

Behavior-Based Safety Management on Construction Sites- A Field Study

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Abstract

Any Behavior-based Study is the application of science of behavioral change to real problems. It focuses on what people do, analyze why they do it, and then applies a research- supported intervention strategy to improve what people do. The national safety council reports that human behavior is the cause of 94% of all injuries and illness. Observation at site Behavior-based Safety (BBS) process depends on site observations including individual feedback, which is the most effective act in the BBS process. The observer meets the worker at site and introduces himself and the job he is performing. The objective of this paper is to document various steps of the BBS process while it is being implemented on a pilot project. Steps of a typical BBS are: (i) Study of company documents (ii) Review of safety meetings (iii) Feedback from employees (iv) Development of Critical Behavior Inventory (iv) Choice of study design (v) Intervention (vi) Safety manual (vii) Site selection (viii) Actual study implementation (ix) Data analysis and interpretation (x) Conclusion and merger into the system. The aim of this paper is to study and investigate the procedures that construction companies use to implement behavior based safety and highlight potential problems faced by them. This paper concludes that it is possible to achieve improvement in worker behaviors by using a simple safety checklist and rating system. More importantly it has demonstrated that the workers began to show better ratings after being introduced to the program and provided with feedback on their safety performance.

Keywords

Safety, Behavior Based Study

1. Introduction

Behavior-based study is based on a larger scientific field called organizational behavior analysis. A behavior-based study program must include all employees; this includes the CEO to the floor associates. To achieve changes in behavior a change in policy, procedure and/or system most assuredly will also need some change. Those changes cannot be done without buy-in and support from involved in making those decisions. Behavior-based study is not based on assumptions, personal feeling and/or common knowledge. BBS initiatives were useful toward improving safety performance (Choudhry, 2012). To be successful, the behavior-based study program used must be based on scientific knowledge. A good behavior-based study program will consist of Common goals (both employee and managerial involvement in the process), Definition of what is expected (Specifications of target behaviors derived from safety assessments), Observational data collection, Decisions about how best to proceed based on those data, Feedback to associates being observed and review. All of the behavior-based study programs

reviewed included multilevel teams. Some programs use them in the assessment phase, some in observation and some in review. Some had all three areas using multilevel teams. Behavior based safety must also have attitude adjustment to be sustaining. It has been proven that “behavior influences attitude and attitude influences behavior”. The goal should be small gains over and over again; continuous growth; behavior-based study is not a quick fix rather it is a commitment.

With an overview of available resources in the field of behavior-based safety, it can be seen that safe behavior promotion in the workplace, particularly in the construction sites is considered as a vital factor of health and safety management. Behavior-based safety is the way mainly aimed at modification of unsafe behavior that is traditionally practiced in different industries. Using behavior-based safety technique as seen in the various sources can be effective in raising the level of behavior and safety of workers and as an alternative to reduce accidents in the industry. Behavioral analysis has shown its ability to strengthen safe behavior in work settings.

Reducing accidents and improving safety performance can only be achieved by systematically focusing upon those unsafe behaviors at construction sites (Choudhry, 2012). There have been much research done on the how to implement the safe practice in construction industry. While safety remains a concern for a lot of companies, there are companies, which are showing excellent improvement in safety performance. These are recruiting expert personnel to run their safety program; they are providing training to the workers and in fact are reporting good results. Therefore the construction industry needs radical changes in the way it approaches safety improvement. Several approaches have been implemented in the industry, each having their own benefits and limitations. Behavior-Based Safety (BBS) approach becomes especially important in tackling safety issues since it focuses on the psychology of the human at work. The national safety council reports that human behavior is the cause of 94% of all injuries and illness. This has pointed out the importance of focusing on employee behavior as a critical element in achieving better safety standards. BBS interventions focus on what workers do on the job and on the contingencies of reinforcement that lead to safe behavior. The existing supervisory-based interventions largely focus on the daily verbal feedback or exchange between supervisors and workers . According to the study (Kines et al., 2010) foremen were encouraged to increase their daily verbal exchange with workers. Performance of foremen on safety-oriented exchange was measured by interviewing their subordinate workers and then provided to the foremen as feedback. The aim is to reinforce workers to behave safely during their activities. BBS is a methodology which aims to improving safety by integrating behavioral science, quantity and organization development principles with safety management in order to reduce industrial injuries (Fellner, 1984).

1.1. History

Behavior-based safety is a topic that has been around for a long time and originated with the work of Herbert William Heinrich. In the 1930's, Heinrich, who worked for Traveler's Insurance Company, reviewed thousands of accident reports completed by supervisors and from these drew the conclusion that most accidents, illnesses and injuries in the workplace are directly attributable to "man-failures," or the unsafe actions of workers. Of the reports Heinrich reviewed, 73% classified the accidents as "man-failures;" Heinrich himself reclassified another 15% into that category, arriving at the still-cited finding that 88 percent of all accidents, injuries and illnesses are caused by worker errors (Cooper, 1994).

Heinrich's data does not tell why the person did what they did to cause the accident, just that accident occurred. BBS programs delve into the act that cause of the accident. It delves into the work place; environment, equipment, procedures and attitudes. Basic Organizational Behavior Analysis is what is used to identify the actions that put the associates in the risk position. Organizational Behavior Analysis has been done for 100 years. Directing the applied research to an organizational application specifically to safety has been going on for around 20 years. Heinrich published work describing the results that he derived by evaluating the accidents from an extensive data base compiled by the insurance industry. He

came to the conclusion that roughly 90% of all incidents are caused by human error. This conclusion became the foundation of what BBS has come to be today. BBS addresses the fact that there are additional reasons for injuries in the work place; environment, equipment, procedures and attitudes. Behavioral Science Technology (BST), pioneers in applying BBS processes, expanded on this work and identified the "working interface", the point where exposure to injury occurs (Cooper, 1994).

Basic Organizational Behavior Analysis has been done for 100 years. Directing the applied research to an organizational application specifically to safety has been going on for around 20 years. The phrase "behavior-based safety" (BBS) was coined by Dr. E. Scott Geller of Safety Performance Solutions in 1979. It then became the catch phrase of the safety systems industry. Traditionally BBS has been used in industrial settings (Haynes et.al., 1982). A new generation has found success using BBS in office/lab settings as well. More recent work has also applied this to MRSA in acute Intensive care wards in hospitals. Dr. Luis López-Mena, Professor of Work Psychology at the University of Chile, has developed a BBS system, his PTAS Method (Psychological Techniques Applied to Safety). The PTAS Method has five steps:

1. Identify target behavior
2. Behavior measurement
3. Functional analysis
4. Intervention
5. Evaluation and follow up

However, this approach is no different than most. The literature review showed several detailed approaches, which would help in adopting a behavior-based approach for safety programs. Amongst them, one article worth noting was (Reber et al., 1993). This article provided a general paradigm for implementation a safety performance management program. This program is a generic program and with modification it could be suitable for small /medium-sized construction companies. The approach suggested here has been greatly influenced by the SPMP-especially the comprehensive manner in which SPMP addresses the safety program of the company. The effectiveness of a road safety intervention was described in a recent study (Glendon et al., 2014) by measuring attitudes toward unsafe behavior and risk perception. Other studies indicate that safety management practices not only improve working conditions but also positively influence workers attitudes and behaviors with regard to safety, thereby reducing accidents on construction sites (Choudhry et al., 2008; Vinodkumar and Bhasi, 2010).

1.2. BBS Methodology

Observation at site BBS process depends on site observation. Site observations include individual feedback, which is the most effective act in the BBS process. The observer meets the worker at site and introduces himself and the job he is supposed to do; there is no sneaking or spying in the process. The observer monitors the worker and notices his safe behaviors and also, monitors the at-risk behaviors the worker is putting himself in. The observer starts his feedback by commending the safe behavior the worker was doing during his work, and then he explains, one by one, the at-risk behaviors the worker was performing. Then the observer asks the worker why he was putting himself at risk; for instance if the worker is welding a piece of metal and the sparks are flying in the workers direction, the observer would then ask the worker why he was not wearing protective clothing, like flame-retardant apron. They both discuss the at-risk behaviors until the worker agrees to try the suggested recommendation made by the observer.

The worker might be aware of his at-risk behavior or maybe not, he may be doing the at-risk behavior for long time without hurting himself; the observer's job here is to highlight this behavior, then explains the associated negative consequences with this behavior. The above discussion and agreement is the individual feedback which helps the worker to change his behavior. This feedback is considered as a form

3. Methodology

First a thorough literature review was conducted; journals, books, research articles and related web sites were reviewed. A questionnaire survey was designed including questions related to BBS. The survey questionnaire was handed over to the construction employees. A pretest survey and a posttest survey was conducted; that can validate about the implementation of the BBS practice. Survey questionnaire was prepared and distributed personally, amongst the contractor's workers on the field and reviewing them closely how it is followed. After the collection of data on the survey forms, analysis of the data was done which identified the flaws, pros and cons of the methods of their work and further recommendations are proposed for improvement. Following are the steps of the BBS process performed on the case projects:

3.1 Study of company documents

Before company begins to implement a program, a detailed analysis of the existing status of the company data of past 5 years was done. While doing this analysis information about the time, location, type of injuries, the demographics of the employees injured, and the costs preventive measures that could be adopted were highlighted.

3.2 Safety meetings

Followed by the study of accidents records, it was also necessary to look at the sites safety meetings. The safety director should conduct surprise visits at the sites during safety meetings and verify whether that they are being carried out properly and whether every worker on the site is attending the meetings.

3.3 Feedback from employees

The safety and management personnel should interact with workers in order to learn about the problems associated with existing systems.

3.4 Development critical behavior inventory

On the basis of the information collected in all the previous steps a critical behavior inventory is prepared. The data obtained so far should be used to prepare a list of a safety and unsafe behaviors. This inventory will provide an insight into which behaviors need to be targeted for improvement and which should be encouraged. These should be checked be targeted for improvement and which should be encouraged. These should be checked with those mentioned in the current checklists thus helping in modifying the checklist.

3.5 Choice of study design

There are many settings, which the safety directors could choose for implementing the study. However, the literature review revealed that intervention is the most commonly used kind of study design for BBS studies.

3.6 Safety Manual

Most companies already have safety manual in place and it is also fairly up to date. However, the safety team needs to study the safety manual very carefully. They should check for any confounding or misleading terms in the manual.

3.7 Site selections

The construction company might find it difficult to implement the program at once in all the sites. Therefore, it would be a good idea to carry out a pilot-study of a project on one or two sites and then widen it on the basis of the results obtained from these sites.

3.8 Actual study implementation

Once the study design has been selected, the actual implementation should begin after careful scrutiny of the work schedule. Often in construction projects, it is not possible for researchers to change the settings to match specific requirements. Therefore, the study design should allow for adjustments and modifications.

3.9 Data Analysis and Interpretations

3.10 Conclusions and Merger into System

Once the data is interpreted and the company starts obtaining the desired results certain elements of the steps taken will be gradually merged into the system where as others will be faded out.

4. CASE STUDY

The pilot study for testing the model was carried out with a medium sized reputed contractor in Cincinnati. The pilot study was carried out at a multi-family residential project site near downtown Cincinnati- Laurel Homes, a mixed-income, and mixed-finance effort totaling over \$102 million.

| # | PROFESSION | WORKER CHARACTERISTICS | NUMBER OF WORKERS |
|----|----------------------|------------------------|-------------------|
| 1 | Framers-I | Caucasian | 6 to 20 |
| 2 | Framers-II | Hispanic | 6 to 20 |
| 3 | HVAC installers | Caucasian | 3 to 8 |
| 4 | Electricians | Caucasian | 2 to 4 |
| 5 | Excavation crew | Caucasian | 1 to 4 |
| 6 | Plumbers | Caucasian | 4 to 14 |
| | | African American | |
| 7 | Brick Masons | African American | 4 to 20 |
| | | Caucasian | |
| 8 | Fire Protection Crew | Caucasian | 2 to 4 |
| 9 | Roofers | African American | 2 to 4 |
| 10 | Cladding crew | African American | 2 to 6 |
| | | Hispanic | |
| | | Caucasian | |
| 11 | Exterior Finishers | Caucasian | 2 to 4 |
| 12 | Interior Finishers | Hispanic | 3 to 6 |

Figure 2: Subcontractor Working at the Site

Following are the steps involved in carrying out the BBS process on the case projects:

4.1. Study of Company Records

There had been no fatalities in the last 3 yrs of the company records. But there had been 2 severe injuries both of which were related to fall protection.

4.2. Safety Meetings

The safety meetings for the company were conducted at the respective sites. The sites staff heads them, usually during the snack break. These meeting were mandatory and a sign in sheet would be passed among all workers present at the meeting.

4.3. Feedback from the Employees

Director of works accompanied the research team and provided a guided tour while pointing the behavior, which needed special attention. After these 2 visits, the researchers began visiting the field almost daily. The workers and site staff were engaged in discussion to collect information.

4.4. Safety Manual

The company safety manual was comprehensive and very specific to the behaviors but was not conspicuously shelved and some staff personnel were not aware of its location.

4.5. Critical behaviors Inventory

A critical behavior inventory was created from carefully scrutiny of the manual, the company checklist and observations made on the site. This checklist is the checklist of behavior and each of them is defined are defined very clearly avoiding redundancy in the list. A separate category was created for the fall protection because it is one of the primary causes of accidents in construction. Moreover, fall protection was separated because the company accident history revealed 2 recent injuries caused by lack of land of a failure to use fall protection.

4.6. Site Selection

The chosen site involved a considerable amount of excavation, stick framing work, HVAC systems and masonry work. Typical to most construction projects, most of the work was scheduled to be built in phases with some amount of overlap in terms of the activities. This overlapping of activities was good form the study point of view as a greater number of groups number of groups could be observed together for a longer period of time.

4.7. Choice of the Study Design

In this type of design the study sample was the entire site. The researchers observed the workers in a baseline study and then provided feedback to them about their status and set goals for them. Then the search team started focusing on the intervention categories PPE, Housekeeping, physical environment controls, fall protection and tools and equipment. The workers were given continuous feedback-both verbal as well as visual by posters. The control category was mentioned only in the weekly safety meeting. Too much focus on the control measure was avoided. Body position and ergonomics was used as a control measure.

4.8. Actual Study Implementation

One external observer by means of the checklist recorded observation. It was necessary for ease of handling and legibility that the checklist be no longer than one page. The observation rounds were done at random at no fixed time of the day. The timings were decided based on the complexity and amount of work. Every group of workers was decided based on the complexity and amount of work. Every group of the workers was typically observed for 10 mins. All safe and unsafe behavior observed were recorded. In order to quantify the behavior the following ratings system was devised;

Ratings = [summation (same behavior)- summation (unsafe behavior)] / [summation (safe and unsafe behavior)]

This value was termed as the safe rating. By this calculation, the rating range between -1 and 1. A value of -1 indicates that the group was at the worst possible behavior- they are very unsafe in that particular act. A value of 1 indicates that the group was at the best possible behavior- they were safe suggested by the standard of the company. A value of 0 indicates that the group exhibited an equal number of safe and unsafe behaviors.

4.9. Data Analysis and Interpretation

The ratings collected over the 6-week study were standardized to represent 5 days of work and an equal number of observations. Although the application of behavior based safety in the construction industry has been limited. In general, the findings of the research quoted in the previous paragraphs shows that is possible to achieve improvement in worker behaviors by using simple safety checklists, as illustrated in steps 1-9, and rating system.

Most importantly the research quoted above demonstrated that workers began to show better ratings as after being introduced to the program and provided with feedback on their safety performance. The purposes of the above quoted research were to increase worker awareness of safety. Also to develop data and metrics to evaluate benchmark improvements in performance. To develop validation of models and methodologies to evaluate and change workers' attitudes to risk and safe work practices.

4.10. Findings

Findings are summarized under the following heads:

4.10.1. PPE

In this study, PPE trends were mainly visible in 2 behaviors; hard hats and protective clothing. All the workers were aware of the necessity of wearing a hard hat. However, some group has continued to show poor ratings in this behavior. HVAC installers showed downward trends in the study. One of the reasons for this that most of their work was done between the beams/rafter where a hard hat obstructed the sight as well as cramped the worker. Gloves and hand/arm protection was not vital to most of the groups. The one group, which deserved special attention for this behavior, was the brick masons. They showed relatively poor start in terms of the ratings. This is primarily because the ratings were recorded very strictly and anybody who seemed to be working with mortar or cement without wearing gloves was immediately recorded. The chief masons usually wore gloves and mostly the helpers did not wear gloves. The behavior continued in the unsafe until the last week during which it crossed into the safe region. A longer study would have most probably seen a great improvement in this aspect.

4.10.2. Physical environment

Most of the behavior in this category was not applicable to the site. The behavior barricading and canopies and fire protection and emergency equipment were again recorded very strictly to almost a theoretical level, which is difficult to achieve in construction sites. Besides, it was believed that pushing for this behavior in a short time might put undue pressure on the already over burden site staff. More about this behavior was addressed in the fall protection category. Barricading and canopies was very important for the excavation group, which showed slight improvement in this respect moving from negative values towards 0. Fire protection was especially important for those workers who would in conformed spaces on upper stories or roofs without more than access.

4.10.3. Fall protection

These are among most important behavior but unfortunately there was lack of observed causes of concern among farmers-II who were predominantly Hispanic. A lot of changes in the attitudes could be observed after the safety director for not wearing safety harness sent 2 of the workers home. However no such changes were observed for this category in the rating for fall protection or all openings covered.

5. CONCLUSION

It is possible to achieve improvement in worker behaviors by using a simple safety checklist and rating system as observed in the case study above. More importantly it has demonstrated that the workers began to show better ratings after being introduced to the program and provided with feedback on their safety performance. There are tangible benefits to these safety improvements, besides the immediate social benefits, there will also be a reduction in injuries and fatalities, this will in turn translate into net economic and monetary gains, by the reduction or avoidance of hospitalization, costly litigation, insurance costs etc.

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