

An Effective Approach to Enhancing Jobsite Safety Management and Performance: Case Study

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Safety management is becoming increasingly important in the construction industry. Effective safety management not only reduces contractors' incident rates and compensation costs but also enhances their productivity and efficiency in project execution. In addition, better safety performance increases contractors' competitive advantage in the market by providing better values to their clients. This paper presents a case study of an onsite safety management program launched by a general contractor. First, it reviews the contractor's motivation and goals for creating this program, the major elements of the program, and its implementation steps. The initial findings, based on quantitative measurement of incident rates, are presented to show the effectiveness of the program. Further discussions are also provided to summarize the working mechanism of this program and lessons learned during its implementation. The information presented will help promote this dedicated effort to the broad sectors of the construction industry. Future research will focus on understanding the influence of the program on safety culture and climate as well as identifying points of resistance and potential problems for continual improvement.

Key Words: Construction, Safety Management, Safety Performance, Focus 4 Hazards

Introduction

Construction is a risky occupation for workers. According to the most recent census data from the U.S. Bureau of Labor Statistics (BLS, 2008), 5,488 work-related fatalities were reported in 2007. Of these, 1,178 or 21.5% occurred on construction sites. The fatality rate (10.3 per 100,000 employed) ranked fourth highest among various industries. Most fatal construction accidents occurred cumulatively in several hazard categories. As identified by BLS (2005), the four most dangerous hazard categories are: 1) falls to a lower level (32.2% of fatal construction injuries), 2) struck-by objects (10.9%), 3) contact with electric currents (9.0%), and 4) caught-in or crushed by collapsing materials (4.4%). They are also referred to as the OSHA (Occupational Safety and Health Administration) "Focus 4" Hazards.

Various safety management strategies and approaches have been implemented in construction to reduce fatal accidents, injuries, and unsafe behavior. Behavior-Based Safety (BBS) is the systematic application of psychological research on human behavior (Choudhry et al., 2007a) through observation and monitoring of unsafe jobsite behavior. BBS also aims to help individuals understand and accept safer behaviors and implement recommendations based on their feedback. Job Hazard Analysis (JHA) focuses on the identification of task-related hazards to reduce the risk of injuries to workers (Chao and Henshaw, 2002; Rozenfeld et al., 2009). 4D CAD technology and a virtual reality-based design-for-safety-process (DFSP) tool help analyze, identify and control construction hazards inherited from the design (Hadikusumo and Rowlinson, 2002; Benjaoran and Bhokha, 2009). Enhancing organizational safety culture and workplace safety climate can have positive impacts on work environment and safety performance (Mohamed, 2003; Choudhry et al., 2007a, b; Zhou et al., 2007; Oh and Sol, 2008).

To reduce fatal injuries and workers' exposures in the four hazard categories, a general contractor (hereinafter called "the GC") in the building construction field launched the "Safety4Site" program at the end of May, 2008. This program aimed to enforce onsite safety management and the violation reporting mechanism for 20 non-negotiable behaviors, such as improperly using a step ladder. These non-negotiable behaviors were considered major contributing factors to Focus 4 Hazards. After implementing the program for more than two years, the GC perceived improved safety performance on its jobsites and also received positive feedback from peers and trade associations

with several industry safety awards. This paper introduces the “Safety4Site” program and presents initial research findings on the working mechanism and performance of the program.

Background

To provide background information, various safety management strategies applied in the construction industry are briefly reviewed. How the performance of these programs can be properly evaluated is also discussed in this paper.

Existing Safety Management Strategies

Besides elevated OSHA safety regulations and standards, various safety management strategies and programs have been applied in construction to improve contractors’ safety performance. BBS is one of the most widely used strategies, which dates back to the work of Heinrich (1931). According to Heinrich, 95% of all workplace accidents are caused by unsafe acts, most of which are “man-failures.” Thus workers’ at-risk behaviors become the focal area of safety management. For example, Lingard and Rowlinson (1998) implemented BBS to improve a contractor’s safety records by inspecting pre-established safety behaviors related to housekeeping, access to heights, bamboo scaffolding, and personal protective equipment (PPE). Although BBS is sometimes criticized for long duration, high cost, and short-term effects on behavior shift (Eckenfelder, 2004), industry surveys have shown positive outcomes from applying BBS to reduce construction incidents and changing behavior and attitude (Cooper, 2003; BSMS, 2010).

Other proactive safety management strategies have also been introduced into construction. JHA, also referred to Job Safety Analysis (JSA), helps identify task-related hazards for accident/incident prevention (Chao and Henshaw, 2002). Based on JSA, Rozenfeld, et al. (2009) developed the “Construction Job Safety Analysis” (CJSA), a structured method for hazard analysis and assessment of construction activities. Hadikusumo and Rowlinson (2002) proposed a DFSP tool to identify inherited safety hazards during the construction utilizing virtual reality functions and a safety database. Benjaoran and Bhokha (2009) described a 4D CAD technology application that analyzes the design information to automatically detect jobsite hazards and generate necessary safety measures. These measures are then inserted into the construction schedule and visualized on the 4D CAD together with construction sequences.

In recent years, it has been gradually realized that the organizational safety culture can play a positive role in promoting safe work environments (Mohamed, 2003; Nieva and Sorra, 2003; Vecchio-Sudus and Griffiths, 2004; Choudhry et al., 2007a, b). Cultural interventions have also been adopted by construction companies and government agencies, e.g., the “Culture and Safety Awareness” campaign launched by the Dutch Ministry of Social Affairs and Employment. These interventions have achieved considerable progress on incident reduction (Oh and Sol, 2008). Zhou, et al. (2007) used a Bayesian Network Based Model to demonstrate that safety climate has a more significant influence on employees’ safety behavior than personal experience. Therefore, understanding the safety climate’s impact on safety performance is important for creating an effective safety program.

Assessment of Safety Management Program and Performance

It is widely perceived by the industry that effective safety management programs can enhance contractors’ safety performance in terms of incident rates (including lost time incidence rate, severity rate, and recordable incident rate) and experience modification ratings (EMRs). Incident rates and EMRs are considered quantitative safety performance measurements (Jaselskis et al., 1996). Some researchers indicated that the outcome data (such as accidents) are not a good measurement of safety performance. For example, Glendon and McKenna (1995) listed 15 drawbacks of outcome-based safety measurement and pointed out that the accident data are “insufficiently sensitive, of dubious accuracy, retrospective, and ignore risk exposure.” Behavior sampling was suggested as a more accurate alternative method for measuring safety performance.

Other researchers categorized safety performance measurements into reactive and proactive indicators (Stricoff, 2000; Cooper and Phillips, 2004; Choudhry et al., 2007a). Reactive measurements including incident rates and compensation costs occur after the event and are measured based on the low levels of occurrence of system failures, which are not reliable. Proactive approaches focus on safety climate, safety behavior, and hazard identification. They are considered superior to accident data because they pay more attention to present activities for accident prevention. Unlike accident/incident-based measurement, which is more straight-forward, measuring proactive

indicators such as safety behavior, safety climate, etc. is difficult. Various dimensions (categories) and methods (both qualitative and quantitative) need to be used according to previous studies (Edkins, 1998; Griffin and Neal, 2000; Glendon and Litherland, 2001; Cooper and Philips, 2004; Wu et al., 2007, 2009; Choudhry et al., 2009; Jiang et al., 2010).

Research Goals and Methodology

This research was one part of a research agenda that aims to: 1) holistically assess the “Safety4Site” program’s overall effectiveness in improving safety performance on the GC’s jobsites, 2) understand the influence of the safety program on organizational safety culture and workplace safety climate, and 3) identify points of resistance and potential problems for continual improvement. *The specific goals of this research* were to understand the working mechanism of the “Safety4Site” program and perform quantitative measurement on the effectiveness of the program in reducing jobsite accidents/incidents.

Literature review was used in this research to help understand existing safety management approaches in the construction industry, their pros and cons, and methods used to evaluate their effectiveness. The researchers conducted face-to-face interviews with two of the GC’s vice presidents and its safety director. The purposes were to collect information related to the “Safety4Site” program and learn their perceptions on the program’s present status, potential problems, and ways of improvement. The researchers also went through the GC’s “Safety4Site” orientation training program and multimedia education materials available. The 5-year incident rate data (2005-2009) from the GC and its subcontractors (Subs) were retrieved and data analysis was performed to compare incident rates before and after implementation of the program. Monthly incidence rates for both the GC and its Subs (during the 19-month implementation of the “Safety4Site” program) were analyzed to understand the impact of the program on reducing jobsite accidents/incidents and how the program was launched and took effect.

A Case Study - the GC’s “Safety4Site” Program

Founded in 1932, the GC is a Cincinnati-based contractor operating in four states with eight regional offices. The GC has established its outstanding safety track records while offering quality construction, project management, and design-build services in a wide variety of construction projects. In the 2007 Economic Development Guide of Excellence in Design and Construction (Building), which shortlisted design and construction professionals in Indiana, the GC had the lowest EMRs among all the contractors listed: 0.53 for the year of 2004 and 0.57 for 2005 (Building Excellence Media, 2007). In 2007, a suspension scaffold fell from a height of 30 feet during a stucco panel installation in the GC’s Indianapolis region. Two workers working on the platform were using proper fall protection and were not injured. The other two workers, who did not use any fall protection equipment, fell to the ground. One suffered fatal injuries and one was badly injured. This incident led the company’s executive officers to reconsider its already prioritized safety goal. They started to look for new and more effective ways to reduce or eventually eliminate accidents and injuries on their jobsites.

The “Safety4Site” program was designed and implemented to reduce injuries and workers’ exposures in OSHA Focus 4 Hazards. This program focuses on increasing the safety awareness and accountability of the GC’s employees, all hired Subs, and material suppliers of all tiers, while achieving positive and enthusiastic changes in safety attitude and behavior. The long-term goal is to “create a lasting impact on the construction industry in terms of workplace safety.” During the coordination of this research, the message from the GC’s executive officers was: They do not want to keep this program for themselves; they hope that this program could spread out and benefit other contractors and the industry as a whole if found to be effective.

Major Elements of the “Safety4Site” Program

The safety program consists of three key elements: 1) eye protection, 2) daily “huddle” meetings, and 3) accountability for accidents, incidents, and near misses. Eye protection is required for all workers at all times on the project except during scheduled breaks away from potential eye hazards or while in a trailer. There is a required daily “huddle” meeting (tool-box meeting) where team members from the GC (including foremen, crew members, and/or the superintendent and project manager) can quickly update the status of what they have been working on and

their daily work plan. This meeting is also mandatory for each subcontractor prior to every work shift. The program emphasizes the accountability for accidents, incidents and near misses by identifying 20 unsafe non-negotiable behaviors within the “Focus 4” categories (see Table 1) and holding all employees accountable for their safety and health responsibilities.

Table 1: 20 non-negotiable behaviors identified in the Safety4Site program.

Hazard category	Non-negotiable
Falls	1) Working 6 feet above the ground or higher with no approved fall protection; 2) Exposed holes, which are large enough for a human to pass through and 6 feet or greater in depth, left unprotected or improperly protected; 3) Blatant, clear and/or intentional misuse of fall protection equipment/systems; 4) Altering or disabling any component of a fall protection system which exposes oneself or other workers to a fall hazard; 5) Improperly using a step ladder.
Struck-by	6) Disregarding red danger tape or barrier/ crossing without proper authorization; 7) Dropping debris off buildings without proper chutes or approved alternate procedures; 8) Riding on equipment not designed for multiple passengers; 9) Using damaged equipment that may inadvertently fire or altering the equipment where the safety is by-passed; 10) Exposing person(s) to overhead struck-by hazards by not barricading the area on lower levels.
Caught-in-between	11) Working in unprotected trenches or excavations (5 feet or greater); 12) Not surveying for utilities before digging; 13) Operator not barricading/protecting swing radius and/or pinch points; 14) Operator exposing employee(s) to an overhead load while working in an excavation; 15) Reckless operation of equipment.
Electrical	16) Working within 10 feet from power lines; 17) Exposing oneself or others to live bare electrical conductors (>50 volts); 18) Working on live electric without proper PPE and procedures; 19) The unauthorized altering, by-passing or removing of any guards, locks, tags, or any other safety device protecting persons from live electricity; 20) Not using a GFCI (ground fault circuit interrupter) when using temporary wiring (including extension cords) for construction or maintenance purposes on active construction sites.

The 20 non-negotiable behaviors are evenly distributed into four categories, namely falls, struck-by, caught-in-between, and electrical. Most of these unsafe behaviors are typical safety violations regulated by OSHA, such as improperly using a step ladder, riding on equipment not designed for multiple passengers, not surveying for utilities before digging, working within 10 feet from power lines, etc. However, a few non-negotiable behaviors are more stringent than OSHA regulations, such as working from a height of 6’ or greater with no approved fall protection.

Implementation Timetable, Steps and Costs

In the 4th quarter of 2007, the GC started to brainstorm concepts to improve its safety performance. Six ideas, such as wearing safety glasses at all times, mandating daily huddle meetings, etc., were proposed and advice and feedback were widely solicited from foremen and craftspeople hired by the company across eight regions. Based on these ideas, the concept of “Safety4Site” was finally formed and further developed. In the 1st quarter of 2008, the GC launched the internal training program for project managers and craftspeople. One-hour meetings with Subs were held to communicate what the company is doing, the purpose of the program, how the program works, etc. A two-month probation/warning period (March-May, 2008) was given to all the parties involved, during which feedback was collected and violations incurred 195 warning tickets. At the end of May, the program was in full effect. The GC expected annual evaluation of the program, so program progresses and problems can be reported.

The actual implementation of this program took multiple steps, adopting both the top-down and bottom-up approaches. The “Safety4Site” commitment started at the top executive level, but all employees (middle

management and workers) were required to provide “buy-in” before it was formally implemented at jobsites. Training was performed at three different levels:

- a. 3-hour Manager Implementation Training for over 100 senior project managers in the GC’s organization. They then became trainers and facilitators of this program for lower-tier management staff. The training focused more on conflict management (how to handle confrontation), the understanding of managers’ needs, and the identification of available program resources rather than on the technical aspects of accident prevention and safety management.
- b. 4-hour OSHA “Focus 4” Hazards Training for the GC’s employees including approximately 450 management staff and 450 craftspeople. During the training, the program was introduced to the attendees, feedback was solicited for improvement, and commitment to attend the program was obtained.
- c. All Subs’ employees received training on “Safety4Site” through huddle meetings, jobsite kick-off meetings, external consultations, and contractor orientations.

Implementation and enforcement of this program at the subcontractor level was deemed most important. Subs were allowed to either use their own safety and health management system or adopt the GC’s. No matter which system they used, onsite contractors were required to follow “Safety4Site” while performing their work. For example, 100% eye protection and daily huddle meetings were mandatory to all Subs’ employees. The program was also communicated to all others involved in a construction project including the owner, designers, suppliers, and the general public. Jobsites hazard awareness and housekeeping were given immediate attention to provide safer work environments. The “Safety4Site” commitment was visualized through specially designed safety banners, flags, posters, signs, hardhat stickers, tapes, measures, etc. The reporting mechanism for safety behavior violations is described below:

- a. First time violation: The workers are immediately removed from the jobsite for one day after violation is observed and/or reported. They must return to the jobsite the following morning to lead the huddle meeting on the “Safety4Site” Non-Negotiable violated. Individual review of the “Safety4Site” program and discussion are to be carried out between the management staff and the workers who committed the violations. They will then be required to sign the engagement letter for the program and be allowed to work again. This enhances the two-way communication and worker involvement.
- b. Second time violation for the same employee: 1) For the GC’s employees, they are separated from the GC for 30 days without pay or benefits, but are eligible for rehiring; 2) For Subs’ workers, they are dismissed from all the GC’s projects for one year.
- c. For Subs who have a higher number of violations, it is mandated by the contract for them to have a plan of action for correction as well as a full-time safety specialist/competent person on the project at no additional cost to the Owner or to the GC. The breach of contract will lead to the termination of the contract.
- d. A violation can be reported by management staff, peer workers, and/or a representative.

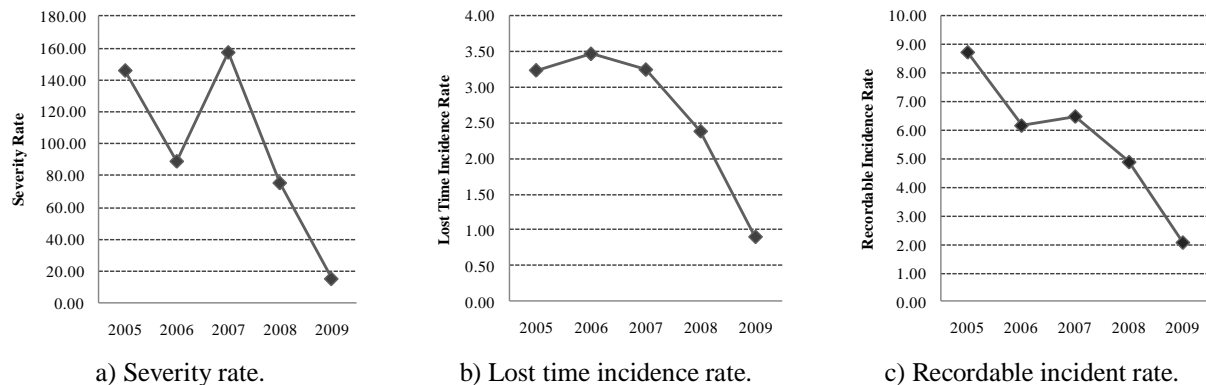
By September, 2009, approximately \$300,000 had been spent to implement the “Safety4Site” program, covering all the education activities (\$200,000) and marketing expenses (\$100,000) for visual aids set up at jobsites. These expenses were reasonable in consideration of the total revenue (approximately \$700 million) of projects that were being put into place by the GC during the program launch period. During the program implementation, regular safety inspections and audits were still performed. For example, the DBO2 Safety Net system was used to provide a comprehensive safety observation process and document safety trends over a wide perspective of site conditions. Incentives to improve safety performance also remained in place.

Data Analysis and Results

According to the literature review, so far there has been no uniform standard to evaluate and quantify the effectiveness of a safety program. This research investigated and analyzed the contractors’ safety performance data—incident rates—to determine the effectiveness of the program. The GC has been tracking its annual severity rate, lost time incidence rate, and total case incidence rate (TCIR) over the years. TCIR was calculated using the recordable accidents, which refer to non-fatal injuries that require more than First Aid treatment. Labor hours were estimated using the formula: $\text{Revenue (\$)} \times 40\% / \40 , in which the total labor cost was estimated as 40% of the total revenue and the labor hourly rate was \$40. For this study, 19 monthly incidence rates during the

implementation of the “Safety4Site” program (from March 2008 to September 2009) were also made available to researchers.

Figure 1 shows the GC’s annual severity rate, lost time incidence rate and TCIR from 2005 to 2009. There was no clear trend or consistency showing that the GC’s safety performance was becoming better or worse during 2005 and 2007 before the launch of the safety program. However, after the program was launched in March 2008, the company’s 2008 and 2009 annual severity rates, lost time incident rates and TCIRs continuously dropped in a significant manner, implying the program’s effectiveness in reducing accidents/incidents in the GC’s organization.



Severity rate = number of days lost \times 200,000 / employee hours worked

Lost time incidence rate = number of lost time incidences \times 200,000 / employee hours worked

Recordable incident rate = number of facilities and injuries and illnesses with and without lost workdays \times 200,000 / employee hours worked

Figure 1: The GC’s safety performance measurements (2005-2009).

During the implementation of the “Safety4Site” program, the GC has kept monitoring monthly safety performance in terms of incident rates for itself and its Subs across eight regions. All of the observed safety violations (non-negotiable behaviors defined by the “Safety4Site” program) have been thoroughly recorded and categorized. The 19-month data provided rich information for understanding how the safety program was applied and enforced in the GC’s and Subs’ organizations and what the outcomes were in terms of incident rates and safety violations.

Figure 2a compares the monthly TCIRs from the GC, Subs, GC-and-Subs combined, and the industry average in the 19 months. In the building construction sector, the 2008 and 2009 industry average IRs were 4.0 and 3.7, respectively, according to the data of nonfatal occupational injuries and illnesses from BLS (2009; 2010). Non-residential building construction had slightly higher IR (e.g., 4.4 in 2008) when compared to residential construction (3.5 in 2008). Since there are variations in practice about the labor hour calculations and reportable incidents from company to company, it is more meaningful for this study to focus on the safety performance within the same organizations over time rather than comparing them with other companies or industry average. Therefore, the industry average IR was just used as a reference. As shown in the graph, in most months, the Subs’ IRs and the combined IRs were below industry average. It seems that in certain months the GC had higher IRs than its Subs and industry average and its monthly IRs also fluctuated more than Subs during the studied period, especially for data in 2008. This might be because GC had less labor hours overall when compared to Subs, so occasionally occurring accidents had larger impact on its monthly IRs.

A further analysis (Figure 2b) provides a comparison between TCIRs in 2008 and 2009 for the GC, Subs, and GC-and-Subs combined. Since 2008 was the first year that the “Safety4Site” program was launched and it took time for the affected employees to get familiar with the new rules, the effect of the safety program was limited. However, when the program was well established after the initial period, the effectiveness of the program improved. This can be seen in Figure 2b. The GC’s annual TCIR was reduced from 5.15 in 2008 to 2.31 in 2009. The 2009 TCIR for Subs did not change very much but was well below the industry average (3.7). Data analysis indicates that Subs’ overall TCIR was lower than the GC’s in 2008 but slightly higher than the GC’s in 2009. This is because the GC had a significant improvement on its incidence rate in 2009 due to the implementation of this program.

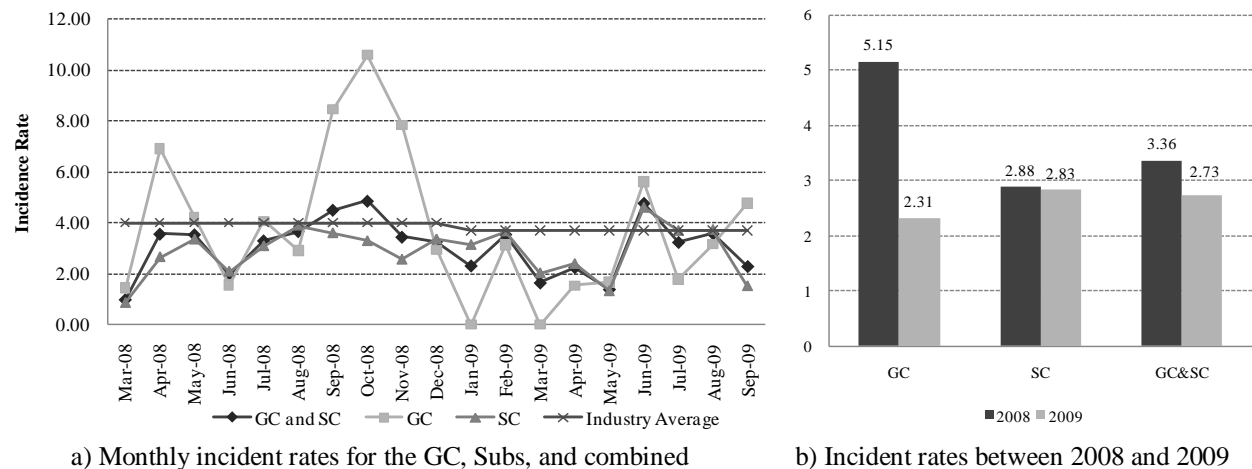


Figure 2: TCIR over the 19-month program period (March 2008 to September 2009).

“Safety4Site” has so far significantly reduced the GC’s incident rates as well as accident costs. An evidence-based estimate showed that over 100 workers were protected from severe work-related injuries or fatal accidents since the program was put into place. The program was also incorporated into several partnership programs between the GC and OSHA later on, e.g., Health Alliance Hospital OSHA Strategic Partnership (\$ 207 million) and Xavier University Hoff Academic Quad Phase 1 (\$89 million). Through close collaboration with OSHA, the GC received a maximum penalty reduction of up to 25% and other benefits. The sites were also exempted from programmed OSHA inspections. The partnership programs not only helped establish a safe work environment but also promoted the best practices for safe operation, e.g., using wet cutting techniques and/or dust collection systems. The GC was recently named one of the nation’s safest construction companies by the Associated General Contractors (AGC) of America and placed first in the National Associated General Contractors’ 2009 Construction Safety Excellence Awards. The “Safety4Site” program has become ingrained in the corporate culture of the company. Due to the overwhelming success of this safety program, how this program was developed and implemented becomes a model for other initiatives the GC plans to launch.

Lessons Learned and Recommendations

The GC has perceived that owners’ awareness, commitment, and involvement are important for the success of the program and the contractor who implements the program. There are a few reasons for this. First, the implementation of this additional safety program adds extra costs to a construction project. This limits a contractor’s ability to offer a competitive price. Second, companies achieving better safety performance will feel discouraged if they do not see any advantage in the bid evaluation and selection process. Owners’ priorities may determine how they select business partners. Third, if the owner does not view safety as one of his or her top priorities, there might be conflicts in project management and execution between the owner and the contractor. However, currently, there is no perceived acceptance, special support, or extra benefit from the owner’s side. The GC has discussed with OSHA about the importance of communicating this program to owners. The incurrence of additional project costs was envisioned during the meeting if measures to enhance communication need to be launched.

In recent years, “Best Value Contracting (BVC)” has gained greater acceptance from both public and private owners as one of the most widely used alternative procedures to lowest responsible bidding. BVC awards projects to contractors who have the best combination of price and other factors such as technical expertise, safety history, training and apprenticeship, etc. This allows owners to pursue the best value for their projects at the best price. The owner’s adoption of BVC would probably resolve the above-mentioned issues because superior safety performance and elevated safety management may help contractors earn a higher performance score and raise their rankings in the competition.

Interviews with the GC’s executive officers and safety director disclosed that safety performance was significantly boosted at the points in time when marketing/promoting activities for the program were conducted. Therefore, to

make the program more effective, continuous promotion and enforcement are needed. These include continually talking about the program, reminding the workers of their obligations, deliberately communicating with project participants, and explaining causes and effects.

Conclusions and Future Research

This paper presented the case study of a GC's "Safety4Site" program. The paper first introduced the contractor's motivation and goals for launching this program, the major elements of the program, and its implementation steps. The initial research findings based on data analysis of incident rates were presented. Through comparing before-and-after incident rates and incident rates between 2008 and 2009, the researchers found that the BBS-based "Safety4Site" program was effective in preventing and reducing injury-causing accidents on jobsites. The improvement in the GC's organization was greater than that of the Subs' organizations.

Several mechanisms were found to be very beneficial for the implementation of the safety program. Firstly, the GC required the full commitment of all the parties involved in a project no matter whether they agreed or disagreed on the safety management measures put into place. However, feedback from participants was collected during the training to optimize the program. Secondly, the GC promoted attitude change in the management staff and construction workers from a firm approach ("*compliance with safety rules and regulations set forth by OSHA – have to perform tasks safely*") to a more soft-sided safety management approach ("*establishing a safety culture – want to perform tasks safely*"). This helped eliminate the "convenience rules" that sacrifice safety. Thirdly, the reporting mechanism and consequences of safety behavior violations were clearly defined. This facilitated the implementation and enforcement of the program. Lastly, the GC's jobsites were cleaned up due to the program. The various safety visual aids on jobsites reminded people of their obligations and kept them actively engaged.

This research evaluated the effectiveness of the "Safety4Site" program using a quantitative measurement method, which was just one part of the holistic approach. Further research will be focusing on:

- Performing data analysis on safety violation tickets to understand the distribution of safety violations among hazard categories and trades and how the violations are reported.
- Conducting questionnaire surveys and related data analysis to understand the influence of the safety program on organizational safety culture and jobsite safety climate. Further analysis will be utilized to identify points of resistance and ineffectiveness in the implementation of the program for continual improvement.

It is expected that the research findings will help the GC further improve this program and facilitate its spread among other contractors to benefit the entire construction industry.

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