positive indicator of enhanced management commitment and safety culture. Survey results also showed that 91% of site management personnel felt comfortable explaining the program to workers, 89% felt comfortable enforcing safety in the workplace and 67% felt comfortable directly addressing a nonnegotiable behavior. In addition, 81% of site management personnel perceived that the procedures for reporting and managing the accountability element were easy to implement.

Among all workers surveyed, 99% knew they would be accountable for their safety on the GC's job sites. Nevertheless, a much lower percentage actually knew the consequences of safety violations. Specifically, only 59% correctly described the consequences for first-time violations and 30% correctly described the consequences of second-time violations.

The statistical analysis showed that the percentage of workers who claimed they knew the consequences of safety violations was significantly higher than the actual percentage of workers who selected the right consequences ($p < 0.01$). The discrepancy confirmed the need for continuing education on the accountability system.

Others. Questions related to the program's effect on project cost/schedule, general safety climate and suggestions for continuous improvement of the program were asked. Examples were: "Do you believe that the implementation of the safety program slows down work progress'"; and "Would you risk getting hurt to get the job done?"

Despite the potential increase of the operating budget (perceived by 20% of top executives and 48% of site management, respectively) and schedule (perceived by 55% of site management), up to 67% of executives and 80% of site management personnel still believed the program was necessary, would prevent incidents and save money in the long run. Through general safety climate questions, the researchers found that 84% of workers would not likely take risks to get the job done. Up to 93% of workers felt responsibility for their coworkers' safety and 79% were likely to address unsafe behaviors.

Survey participants were asked to briefly describe both the positive and negative feedback they had heard regarding the program and from whom. The results showed that the safety program was well received by various stakeholders, including owners, subcontractors, management, workers, OSHA and other organizations such as Associated General Contractors of America and Builders Exchange.

While survey participants from all three levels provided numerous positive reviews for the program (e.g., enhancing safety awareness, attitude and accountability, providing clear rules and expectations, and creating safer job sites), they also provided suggestions for improvements. The most frequently mentioned strategies included seeking feedback from subcontractors/workers, providing continuing education and training, enhancing the consistency of safety enforcement, keeping safety rules updated, and providing safety incentives/rewards to workers. This insightful feedback showed the employees' strong willingness to be actively involved in and educated about the program.

The findings indicate that the GC has established a relatively positive safety culture represented by a comprehensive SMS, decreasing rates of behavioral violations, and overall positive perceptions of the safety program and the importance of safety in the workplace among its own employees and subcontractors hired.

Limitations

In this study, the information obtained through safety climate surveys was subjective in nature. However, by designing effective questionnaires, administering the survey carefully, and properly analyzing survey results, this study provides valuable insights to the GC and other contractors to improve their SMS. The survey questions were organized into several widely applicable themes (e.g., awareness, accountability, acceptance). However, most were still specific to the safety program investigated. Therefore, when used to assess other contractors' safety programs, these questions must be revised to capture the characteristics of those programs.

Conclusion

This research took a holistic approach to assessing a GC's safety culture based on an integrated safety culture model that consists of three interdependent dimensions: environment, behavior and person. The purpose was to help evaluate the effectiveness of a safety program the GC launched to build a positive safety culture. Researchers audited and summarized the key components of the GC's SMS, tracked 20 nonnegotiable behavioral violations, and surveyed top executives, site managers and workers about safety climate. The analysis reveals the program's overall positive influence on the SMS, safety behavior enforcement and monitoring, and job site safety climate.

Specifically, the researchers found that the SMS was comprehensive in that it included almost all components reported in the literature, and the elements of the safety program connected with and strengthened many of these components to varying extents. The only missing component (incentives for worker participation) was noted by survey participants in their suggestions for continuous improvement. This showed that positive reinforcement was generally favored by both workers and management, and was deemed important to the success of a safety program requiring behavior change.

This study found decreased safety violation rates among both the GC's and subcontractors' workers. The wide participation of middle managers in enforcing site safety and reporting violations (required by the program's accountability system) could be the main contributor to the success achieved. The philosophy that safety is not just the concern and responsibility of safety personnel but everyone on the site will not only continuously benefit this GC but also have a far-reaching influence on other contractors' safety culture and management practices. The longer time subcontractors took to make positive progress toward better safety performance demonstrates the importance of continuous education about and enforcing a safety program among subcontractors' workforces.

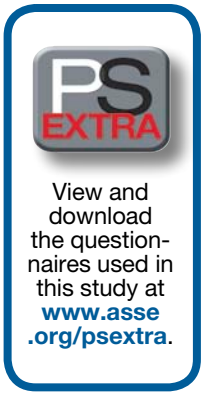
Feedback from safety climate survey respondents shows that the safety program was well received by various stakeholders inside and outside the GC's organization. Overall, high program awareness, acceptance among survey participants and increased employee accountability for safety further indicate its effectiveness in building a positive safety culture.

However, despite these achievements, continuing education/training are needed to enhance workers' awareness of specific program elements, detailed safety requirements and consequences of safety violations. Better employee involvement and feedback, including subcontractors' workers, will help to continuously improve this program.

This research provides practitioners with an example of how safety culture could be measured holistically and how it could be improved through an effective safety program. Although it was perceived that the GC's safety culture benefited more from the program than did the culture of subcontractors, the feedback from subcontractor employees revealed that their companies had already implemented, or were considering implementing, the same or a similar safety program.

No matter the specific format the programs take, the enhanced safety awareness, attitude and accountability of employees would help build a more positive safety culture for those contractors and benefit them in the long run.

Based on these results, the authors recommend that contractors use safety culture measurement as a self-assessment tool to assess how safety is viewed, communicated and enforced in their organizations; whether the safety programs in place are effective; and whether new safety initiatives should be developed and implemented. It is also a good strategy for a GC to build long-term business relationships with its subcontractors. This will help reduce the number of workers who are new to the GC's safety policies/programs and enhance the influence of its best safety management practices on a subcontractor's workforce. **PS**



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