

Behavior Based Safety (BBS) for Accident Prevention and Positive Study in Construction Enterprise

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Keywords: Behavior based safety (BBS), Accident prevention, Safety index (SI), Construction enterprise.

Abstract. Behavior Based Safety (BBS) is one effective method on accident prevention widely applied by Europe and American countries since 1980s, however little research and application is carried out in China. The experiment course of BBS was designed in this paper for China construction enterprise based on BBS research situation. Safety Index (SI) change trend chart was established and SI was used to evaluate safety behavior and change trend. The experiment results showed that BBS made remarkable performance on accident prevention and the trial employee's SI was enhanced 15% than base line during the experiment. The above results also showed that the BBS method designed in this paper was effective and adaptable to construction enterprise in China.

Introduction

According to Heinrich on the foundation of 75,000 of industrial accidents that 88% of accidents were caused by human unsafe behavior, 10% accidents were caused by unsafe psychical environment and only 2% accidents were attributed to unresisting factors [1]. Heinrich research results indicated that 98% accidents could be prevented and controlled within human ability. In nowadays a great deal of industrial accidents were also caused by human factors [2]. Therefore, it has become an important subject to prevent and control human behavior on accident prevention.

To human unsafe behavior, the most effective method is Behavior Based Safety (BBS). BBS is one effective method on accident prevention widely applied by Europe and American countries since 1980s, which it can realize the target that safety performance index, such as accident rate and injury rate, change from dragging indicator to leading indicator[3]. Meantime BBS can provide one structural and quantitative approach for safety management and safety production long term mechanism.

As Fig1 shows that BBS principle can be induced that human safety conscience and safety habit is not innate but could be improved by training [4]. Through observing and rectifying others behavior while observed and rectified by others, human safety behavior and safety conscience could be enhanced. The BBS advocators believe that unsafe behavior is mainly accident cause and accident could be decreased by correct behavior. Praising and encouraging the employee's safety behavior is better than punishing the employee's unsafe behavior. Behavior could be measured and improved by some methods such as observation, analysis and feedback. The best person selected defining unsafe behavior is the employee itself and the employee's participation and communication can improve organizational safety performance [5]. This paper holds that the above opinions are applicable to construction enterprise in China.

BBS Research Situation

BBS theory foundation

BBS theory foundation is operational learning theory. Such theory advocates establishing adaptable or ideal safety behavior by operating or refining learning process. The theory emphasizes on observing

human behavior without presuming human mental course and attitude, and listing influencing factors on safety behavior through observation, rectification and analysis and then taking measures to encourage safety behavior for accident prevention [6, 7]. Such process is regard as reinforcement in psychology.

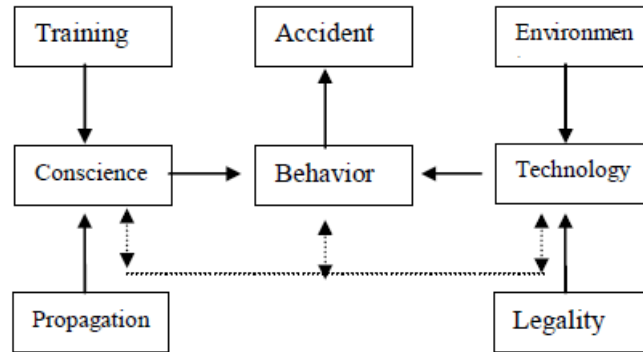


Figure 1 BBS principle to accident prevention

BBS implements procedure

BBS is one “DO IT” sustainable improvement process (As Fig2), D=Define target behaviors, O=Observe target behaviors, I=Intervene to improve behaviors, T=Test impact of intervention.

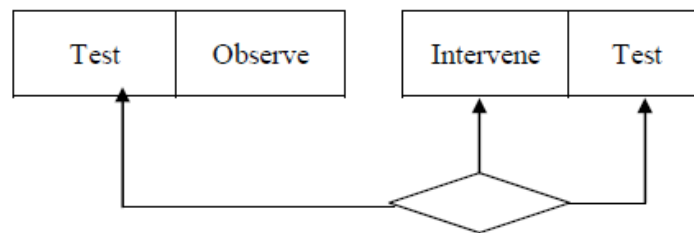


Figure 2 BBS process of “DO IT”

BBS application effect on accident prevention

In Europe and American countries, BBS has been widely applied on many industries such as construction[8,9],petroleum[10,11],machinery[12,13],nuclear[14],traffic[15,16],chemistry[17]and mining[18].

BBS on Olefines6, ICI. Olefines6, ICI started to adopt BBS from 1977. Safety Index (SI) was used as weighing BBS effect [17]. Fig3, Fig4 and Fig5 were three different behavior observation results on three phases (according to week) implementing BBS from in 1998. In figure, % safe showed safety index (SI), BASELINE showed SI Baseline, GOAL showed behavior safety target.

Safety Index Baseline was 42% on first phase and Goal arrived at 61% after 15weeks implementing BBS; Safety Index Baseline was 52% on second phase and Goal was arrived at 71% from 61%. On third phase SI Goal arrived at 85%.

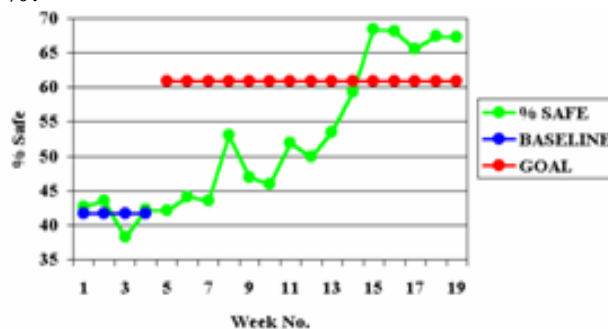


Figure 3 SI change trend chart for the first phase

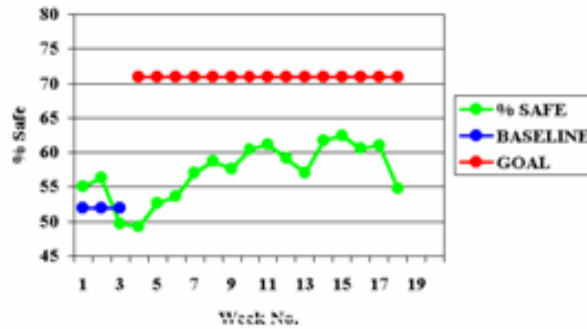


Figure 4 SI change trend chart for the first phase

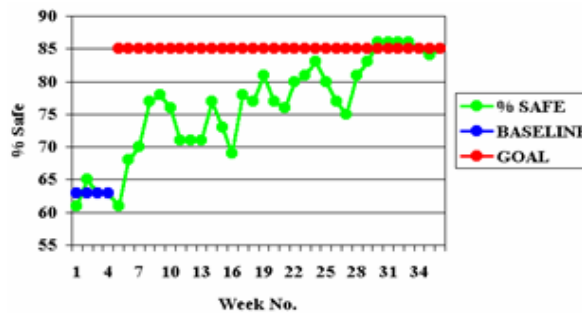


Figure 5 SI change trend chart for the third phase

BBS on FFBU. FFUB started to implement BBS from 2000. Before using BBS the average injury rate has attached to 1.5~2.0. With the implement of BBS the Total Record Injury Frequency (TRIR) decreased to 0.7, the decreasing grade was 50% (As Fig6). Since implementing BBS, the SI of 1993-2002

Seven sub-companies realized the SI GOAL. Especially several factors were keeping zero accident till today.

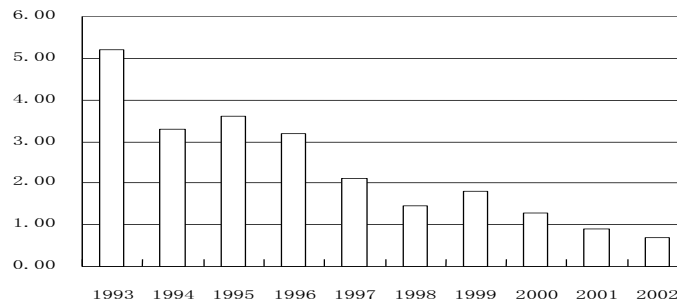


Figure 6 TRIR change for FFBU Corporation

BBS feasibility for construction enterprise in China

BBS generally is applied under the background of Europe and American countries. Little research and application was adopted in China. However this paper advocates carrying out BBS in enterprises in China. The reason lies in the fellow aspects:

- 1) Through case analysis on overseas enterprises some enterprises having made excellent safety performance still made remarkable effect. So it is necessary to carry out BBS for enterprise in China.
- 2) The present safety technology, method and management in China are mainly referenced to overseas enterprises, for example OHS. Since BBS could made excellent accident prevention effect, it should also be by enterprises in China.
- 3) Construction accidents in China largely were caused by human factors, according to statistical date of Ministry of Construction of People's Republic of China, almost 80% of construction accidents were

caused by human unsafe behavior [19]. BBS is exactly adaptable to such situation of construction enterprise in China.

BBS Experiment Design

General situation of experimental construction enterprise

One construction enterprise was taken as investigation unit. This construction enterprise has Safety Production Committee and safety inspection department. Meantime this construction enterprise has one safety training center charging of safety education and training. By the end of 2005 there were employees 1877, and 1415 were on construction workshop accounted for 75.4% of total number. The employees in other departments were 462 accounted for 24.6%of total number. The employee’s age and education level distribution as fig7 showed.

BBS experiment course

Method introduce and training. The fellow steps were taken on BBS method introduce and training:

- 1) Communicating with project manager, safety manager and the director of construction troop. The communicating subject content included accident cause of construction project, BBS brief introduction and implementing procedures aiming at the support by management level.
- 2) Transferring one professional technology employee from safety inspection department charging of subject work and explaining to the employee.
- 3) Carrying out all-around training for technology employee, monitor, safety manager and part of the employee.

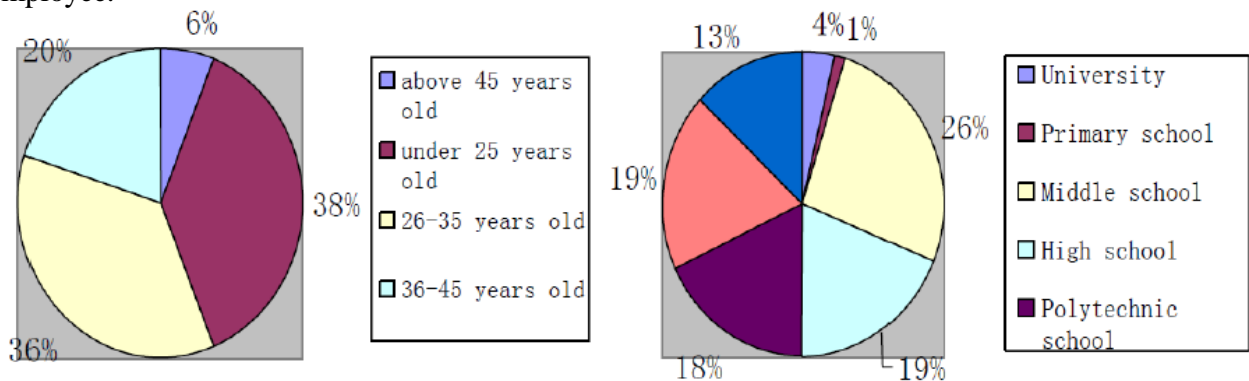


Fig.7 Employee’s age and education level distribution

Key behavior notarization. It is the most difficult to notarize key behavior. If it is not correct it will influence the experimentation meaning for the employee not adopting the key behavior and critical task. Key behavior and critical task notarization could be acquired as Fig8 showed.

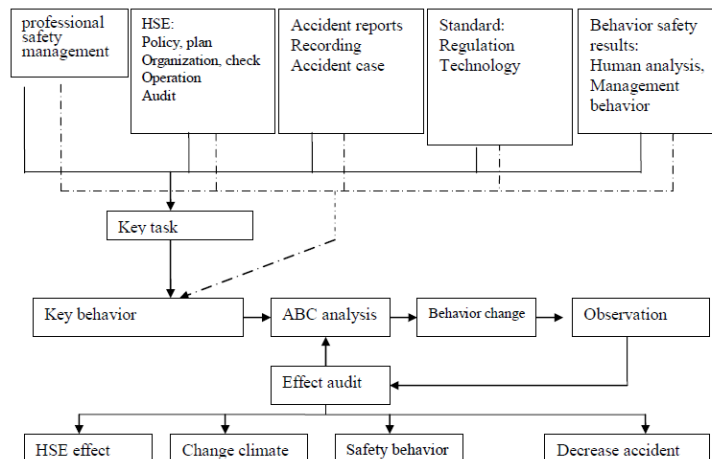


Figure.8 Methods to search employee’s key behavior checklist and critical task

Behavior observation method.

- 1) According to key behavior checklist the observer sets about behavior observation and rectification 30minutues;
- 2) The monitor of experiment troop takes behavior checklist taking on behavior observation and rectification and deliver the checklist;
- 3) Considering of construction complexity and mass unsafe behavior the checklist content should be 30~40 items;
- 4) Discussing with the employee to discovered unsafe behavior and recording the cause.

Experiment results analysis

Accident prevention effect of BBS experiment design should be tested on workshop. Safety management index in China generally included breaking times, accident times and cutting payment. Safety index (SI) was adopted as testing BBS effect on accident prevention.

$$SI=100[N_2 \div (N_1+N_2)]\%$$

N_2 : observed times of safety behavior;

N_1 : observed times of unsafe behavior; N_1+N_2 : total times of observed behavior.

Through SI change it could learn safety condition of individual or department, and for the reason that unsafe behavior often takes place before accident occurrence so it is necessary to learn SI change. When times of unsafe behavior are increasing it is to take measures to control accident occurrence, therefore, SI could be called “proactive” index [20].

Collective descriptive statistics for SI change.

Behavior observation results were displayed through SI change on chart board. SI change content included: behavior observation record, observation date for a certain day, compare among different quarters for acertain day and trained units SI change trend. See Table1, Fig9 and Fig10.

Table 1 Collective descriptive SI statistics

Project	SI	Min	Ma x	Averag e	Average standard deviation	Standard deviation
Experimental value	0.5 4	0.3 4	0.8 8	0.648	0.0157	0.1090
Construction troop(A)	0.6 9	0.2 2	0.9 1	0.588	0.0297	0.1597
Construction troop(B)	0.6 7	0.3 3	1.0 0	0.671	0.0216	0.1497

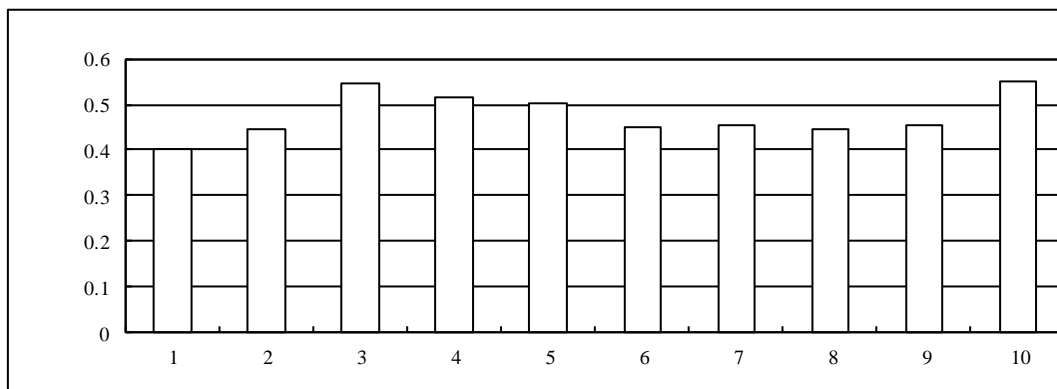


Figure 9 Compare among different quarters for a certain day

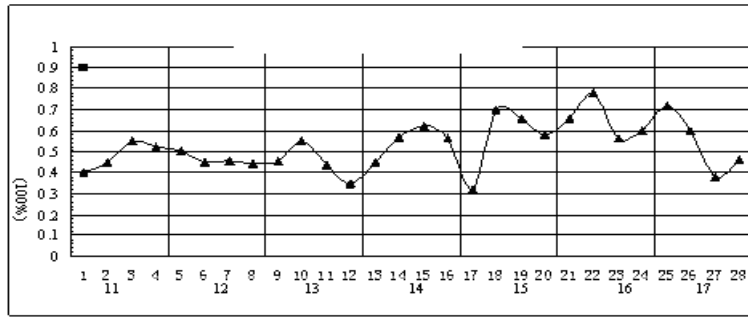


Figure 10 Trained units SI change trend chart in a certain week

Total safety index level during the experiment phases. During the first phase SI value was higher and arrived at 0.65, and by the end of August SI arrived at 0.85. Through analysis the Fig11, this paper believed that SI during the experiment phase increased 10%. (See Fig11)

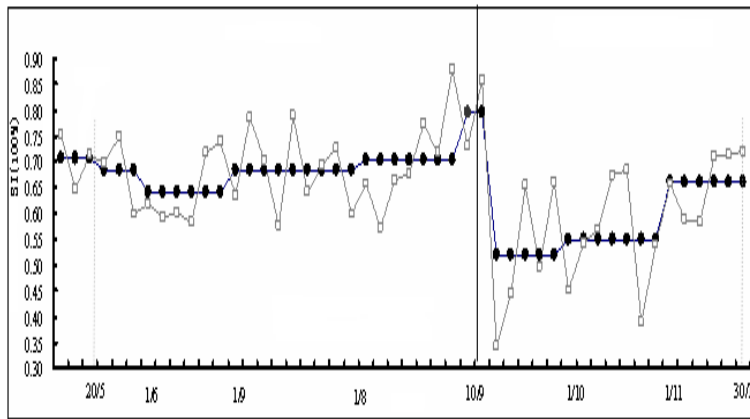


Figure 11 Total safety index level during the experiment phases

Meantime it should be discovered that besides SI increased during the experiment phase it founded that the employee had more interest anticipating in safety work.

The employee would like to discuss with the author on safety work and put forward much advice as, Table 2 showed.

Table2 Employee advices to behavior project

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- 1 BBS need leader to anticipate
 - 2 It should strengthen training for the employee
 - 3 It should establish professional agency to manage and coordinate
 - 4 It should take incentive measures
 - 5 The employee is not very familiar with itself unsafe behavior
 - 6 Owing to heavy construction task the employee fail to observe behavior
 - 7 Others
-

From Table2 advised by the employee it could be found that although the author made much efforts on training method the most important factor could be viewed training and communication so as to be learned and mastered by the employee; besides it need the leader's support and anticipation and form the common acknowledgement encouraging the employee's activity.

Another should be pointed is that the employee think it is necessary to keep professional department and staff to guarantee BBS sustainable and effect operation, after all the experiment is one special improvement and systematic course it should be coordinated by professional staff.

Last but not the least it is important for BBS to be strengthened all kinds of incentives. The effect operation of safety management and especially BBS should not only implemented by safety manager and safety department but it also should encourage and incentive the employee's activity. It should demolish

the employee's consideration of being punished during observation course and taking measures to change traditional punishing method into culturing and encouraging the employee's correct safety behavior and safety habit, otherwise it is difficult to carry out BBS under the condition of the employee against with safety management level.

In conclusion the results in this paper indicated that the employee SI was enhanced by the employee anticipation and effort during experiment phase and the employee initiative conscience was higher then before and realized the experiment aim. But it should be reminded that behavior improvement in short period could not mean lasting improvement, and it is the reason that the author hope to continue the BBS experiment.

Conclusion

(1) BBS is subject application of behavior science on safety field. It has more than 20 years in overseas and has great effect on accident prevention. However it is still not discovered systematic and quantitative research documents in China.

(2) Effective BBS should aim at the actual condition of experiment unit. This paper designs BBS form training method, key behavior notarization and behavior observation method based on BBS research situation and implementing steps in Europe and American countries. This paper supports that BBS is not only adapt to construction industry but also other industries.

(3) In this paper BBS experiment made remarkable effect on accident prevention and SI of the employee enhanced 10% than baseline.

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