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Behavior Based Safety (BBS) System Study – An Effective Tool for Assessing Construction Safety Culture

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Abstract: ***Worldwide behavior based safety (BBS) studies are accepted and proved to be successful tools to assess safety culture in a construction industry. Safe behavior at work is the testimony of the success of the safety management system. The organization management strives to ensure a safe working environment, specifically at construction sites through an effective and established BBS. The authors with their experience have noted that behavior studies are good techniques to understand the behavior at work place, to identify at –risk / risk –assuming individuals and initiate necessary corrective actions through a proper safety communication system. The authors have conducted Ad- libitum (in Latin "as you desire") random survey and periodic reviews through a structured questionnaire / opinionnaire to study safe behaviors where the large scale construction activities are in progress at geographically different sites in India. The observations reported in this paper are mainly focused on hazards like fall from heights, hit or struck against and electrocution which are the contributors for severe / fatal injuries. This paper advocates educative approach through appropriate awareness / training programs to modify the work behaviors/ practices rather than enforcement/ disciplinary measures to change the work practices.***

Keywords: Behavior-Based Safety System, At-risk behavior, Safety Management System, Safety Culture

1. Introduction

1.1 General

Construction work where ever it is taken up is constrained by fixed work schedule, intensive illiterate work force of transient nature, dynamic and changing working conditions, myopic view of management and the burgeoning contract system. In this situation the safety is the casualty and uncared. The accident investigation studies, construction project safety assessment and review studies indicate that the human error is the root cause for many unabated injuries that are happening at all parts of the globe in the construction industry. The authors strongly believe that very less is done in the area of human error reduction and enhancing safety performance by a fault tolerant system particularly in construction process.

1.2 Objectives

The management has a critical role and responsibility in promoting safe behavior at work with active co-operation and participation of workers, because the behavior at work turns systems and procedures into reality. The primary objectives of the Behavior Based Safety (BBS) system study are:

1) To understand the theory and strategies to promote safe behavior at work place;
2) To identify key elements which promote safe behavior.
3) To use behavioral change strategies to promote a wider acceptance to workers.
4) To assess and benchmark safety performance based on BBS
5) To integrate behavioral changes strategies into a safety management system to improve safety culture.

1.3 Construction Safety Culture

The Construction Safety Culture is an "attribute encompassing behavior and commitment of all the workers, supervisors and managers in achieving, a safer working environment and creating safe place for construction". The above statement is versatile and has a human engineering approach. The construction is a hazardous process. The integration of human behavior with the work environment is a challenge to safety. The management should develop effective safety management tools to promptly identify the unsafe situations and take rapid corrective actions to exercise controls and prevent injuries. This all depends upon on the various tools available with the management, their suitability and effectiveness. In general, organizations tend to develop more advanced tools, techniques and methodologies by updating or changing or improving with time. However, the tools are not universal, common and applicable to all areas of a large construction organization. The tools are specific to person, process, place or premises. The organizations should take adequate care when establishing overall objectives and initiatives for assessment of safety culture. The benchmarking should be based on requirements with minimum impedance. Tools and safety performance indicators suitable for the organization should only be selected.

1.4 Safety Culture Tools

The tools available for assessing and improving safety performance are based on the safety culture level prevailing in the organization. In general, authors observed that safety culture level in the construction industry is in the incipient stage i.e evolving and developing so tools applicable,

appropriate and effective should be chosen. The tools available in practice and literature are shown in Table 1. A combination of more than five tools is the best to objectively evaluate the behavior at work.

The Table 1 identifies the 10 tools of assessing safety culture in the construction organization. The description about their nature of hazard to be assessed, focused areas, suitability, methods, and applicable levels in the organization, periodicity, demanding situations, and their nature whether prognostic or diagnostic.

The tool that is both prognostic (refers to a forecasting or prediction about the likely outcome or a course of disease) and diagnostic (means identification and recognition of a possible disease or disorder) is best suitable to select for assessing construction safety culture. Each tool has specific advantages and disadvantages, constraints and limitations. The organization shall evaluate the cost benefit analysis, acceptance, the safety management system and the prevailing safety culture in the process of selecting the tool.

2. Literature Survey

2.1 General

Since its inception and application in the mid- 1970s, behavioral safety has undergone a series of evolutionary changes. The first approach, [1] popular in the early 1970s to mid-1980s, was largely a supervisory, top-down-driven process. Based on operant theory [2], supervisors observed worker behavior, gave feedback and provided some form of positive or negative reinforcement. Behavior change did not last once reinforcers were removed. Simple and cheap to implement, this approach attracted legitimate criticism [3]-[4] that has since been hard to dispel. Perhaps as a reaction to those criticisms, employee-led processes emerged during the early-1980s. In these interventions, which are still common, employees develop the overall process, conduct peer- to -peer or workgroup-based observations and provide feedback. However, the down side was (and is) the exclusion of management, leading to the common perception that behavioral safety processes focus solely on employee behavior [5]. This led, in the 1990s, to the cultural approach based on the concept of a managerial and employee partnership. Employees monitor the behavior of all members of a workgroup or work area, and managers regularly monitor their own safety-related leadership behaviors (e.g., whether they reviewed and closed out corrective actions). Everyone involved receives regular feedback, with some also receiving tangible reinforcers or incentives [6].Surveys of behavioral safety users show that all three approaches are widely used around the world [7]

2.2 Need to Study

To study and understand the human behavior at work the information, theories, hypotheses, models, etc and the published data available in the literature from various sources was surveyed and reviewed. The behavior of persons in different industries like, operating(electrical and mechanical systems, power generation, etc), producing(heavy chemicals, oil and gas processing, hydrocarbon ,etc.), manufacturing (components, assemblies, machining , presses, fabrication, etc), construction(infrastructure projects, buildings, factories, etc) and services(health care, etc) published reports were reviewed to assimilate the human behavior process at work.

The survey mainly focused on safe behavioral factors which varied across the different industries, within industry, within functions in industry, between persons of same group / team and different groups/ teams. The link, interrelationship, interdependency and interfacing between the individual, groups, nature of function/ work and the organization's management are the essential elements in determining the perceptions, attitudes, beliefs and complex behavior at work. The degree of safety at work place is the indicator of a good safety culture.

2.2 Principles of Human Behavior

The Behavior- Based Safety (BBS) system is gaining importance in effective safety management at work places be it, a construction, manufacturing or services sector. In the past, safety has been managed primarily as a technical problem that can be "engineered out". More recently, it is becoming widely accepted that technical approaches alone are inadequate to reduce the accident rates to desired levels The improvement of organizational safety performance is directly dependent on the workers behavior at work place in any organization. The 5 cardinal principles of human behavior at work, are arrived at by the authors after surveying /reviewing the behavior theories, models and principles available in the literature. The principles appropriate / suitable for a construction industry are as follows:

The principles of human behavior [8]-[9], that need to be understood prior to carrying out any study at work environment. These principles are realities and living truths not limited by age, time, location, or situation. The authors advocate that familiarization of the behavior principles is essential for assessing the safety at work meaningfully. The authors express that it is impossible to narrate or write an article that covers every aspect / scenario of the work place which one may encounter as a trainer / observer / supervisor /manager, etc. However, when one knows and understand principles, actions/ reactions can change, increasing the likelihood that the workers in the organization / industry will behave appropriately.

Principle One: Persons irrespective of their behavior should be respected with human dignity.

Principle Two: Behavior is instinct with a purpose largely based on the immediate work environment.

Principle Three: Behavior is influenced (strengthened or weakened) by its outcome like near –misses, events, accidents, rewards, etc.

Principle Four: Behavior change process responds better to positive (motivation , encouraging , suggestions, etc) than

to negative (warning , fines, punishments , retribution , etc) consequences**.**

Principle Five: Reinforcement of behavior (positive or negative) is known only by the recurrence / repetition of that behavior in the future**.**

The study encompass all the five principles to the extent applicable to the construction industry.

2.3 Behavior Model

The ABC (Antecedents, Behavior and Consequences) Model is an essential tool of safety management in discovering the behavioral aspects and addressing the root causes of all accidents [10]. The employees safety performance is strongly dependent on their behavior at work. Applied behavioural analysis help the organisation to assess the factors that are really driving its safety efforts. This basic tool of behavioural analysis is known as A (Antecedent), B (Behavior) and C (Consequence) Analysis, and it provides the powerful foundation of behavior –change process and technology. In this analysis, an antecedent is an event which triggers or an observable behavior. A consequences any event that follows from that behavior. This is pictorially represented in Figure 1. It is the goal of ABC to discover which antecedents and consequences are influencing a particular behaviour. In the ABC Analysis of real- world situations, one finds that most behaviours have a cluster of consequences which follow from them. By changing the antecedents, behavior can be controlled and consequences can be influenced.

A (Antecedent) →	B (Behavior) ↔	C (Consequence) →
A stimulus or event that manifests prior to and may result in the behavior. Examples; goals, peer pressure, workload, lack of training, supervision, etc	Any action that a person does or says Examples; Failure to wear safety helmet. Lack of regard to safety rules Short-cuts	An event that occurs after a behavior. The consequence could be desirable or undesirable in future, depending on its reinforcing positively or negatively. Examples; Recognition, Task completion, Goals achieved, Rewards, etc.

Figure 1: Behavior Based System (BBS) -A (Antecedent), B (Behavior) & C (Consequence) Model

ABC Analysis involves the following principles,

- Both antecedents and consequences can influence the behavior positively or negatively ,
- Both will do either synergistically or differently,
- Behavior is balance which controls the cause and consequences of antecedents,
- Consequences influence behavior powerfully and directly, and
- Antecedents influence behavior directly, primarily serving to predict consequences.

The behavior change process essentially targets the change of antecedents so that consequences of the unsafe behaviors are reduced / minimized. The management of a construction industry attempts to reduce the consequences like severe / fatal injuries. The ABC analysis plays a positive and constructive role in reinforcing the positive behaviors through the training / awareness programs

3. Methods / Approach

3.1 General

The construction is a complex hazardous process, with intensive work force which is mainly contractual, young age group (in 20s), illiterate, unskilled, temporary, enthusiastic, energetic, dare –devil actors, risk assumers, safety challengers and non-changers. There is less direct control due to sprawling work areas and combined with supervision and co-ordination between contractor personnel and the construction project management personnel and also between the contractor and subbies (sub-contractors, sub-sub-contractors, etc.) is weak. The wide communication gap and barriers are predominant due to language and culture diversity, multiple un-recognized channels, multiple contractors, short duration works, etc.

Table 1: Construction Safety Culture Assessment Tools

Tool	Description	Nature
Reporting /Communicating	Methods, nature of accidents, near misses, levels, periodicity, etc	Prognostic /Diagnostic
Reviewing / Learning	Extent, levels, periodicity, past incidents, follow-up, etc	Prognostic /Diagnostic
Investigating	Accidents, disabling injuries, near misses , etc	Diagnostic
Studying / Analyzing	Job hazards, potential threats, system failures, root causes , extent , etc	Prognostic/ Diagnostic
Surveying	Using questionnaires, opinionnaires, etc. working conditions, working areas, levels, e-mails, telephone calls, etc	Prognostic/ Diagnostic
Inspecting/ Observing	Checklists, working conditions, tools, tackles, equipment, periodicity, follow-up, suggestions, etc	Prognostic/ Diagnostic
Auditing	Independent, evidence , corrective actions, improvements ,etc	Diagnostic
Sampling	Safe behavior, walk and talk , work environment, observations, interactions, questionnaires, checklists, periodicity, improvement, etc	Prognostic/ Diagnostic
Interviewing /Informing	Scheduled , structured , target group, periodicity, opinions , improvements , etc	Diagnostic
Campaigning	Issues, target groups, promoting, educating, training, etc	Diagnostic

3.2 Methods /Tools

The authors have devised questionnaires/ opinionnaires for the study covering behavioral aspects along with various

elements of safety management system and safety culture for manufacturing, construction and research and development organizations. The methods/ tools used for the study from the Table 1(shown bold) are reviewing, investigating, studying / analyzing, sampling, surveying, inspecting / observing and interviewing. The combination of prognostic and diagnostic tools are used for the BBS study.

3.3 Approach

3.3.1 Traditional Practices

The traditional approaches and scientific principles revolve around what motivates and reinforces people's behavior during work.This study highlights the impact of the BBS on the safety performance and the construction safety culture as a whole. The management's role and responsibility is to identify the safe behavior against the at-risk behavior (risk – assumers) at work place. The observation of workers while performing work is the pragmatic and pro-active step to control unsafe behaviors and practices at work places. There is a fear and insecurity amongst workers when they are observed during the course of work in a manufacturing / processing industries in shop floors / control rooms, work stations etc. They resist such management practices as invasion / encroachment into privacy. The implementation of BBS at work place has many challenges which include voluntary participation by workers and active involvement of supervisors. The investigations and analyses are done post – event for the purpose of identifying the causes and the preventive measures. This has a marginal or no effect on the future behavior. The recurrence of severe / fatal injuries due fall from heights or struck- by or struck-against or contact of electricity during construction activities around the world is the testimony of uncontrolled and unabated, unsafe behavior at work place despite knowing the hazards and consequences. This requires an attitude change and empathy.

3.3.2 Current Practices

The current approach for the study envisaged is a positive and encouraging participation of all levels of work force in the industry with a vision of top- bottom and bottom –up for flow of suggestions and improvements in the safe working culture. An education and engineering tool rather than an entrenchment and enforcement tool is adopted to encourage free participation and positive response.

With the advent of the information, computer technology and intelligence systems the work stations are being monitored by the supervisory authorities due to security reasons. The authors have also used the footings / clippings of the closed – circuit TV for the purpose of investigation / assessment of the accidents as a diagnostic tool.

3.3.3 Implementation Approach of BBS Study Program

The approach is based on theoretical and practical experience and is concerned with the outlining principles and practices of the organization involved. The approach should be flexible, adoptable and implementable. The steps involved in implementation of BBS is presented in Fig 2.

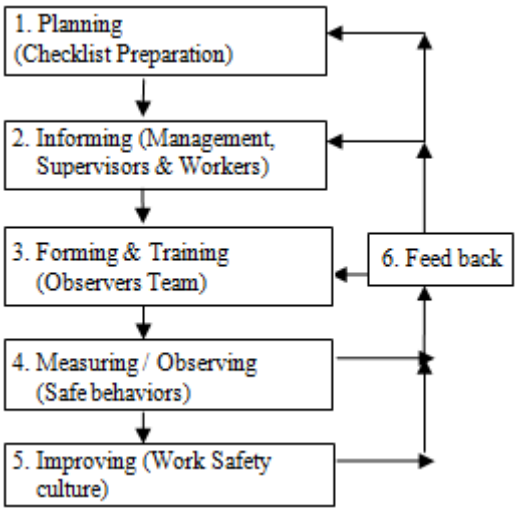

Figure 2: Steps in Implementation of BBS System Study

The following aspects should be considered in designing the BBS Study program and improvement.

1) Good planning with a checklist of targeted unsafe behaviors from past accidents / incidents / near misses
2) Management appraisal and approval
3) Observers Selection & Training.
4) Informing the target work force.
5) Measuring and assessing the Safe performance (% unsafe behaviors)
6) Reporting and setting targets/ goals.
7) Periodic Observing/ measuring
8) Continual improvement.

The implementation of BBS System in any organization basically involves 6 steps.

Step: 1 Planning is a vital step in implementation of BBS. It is also an effective method to design a BBS program through a team consisting of management and frontline employees, and each member of the team should be familiar with the program. The team selects targeted areas/ tasks which are identified earlier and through safety audits, safety deficiency/ improvement data, information from safety review meetings and informal interviews with staff (from the past 5 years, if possible). This will provide a wealth of information around the areas in need of improvement. The team determine what would have prevented the reported injuries; if it is not immediately obvious the team use methods like discussing how increased situation awareness might have affected the situation. From this analysis, the team will identify focused critical safe behaviors for an observation checklist.

Step 2: Informing is the critical aspect which determines the success of the program. All the key personnel like managers, front line supervisors, workers involved, etc are to be informed and involved. The sense of ownership should be entrusted to him. The observer team members should closely interact with all as they have a big role in the exercise. The critical safe behaviors in the checklist for a specific activity, for example; working at height is worked out and presented in Table 3. The acceptance of all is the pre-requisite for the commencement of the program.

Step 3: The team of observers is formed and the training on the behavior program to be conducted is imparted. The team is familiarized with the information on analysis of a causes that would have prevented the past reported injuries; if it is not immediately obvious the team to use methods like discussing how increased situational awareness might have affected the situation. From this analysis, the team will identify critical safe behaviors for an observation checklist.
The checklist is comprised of the list of safe behaviors identified in the above step. The list can be shortened according to importance of safety, frequency of occurrence, observability and overlap with other items on the list. The list should be no more than 1 sheet of paper (1 side). It helps to have definitions for everything that is being measured on the back of the checklist– nothing is left to subjective interpretation. The best way to know if the checklist is useable is to conduct a trial observation on employee working, and see if all categories on the list can be filled out in an observation. The list, if required will need to be revised a number of times before it can be considered ready-to-use
Step 4: The measurement system for an observation programme is simply a frequency count of safe and risk behaviors during an observation. Note of caution: measuring is an antecedent, and we need a consequence in place to strengthen the behavior under measurement. When measurement is used effectively, the employer can create an environment in which people actually want to be measured. This can happen when positive consequences are delivered based on the behavior change that is observed through measurement. When employees receive specific, positive feedback about the results, then they will see a benefit, aim higher, and want to be measured.

Consider who will conduct the observations. Data shows that the most beneficial system is to have all employees involved in the observation process. Behavioral observations increase safety behaviors of the observed but also the observer, so encouraging employees to conduct observations on each other will benefit all employees. The team and all employees will need to decide how often observations will be conducted. All employees will be involved in implementation of BBS in an organization.

Step 5: The improvement goals are set. Employees are encouraged to participate in this exercise, and the goals are realistic and based on the current observations data. The short goals are set to ensure that each employee knows what behavior or process they need to work on to reach the each goal. Remember to focus on the safety process itself and not on the results – attempting to manage results will ruin the integrity of the programme. Instead of setting goals to increase or decrease results, set goals around the behaviors that lead to these results (e.g., increase wearing of safety helmets from 80% to 100% in construction activity).

We should make use of valuable data that can inform us on behavior process changes. The mechanism for review of the data in meetings/ discussions and also to ensure that all staff are informed of any changes made based on the observed data, and that they know it was because of their contribution (as a group - no names are recorded).

Step 6: Feedback is a process in which the observers discuss and summarize significant normal positive safety behaviors that were observed and then one or two areas that require change for example work at height, material handling etc. The feedback is delivered as soon as possible after the observation (unless this poses a risk). At –risk behaviors should be immediately communicated for stoppage of work/ discontinuation of unsafe practice. Briefing the behaviors observed discussing the potential impact and listening to the person observed is a formula can be used for both positive and corrective feedback. In addition to individual feedback by the observer, overall site feedback should be delivered. The leader should discuss the results of the observations (categorically, not personally) at safety meetings, while also providing visual feedback. The easiest and most effective way to do this is through creation of a graph. Visual feedback helps us to see how we are doing and also helps us to set goals. Leaders should respond with positive feedback about any improvements, and not respond negatively to low numbers on observations. The objective problem solving techniques are encouraged.

4. Results / Discussion

The results of the two studies viz; Opinionnaire and Safe Behavior Observations are presented in the succeeding paragraphs. The inferences drawn out of the studies are presented. The results are analyzed and findings are listed out.

4.1 Opinionnaire on Safety Culture

The authors have put substantial efforts to understand the psychological phenomena relevant to attitudes, beliefs, cognitive skills and behavior at a construction organization. The authors believe that observing, discussing and suggesting positive methods to improve behavior at work place is a human approach and a good sign of safety culture. The authors developed structured and scheduled Opinionnaire/ Questionnaire/ Discussion methods to elicit information from supervisors and managers of all levels. Observations / Inspection / Interviewing/ Interaction methods which are semi-structured like checklists, work sheets, etc were deployed to study the behavior of workers at work place.

The safety culture survey programs were conducted on a campaign basis in the 3 construction organizations located in different parts of the India. An Opinionnaire was developed with 12 elements which cover various elements like safety leadership and responsibility of top management, safety as value, learning organization, safety improvements through inspections and audits, supervisions and survey of work places, mutual trust , workers motivation and accountability towards safety. The elements are mainly factored on human factors at work like attitude, behavior, commitment, ownership, etc of supervisors and managers. The participants of the survey were mainly front –line supervisors and managers who have the key role in controlling the behaviors at work place. The (No of Respondents (N = 495)) participants who are mainly contractor personnel (77) % and

23% are the project client personnel who have wilfully and voluntarily responded to the opinionnaire.

The opinions are taken in a 5-point Likert Scale [11] ranging from Strongly Disagree (A) to Strongly Agree (E). The notation used in the Table 2 is explained below.
A- Strongly Disagree
B- Disagree
C- Neutral
D- Agree
E- E-Strongly Agree.

The % responses obtained in the survey for each of the 12 elements are tabulated and presented in Table 2.The elements are so chosen so that opinion on a range from strong disagreement or strong agreement is given and neutral / ambiguous responses can be avoided except in exceptional / rare cases to a large extent. This helps in assessing the firm safety attitude and behavior of the respondents.

The major inferences from the opinionnaire are as follows:
1) 46 %(Agree) and 54 %(Strongly Agree) to the statement that "Accountability towards safety should be defined at each level in an organization".

This is in line with the argument that individual and group accountability at any level for safety is not clearly defined. This leads to lack of ownership.

2) 45% (Agree) and 55% (Strongly Agree) to the statement that "Supervision and survey of working areas improves safe performances".

The management should realize that the supervisory and survey functions are key to improve work place safe behavior.

3) 73% (Agree) and 27% (Strongly Agree) to the statement that "Safety has a value in an Organization".

The organization should accept and incorporate in its mission and vision statements.

4) 45% (Agree) and 52% (Strongly Agree) to the statement that "Workers should be motivated towards safety ".

The management should take an initiative and devise a program to motivate workers towards safety in the work environment.

5) 46% (Agree) and 48% (Strongly Agree) to the statement that "Mutual trust and faith between workers and management strengthens Safety Culture".

The management should evolve and establish a trust and faith building program to enhance safety culture in the organization.

Table 2: Response of Construction Projects Personnel Opinionnaire

Opinion on Safety Culture	Percentage (%) Response				
	A	B	C	D	E
Development of Organizational Safety Culture is the responsibility of top management only	24	27	4	24	21
Leadership in safety is the manager's role and responsibility	9	9	3	58	21
Safety has a value in an Organization	0	0	0	27	73
Employees are interested in learning safe methods / practices	0	3	6	48	43
Safety can be improved by more inspections /audits of work places.	0	0	0	54	46
Safety Culture is measurable	0	3	15	62	20
Key meetings should start with safety briefs	0	3	6	67	24
Supervision and survey of working areas improves safe performances.	0	0	0	45	55
Top-down approach is best for improving safety culture	0	3	6	69	22
Mutual trust and faith between workers and management strengthens Safety Culture.	0	0	6	46	48
Workers should be motivated towards safety	0	0	3	45	52
Accountability towards safety should be defined at each level in an organization	0	0	0	46	54

6) In general more than 90%[Agree and Strongly Agree combined] are recorded in statements "Employees are interested in learning safe methods / practices", "Key meetings should start with safety briefs", & "Top-down approach is best for improving safety culture".

This indicates that management's leadership and pro-active role has a long way in the success of safety culture management.

The opinionnaire studies and discussions at various construction sites and at different levels of revealed that the enhanced hazard awareness, change in work attitude and individual accountability towards safety builds a positive work environment and a robust safety culture in the industry which is the long term goal of the organization.

4.2 Safe Behavior Observations

Observations are the basis of a behavior safety study process. They provide us opportunities for on the spot verbal feedback and coaching / mentoring at the point of contact. In principle, observations are analyzed to provide objective decision-making inputs for identifying training needs. The observation process should consider the frequency and focus point for improving the safe behavior. This research work is focused on the work at height, because the worldwide studies, safety researches and experience has proved and established that fall from height is the single largest cause for the severe injuries / fatalities in the construction sites. The cause of every 2nd or 3rd accidental death reported from the construction sites worldwide is 'fall from height'. This is a verified and validated information in Indian context also. The other potential construction hazards responsible for injuries are- caving in, struck by / against objects, hit by projectiles, collapse of scaffolding, working in confined

space, handling of heavy materials, contact with electricity and substances, vehicular movements, etc.

The observations are carried out in the 5 large scale construction projects being executed in different parts of the country. The visits to the sites were made at regular intervals during the period 2006 -16 (10years). The visits are random in the range of 10 -15 per site during the inspection of construction phase involving primarily work at heights in construction industries. A construction industry safety behavior could have different horizon as compared to a service or a manufacturing industry. The study is mainly targeted on safe behavior in construction. The observations by the author and other colleagues who are equally competent are recorded in the Table 3.

Table 3: Typical Observations Check list for Work at Height (Relevant Observed Behavior Situation to be ticked)

Description of Safety Requirement	% of Behavior Observations		
	Normal (Accept)	Tolerable (Action)	At-Risk (Stop)
Permit to work	40	45	15
Worker ability	20	56	24
Job training	45	30	25
Work conditions	33	35	32
Supervision	30	26	44
Communication	25	23	52
Access to height	20	25	55
Working platform	23	32	45
Safety Net	45	35	20
Protection levels	55	23	22

The total number focused observations on working at height in a large scale construction industry, reported and recorded are around 650(individual and group) in 5 sites [12]. These observations are made by around 15 observers (individually and as a team) in 10 years. The total no persons observed working in construction sites are 16,000 (average).The observations were recorded in the presence of concerned supervisor, safety professional, etc who have accompanied during the visit.

The observations were mainly focused on 10 elements which are related to work at heights. They are the permit to work system, worker's abilities (physical, mental and technical), training on hazards which includes hazard awareness programs, pre-work briefing, tool box talks, supervisory talks, etc, working environment which includes conditions, situations and usage of personal protective equipment, effectiveness of supervision, efficacy of communication modes, methods and means and engineering provisions like access to height, working platform / scaffolding , safety nets, etc.

The observations are categorized as Normal (Acceptable), Tolerable (Action required) and At –Risk (Stoppage of activity). The normal behavioral observations are considered to be safe practices which required to be monitored continuously by the concerned contractor's supervisory personnel for sustenance. The tolerable, behavior patterns are acceptable at present but requires a time bound management action plan for safety deficiencies reporting , monitoring, reviewing follow up and closing system. The At-risk behavior is discontinued by stopping the work immediately with the knowledge of supervisors. This pattern of behavior requires close and continuous monitoring. The management normally resorts to educative and engineering approach (positive reinforcement) to effect the behavior change. It is also observed that, the enforcement and entrenchment means (negative reinforcement) techniques are also resorted in habitual or repetitive cases. The authors experience narrates that the positive reinforcement techniques have given good results. The negative reinforcement methods like warnings, penalties, etc have also not much improved the behavior and unsafe behaviors are unabated while working at heights, may be by different persons, groups or contactors. This situation requires to be studied more by progressive and prospective construction organizations.

We can infer the following from the Table 3, above:

4.2.1The max (56 %) of Tolerable observations are related to "worker ability", which is mainly the mental and technical ability to perform the assigned jobs safely.

The managements should devise the safety training and awareness programs to enhance and strengthen the understanding of work hazards and to improve safe behaviors to prevent injuries.

4.2.2 45% of the Tolerable observations are related to "permit to work system".

The permit to work system is viewed as a mere compliance and a pre-requisite to work rather than the spirit to work k safely with adequate preventive measures. The attitudes of management and supervisors towards the permit system needs positive approach and improvement.

4.2.3 35% of the Tolerable observations are related to "Work conditions" and "safety net".

The observations indicate that the work conditions including safety net provisions are marginal and just sufficient to work. This requires to be reviewed and strengthened to ensure humane work environment.

The above 3 inferences are precursory to incidents. They are needed to be reviewed and addressed in a time bound manner to prevent deterioration and degradation of the work environment further.

4.2.4 The max (56 %) of the At-risk behavior observations are related to "Access to height ", which is mainly the cause of fall from height.These observations are due to short cuts , non-availability of engineered access to work place , make-shift methods, unsafe ladders and scaffoldings, etc.

These observations are viewed seriously and brought to the notice of all levels for the immediate action. The work was temporarily suspended or stopped. The managements act immediately on the engineering provisions and institute a safety awareness program to enhance the knowledge on the

hazards and safe work methods to improve behavior/ attitude towards the safety.

4.2.5 52% of the At-risk behavior observations are related to "Communication".

The communication is a critical element in safety at work place. The past accidents also reveal lack of proper communication between the workers, workers and supervisors and supervisors and also between the contractor and the project client. The oral and written communications are to be clear. Non –verbal communications using Information Technology and audio –visual aids help in enhancing communication on hazards and accident prevention. The communications along with a good training program influences the work behavior and enhances the safety culture.

The results of the observations and studies were discussed internally with the construction project managements, supervisors and the workers. They were receptive to suggestions and improvements. The necessary corrective measures were taken to improve the safety performance.

In general, the authors advocate that the job safety observation of the construction activities is an effective and powerful tool to influence and reinforce the safety conscious behavior amongst workers and enhance the safe working culture. The interactions between the workers, supervisors and management at construction sites is very encouraging. This is a proactive tool to promote blame –less, committed and safety conscious work environment in the construction industry.

4.3 Analysis and Findings

The analysis and findings of the study are enumerated and are as follows:

1) A behavior is any observable and measurable action [13]. The safe observation frequency is decided based on the contact rate—the rate of contacts between observers and those observed. While some processes advocate daily contact because it pro-vides a more reliable picture of ongoing safety performance others recommend two or three times a week [14], once per week or a few times a year. Anecdotal evidence [15] suggests the greater the contact rate, the larger the impact on incident rates. The experience of also shares the view that more frequent the safe behavior is observed, the higher it influences to positive reinforcement.
2) Behavior is an outcome of its social and work environment. It is influenced by its consequences. The management should mitigate the consequences by engineering factors. The change of behavior process responds better to positive rather than negative consequences.
3) The observations study was carried out without prior intimation and permission of workers. The work group approach and discussions with all the stake holders (worker, peers, supervisor, manger, etc) is successful in identifying the causes of unsafe behavior and improving the safety performance.
4) The impact and influence of observations on injury reduction and behavior change[16] has been objectively assessed. The feedback mechanism was effective in communicating the observations and the expected / desired safe behaviors which was well received and accepted by all. The observations list is also updated.
5) The sustainability of the enthusiasm and motivation is an important factor in determining the future shape and direction of the safety observation program.
6) Self-observation approach is a successful approach in construction industry, to check the behavior of individuals by themselves, introspect the outcomes and correct themselves. If any training needs are identified, the same can be communicated to employer. The safety shall be self-driven and self –motivated.
7) The focused observations of management walk-talk rounds related to house-keeping, use of personal protective equipment, at-risk behavior, safety challenges, etc received immediate verbal feedback. The persons were informed for corrections and corrective actions on the spot to adjust their behavior. The author during the visits has observed such phenomena.
8) The observation process only reveals the responsive action to a behavior at a work place. This is not a definite indicator of such repetitive behaviors in future unless the positive or negative reinforcing is done. The reinforcement is dependent on management approach, a punishment to one person may reinforce and perpetuate, a similar or different behavior in another. The authors believe that human behavior is a complex and sensitive process and should be handled with extreme care and caution.

   To understand the concept, a simple statement reads as "If an appropriate behavior is repeated, it has been reinforced. If an undesirable behavior is repeated, it too has been reinforced. If an undesirable behavior has discontinued, it has been properly disciplined". The challenge to construction management is what is wants to reinforce?
9) The authors believe that workers are like school children, reinforce the concept that the positive outcome based learning environment is the need to enhance and succeed in the safe behavior management during construction activities.

The learner's self-esteem should be understood and respected. This is a prerequisite to manage behavior at work place.

10) The systemic approach to behavior based safety management system should be envisaged /adopted to change perception , belief , attitude and cognition of the workers.

Conclusion

The study on BBS System in construction industry concludes that working with people is rewarding and challenging. The individual behaviors reflect in a group behavior and vice-versa. The opinionnaire and observation study process of the research work is based on the individual and the group behavior in the construction process. The authors believe that

high lighting of positive behaviors rather than negative, with persuasion/ counselling of individuals to the change the work situation has yielded good results.

People are complex with thoughts, actions, expressions, purposes and emotions handling them at construction industry is a herculean task to management. The management should design, establish and implement a robust BBS program to ensure safe working environment.

To end, the management should remember the following:

1) Behaviors are purposeful.
2) Positive recognition / reinforcement of behavior is repeated.
3) The caring attitude and positive perception of management produces safe behaviors at work place.
4) The resolution of conflict is the success of management.
5) Encourage and promote responsible, accountable, transparent, committed work behaviors and positivism rather than the blaming, fault-finding and retribution culture.

5. Future Scope

The BBS has been a promising tool to reinforce positivism in the construction industry and has a potential scope for future improvement in the following areas:

5.1 Way forward

The BBS studies should be taken up a regular intervals to completely study the behavior at work.

5.2 Accidents prevention

The prevention of accidents by design of work place, by built –in safety systems, advanced safety monitoring software based systems like Closed –circuit TVs, Physical Protection Systems (PPS), Infra-Red (IR) sensors, etc. to impersonally observe the work practices and controlling unsafe behaviors.

5.3Workers Driven

Efforts to evolve and encourage aworkers driven BBS system should be rather than the management requirement to build a safe working culture in the construction industry, which are of short gestation periods.

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