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AN EFFECTIVE TOTAL CONSTRUCTION SAFETY MANAGEMENT IN INDIA

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ABSTRACT

Construction safety management has always been a big issue in india. Though much improvement in construction safety has been achieved, india still continues to lag behind most other countries with regard to safety. The safety in construction of any organization consists of employee's attitudes towards and perceptions of health and safety behavior. Construction safety are influenced by perceptions of risk, management, safety rules and procedures of the workers. A measure of safety management could be used to identify those areas of safety that need more attention and improvement. The dynamic nature of safety management, which has the ability to change on daily basis, means there is a great need for reliable tools that can measure safety climate. Safety management is a leading performance indicator that can provide insight into safety performance before accidents have occurred. In this paper, several construction safety techniques were used for the safety of major construction organizations across India involved in construction of Thermal power plants, Hydro power plants, Highway projects, Bridge works, Refinery works, High rise works, Pipe line works and Dam woks and its content validity was verified. These techniques are very much useful for the safety construction. Moreover, Total Construction Safety Management (TCSM) is proposed for the effective construction safety in india. Safety climate is used for the evaluation of the TCSM.

Keywords: Fatal accident frequency rate (FAFR); safety related deficiencies (SRD); job hazard analysis (JHA) and task demand assessment (TDA); total construction safety management (TCSM); construction safety management

1. INTRODUCTION

In India, construction industry holds the second position next to agriculture industry. The annual turnover of the construction industry in India is about 4000 Billion Rupees, which is

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more than 6% of the National GDP employing a large work force. The construction works in NPCIL, are enormous. The number of fatalities occurring from construction work in the industry is quite disturbing and fall of person from height and through openings are the major causes for serious accidents. But the accidents occurring in India is very high compared to the foreign countries

With strong planning, effective implementation and continual training with focused safety management a good safety record could be achieved comparable to international level. The average Fatal Accident Frequency Rate (FAFR) in NPCIL during last five years is 0.22 incidents / 1000 employees /year as against an estimated value of 15.8 for Indian Construction Industries. In this context, it is worthwhile to mention that FAFR for construction industry in the US as per data published US Dept. of Labor for the year 2005 is 0.23. However, we are not complacent and efforts to achieve the next level of excellence are being invested on a structured manner [1]. Therefore we need to focus on the following aspects,

- Innovation in the training methodologies to achieve higher effectiveness of training among the contractor employees.
- Developing and implementing Behaviors Based Safety Program to improve orientation of work force towards safety in work.
- Implementation of innovative engineering measures to strengthen the safety requirements at design stages to achieve safe working environment during construction.
- Training and certification, in Industrial Safety requirement, of line managers and others responsible for construction activity essentially to enhance their perception and appreciation for industrial safety.

The role of line managers and safety professionals in preventing the safety-related incidences is quite important. Therefore, it is necessary that safety requirements are assured on regular basis by scrupulous field rounds and the deficiencies identified are attended to promptly. Further, the attributes and requirements to achieve effective management of safety right from the design stage to execution and operation must be identified and addressed appropriately through a structured program. To achieve this important objective, it is vital to recognize the important elements of the safety management system and strengthen the same at each stage.

1.1 Related works

Construction safety in the literature review mainly falls into 4 categories.

- Accident statistics and causes of construction injuries or fatalities.
- On site accident prevention methods.
- The role of stakeholders, apart from contractors, in preventing accidents.
- Institutional aspects of construction safety.

There is very little literature relating directly to the construction safety sites in developing countries. Present works provide information on how accidents may be prevented but assume that a strong regulatory body exists to enforce legislation. This literature review therefore presents information which is either specific to developing countries or has been prepared in a developed country context but would also be applicable to developing countries.

The construction industry is a labor intensive industry both in developed and developing countries, with a large number of tasks being undertaken in similar ways in both regions. But

the number of accidents in foreign countries is very less compared to India.

1.2 Accident statistics

In the economic point of view, the construction industry plays a vital role as it typically contributes 10 per cent of a developing country's GNP. It is also very hazardous with almost six times as many fatalities and twice as many injuries per hour worked relative to a manufacturing industry. In Helander [2] analyses 739 construction fatalities that occurred in the UK. He found that fifty two per cent occurred due to falls from roofs, scaffolds and ladders. Falling objects and material were involved in 19.4 per cent of the deaths, and transportation equipment, (e.g. excavators and dumpers) were involved in 18.5 per cent. Helander also found that 5 per cent of construction accidents occur during excavation work.

The categories used for classifying fatal accidents were:

- Falls
- Falling material and objects
- Electrical hazards
- Transport and mobile plants
- Other

Most of the accidents that involved falls occur during work on roofs, scaffolds and ladders. Moreover, collapses of structures and falling materials also contribute for a large proportion of victims [3]. Many of the safety hazards are particular to the different trades, and usually construction workers underestimate the hazards in their own work which affects the motivation for adopting safe work procedures. The establishment and use of procedures and regulations to enhance safety can avoid a large proportion of these accidents. There are also forceful monetary incentives in construction safety as it is estimated that construction accidents amount to about 6 per cent of total building costs; this should encourage the industry as well as the regulatory agencies to invest in construction safety.

In Dedobbeleer and German [4] estimated the relationships between a worker's safety performance index and attitudinal issues related to safety. The authors considered three factors; reinforcing factors, enabling factors, and predisposing factors. Reinforcing factors compute the attitudes of other towards safety; enabling factors measure the availability of safety factors at the work place; predisposing factors measure the knowledge and attitudes towards safety of the individual worker. Some other factors like demographic were also used for interaction. The inclined factor alone explained most of the variation in safety performance. Majority of the workers under the age of 26 had relatively low safety performance scores & relatively little knowledge about safety and an unfavourable attitude towards safety performance.

The study concluded that:

- Falls are the most serious hazard.
- Research on safety motivation shows that hazard recognition is an essential element.
- Many accidents involve hand tools. Ergonomics can improve safety through better design.
- Protective equipment needs to be comfortable.
- The paper also dealt with the psychological aspects of safety, such as motivation

and attitudes.

Hinze and Pannulu [5] explored the impact of new workers and turnover rate on safety. In this paper they identified the following key factors:

- Superintendents with the same crew from the earlier jobs had fewer injuries.
- Employer Safety enhances when the employer retains the worker for one year, and the advantage increase with longer continuous service.

Hinze and Pannulu [5] investigated the characteristics of superintendents associated with improved safety. They found th followings:

- Job oriented pressure increases the injury level
- Competition within or between crews supported by the superintendent cause more injuries.

1.3 Accident prevention

Jannadi [6] conducted a model survey of 86 safety officers and 173 workers from the top 200 construction companies in the UK to discover the key factors in accident prevention. Unlike many other studies the opinion of workers as well as safety officials was also considered; more conventionally, the focus remained on large construction companies.

The six most important factors were:

1. Maintaining safe work conditions
2. Establishing safety training
3. Safety education to support good safety habits amongst workers and supervisors
4. Effective control of the main contractors on site
5. Maintaining close supervision of all work
6. Assigning safety responsibility to all levels of management and workers

Another study (Samuelson [7]) focusing on the middle level management found that:

1. Management attitudes have more influence on safety than the foreman or peer groups.
2. Workers work more safely for a supervisor who respects his men and their contribution.
3. Better co-ordination improves safety.
4. Work on piece rate basis rather than a fixed hourly basis increase the probability of accidents.

The study did not imply that middle level management was the only key factor, and indicated the findings need to be considered in conjunction with other studies.

Hinze and Pannullu [5] found that the safety performance is improved by the increased job control. Damages or injuries are found to be lower for projects in close proximity to the home office which was primarily due to more frequent visits by top management [8]. A longer duration of employment also improves a worker's safety performance.

Hinze and Figone [9, 10] investigated the effect of the general contractor on speciality contractors for small, medium and large-scale projects. In additional to the safety factors discussed above, they found the following additional factors improved safety with subcontractors: Companies that negotiated a majority of prime contracts were safer.

- Smaller projects, projects with fewer specialty contractors and negotiated contracts resulted in fewer accidents.

- Daily inspections and good housekeeping.
- Less schedule pressure.
- Involvement of speciality contractors in meetings with owners/clients.
- Project schedules produced with on site departments.

Hinze and Harrision [11] identified safety program practices in large companies which resulted in a reduced injury rate. They identified the following key factors in safety:

- Field safety representatives hired by the corporate safety director.
- Field safety directors trained their subordinates.
- The safety director reports to the vice-president or the president of the company.
- New workers received formal safety orientation.
- Safety awards were given to the workers and the foreman.

This was followed by another study by Hinze and Rabound [12] which founded the suitable means of achieving or maintaining an acceptable safety performance. The vital factors included top management support which endorsed employing a full-time company safety officer. Regular safety meetings and performance monitoring undertaken for supervisors are also required. Since job pressures influence the safety performance more attention should be given to better scheduling of works and discussion of safety issues in co-ordination meetings.

1.4 Stakeholders in safety prevention

Kilbert and Coble [13] explained the relationship and overlap between safety and environmental issues. The overlap has insinuations for the roles and responsibilities of the many organizations involved. This research was based on the experience in the USA, but the problems discussed are very generic in nature. The authors suggested combining safety and environment procedures and merging of OSHA and EPA. The study assumes that a single agency dealing with a well-defined area will be more effective than many agencies with overlapping issues and responsibilities. The authors also recommended that the contractor should be provided with a bid package that clearly identifies the responsibilities of contractor and owner for safety and environment requirements. It was recommended that legal duties should be explicitly communicated to the potential bidder at the time of invitation to bid. The suggestion is that in many cases the contractors are not aware of their implicit legal responsibilities in relation to the health and safety issues.

Young [14] described the role of site engineers to improve safety at sites. In order to obtain fully common project goals of greater value, lower costs and reduced risk, engineers on the front line must take the lead in implementing innovative, yet pragmatic approaches that strategically integrate safety concerns into the project management process.

While significant improvements in safety performance have been made in the past few decades, one party within the project team, the designer, has not been directly involved in the safety effort. In Gambatese et al [15] also cited a study conducted by the Construction Industry Institute (CII) [16], in which best design practices to minimize or eliminate construction site hazards have been tabulated. These design suggestions have been incorporated into a computer program, entitled ‘Design For Construction Safety Tool box’ that assists designers in recognizing project-specific hazards and implementing design suggestions. This computer program links the design and construction phases to improve

construction worker safety. Although the toolbox was designed for developed counties, it may be a useful tool for issues related to some of the design aspects in developing counties.

Sweeney [17] pointed out that the future of health and safety in the construction industry depends on a collaboration of many parties, including labor, industry, academia, private organizations and government. The National Institute for Occupational Safety and Health (NIOSH) is the single federal organisation mandated by US Congress to conduct research to protect the health and safety of workers. Its successes through its partnerships over the past five years demonstrate that H&S is an important element of the construction job. Samuelson and Leveitt [7] provided owners' guidelines for selecting safe contractors and monitoring safety performance. The useful strategies which have an impact on contractor's safety were:

- use of short-term permits to regulate hazardous operation;
- stressing safety during periodic visits;
- maintenance of safety records;
- incorporating detailed job-specific safety requirements in the specification;
- periodic inspections;
- awards for safe practices; and
- considering safety as a criterion in pre-selection of contractors for bids.

Construction Industry Training Board (CITB)(1988) in [16] prepared a construction site safety course (1988) aimed at the industry in the UK. The course assumes the availability of a legislative and regulatory framework, and that the relevant institutions exist to train the workers and monitor the safety at workplaces

1.5 Institutional

Labour [18] explained how the construction industry developed from the master builder system into design and construction specialities, and how these have influenced perspectives on responsibility. He described about the issues regarding the liability of the designers in the traditional design-bid-build system. It was argued that designers should contribute more in achieving the safety objectives. The construction industry had 15 victims per 1000 workers in 1996 as compared to 4 per 1000 workers in all other industries combined. The frequency of disabling injuries was 5300 per 100,000 as compared to 3100 per 100,000. The records of the last 45 years confirm the trend that the construction industry has very high fatality and injury rates.

From the review, it is very clear that there are very little data present on the safety on construction sites in developing countries like India. Although it is reasonable to assume that the type and level of accidents are similar to those in the UK where data exists, surveys should be undertaken to confirm a baseline for the level of accidents in India.

2. PROBLEMS DEFINITION

These surveys would aim to give the following information:

- Confirm the types of injury and fatality are similar to UK statistics;
- Level of accidents, i.e. the percentage of workers injured each year / probability of

injury;
- Type of work and trade which is most at risk of accidents;
- Level of safety training / awareness that exists in country; and
- Relationship between hazard perception and safety performance of the workforce.

Contractors will frequently have insurance against claims made by the client, through the contract, but the level of insurance against injury claims from employees is unclear. Investigations should be carried out to determine the safety nets that exist when workers are injured and how effective they are at protecting or supporting the workers.

Most of the small project construction works in developing countries like India are carried out by labor-based methods, which utilize a large number of hand tools. Research has shown that poor quality hand tools not only increase the time taken to complete a task but also the fatigue of the worker (Dennis [19]). Poor quality hand tools are more likely to cause injuries to the worker. Necessary steps must be taken in order to promote the benefits of improved quality of hand tools to justify their increased cost.

The responsibilities of all the parties involved in the project are sketched by the contract documents. Where local or community contract documents are used for a project they should be reviewed to guarantee that the safety risks and responsibilities of all the parties are clearly stated. Necessary amendments or additions should be made to ensure responsibilities that are realistic and achievable in order that they will be adhered to rather than ignored.

Finally, there are two important factors that should be considered in the safety construction management.

- Promoting awareness and enforcement of realistic safety legislation.
- There is a need to encourage hazard awareness training of workers and employers on construction projects.

As a temporary measure, **Department for International Development (**DFID) may consider developing a construction safety policy for its projects. Construction Safety will not be improved unless there is a demand or incentive provided to the contractors. As workers often feel that their jobs are too insecure to make large demands on their employers, the initiative for improved safety must come from the client. As DFID will ‘hold the purse strings’ on many projects it will be in a suitable position to encourage or demand improved safety procedures on these projects, in line with its safety policy or guidelines.

3. SAFETY MANAGEMENT TECHNIQUES

There are several techniques adopted for the safety construction in India. Some of the main techniques are

3.1 Safety organization

A well designed safety organization for contractors, sub-contractors and interface with department is are very essential. Implementation of Safety is a line management function; therefore its ownership lies with them. These line managers are to be backed up by competent persons in Industrial safety that provide expertise and supervision of work environment and equipment such as lifting tool, tackles, scaffolding, ladders etc used in construction. Jain [1]

indicated that the principles and procedures for effective safety management in NPCIL have been evolved over a period of time and are based on the experience feedback of 170 reactor years of construction. Scrupulous implementation and adherence to the industrial safety procedure and requirements is needed to be observed at all levels as an on-going program. Some of these systems to identify areas of improvement and achieve enhanced industrial safety status are enumerated below:

- Safety surveillance and Safety Related Deficiency Management system
- Area-wise Task Force for enforcing safety at construction Projects
- Contractors Safety surveillance and correction programme
- Entry passes to the work site only after Induction Safety training etc.
- Periodical Safety Audits

As the concept of mega package contract is implemented for construction activities in industry in general and specifically in NPCIL the interface between the Safety officer of the contractor and departmental Safety organization, for ensuring a regular communication between them, is essential. One of the administrative controls in this view needs to be that contractor safety professionals functionally report to Head, Industrial Safety, of the department. This will help in implementing safety during work.

Approval of Industrial Safety requirements and their implementation takes a priority for all of us. Hence, we must develop and institute procedures, work plans and programs that are implemented with a common understanding of utility and contractor team. In this context, the regulatory requirements are equally important which need to be understood and implemented in clear and unmistakable terms by all concerned including the contractor organization.

3.2 Safety related deficiency management

Though all things are in place, while the construction work is in progress; Safety Related Deficiencies (SRD) emerges either due to change in status at work floor or multiple agencies working in parallel. SRD also get emerge due to decline in safety culture [1]. It is so required that SRDs are detected and corrected punctually on a routine basis. Presently a LAN based system of communicating SRD is in practice in our plants. The system is called “SRD Management System”. In this system, the detected SRD’s are communicated through e-mail and reminders are automatically sent depending upon the severity assigned to the SRD. The safety professionals/safety group is also able to get timely feedback of corrective actions, which are verified to close the SRD. It is intended that no SRD remains for more than 24 hrs and thus safe work conditions and safety culture would be ensured.

3.3 Job hazard analysis (JHA)

The dynamicity, complexity and parallel activities in construction are unavoidable at times [1]. These activities, though planned, are carried out by the work force which is skilled in the execution of work but lack of awareness of safety requirements overconfidence, complacency, at times, leads to breach in safety requirements. So, a regular monitoring and surveillance program along with coaching and mentoring of employees during execution becomes necessary to correct the aberrations in safety implementation. The personnel are to be given required induction training and PEP talks.

The main objective is to assure safe working conditions to prevent accidents, hence it is

necessary to understand and implement proactive control measures at work place prior to execution of the work. Training to the executing team members needs to be imparted on risk management. Therefore, risk assessment/hazard analysis has to be carried out for all significant works. Several workshops on JHA have to be conducted. These JHAs need to be further evolved at site and rigorously implemented.

3.4 Safety training

The importance of training cannot be undermined. Over a period of time standard training modules have been evolved. In addition to this Pre Job Briefing and PEP talk also are given to bring in requisite awareness to the contract and departmental employees. But for enhanced effectiveness of training, it is necessary to develop such training modules and methodology in a lucid manner, which can provide the required safety. The use of modern educational teaching aids such as audio-visuals, mobile training with will improve the performance of training. I still feel that there is a scope of further improvement in our training methodology. Hence, the training to such a large work force should be organized in a more structured and job specific manner through interactive methodology. The workers who demonstrate good safety behavior and practices should be motivated by way of rewards. Enhanced field visit by the line managers and interacting with the workers with the philosophy of "each one teach one" will go a long way in strengthening our objective of achieving safety and desired safety culture.

3.5 The task demand assessment (TDA)

It is a new technique for measuring the safety risk of construction activities and analyzing how changes in operation parameters can affect the potential for accidents. TDA is similar to observational ergonomic methods—it does not produce estimates of probabilities of incidents, but it quantifies the "task demand" of actual operations based on characteristics of the activity and independent of the workers' capabilities. The task demand reflects the difficulty to perform the activity safely. It is based on (1) the exposure to a hazard and (2) the presence and level of observable task demand factors—that is, risk factors that can increase the potential for an accident. The paper presents the findings from the initial implementation of TDA and demonstrates its feasibility and applicability on two different operations: a roofing activity and a concrete paving operation. Furthermore, TDA method can compare different production scenarios and measure the effect of production variables on the accident potential. The findings indicate that the method can be applied on activities of varying complexity and can account for several risks and task demand factors as required by the user. The selection of task demand factors is a vital issue for the validity of the method and requires input from the crew and safety management. The limitations of the methodology and the need for further research are discussed. Overall, TDA provides a tool that can assist researchers and practitioners in the analysis and design of construction operations.

4. TOTAL CONSTRUCTION SAFETY MANAGEMENT (TCSM)

This approach consists of three phases;

(1) Planning and Preparation Phase,

(2) Identification and Assessment Phase, and
(3) Execution and Improvement Phase.

Phase 1. *Planning and Preparation Phase*(as shown in Figure:1): In this phase, construction organizations must first initiate the safety program through an effective pre-planning and resource development process. During this period, organizations must establish a vision, develop strong commitment from senior management, develop an employee-training plan, and must verify that all operational resources are in place to accommodate the program change.

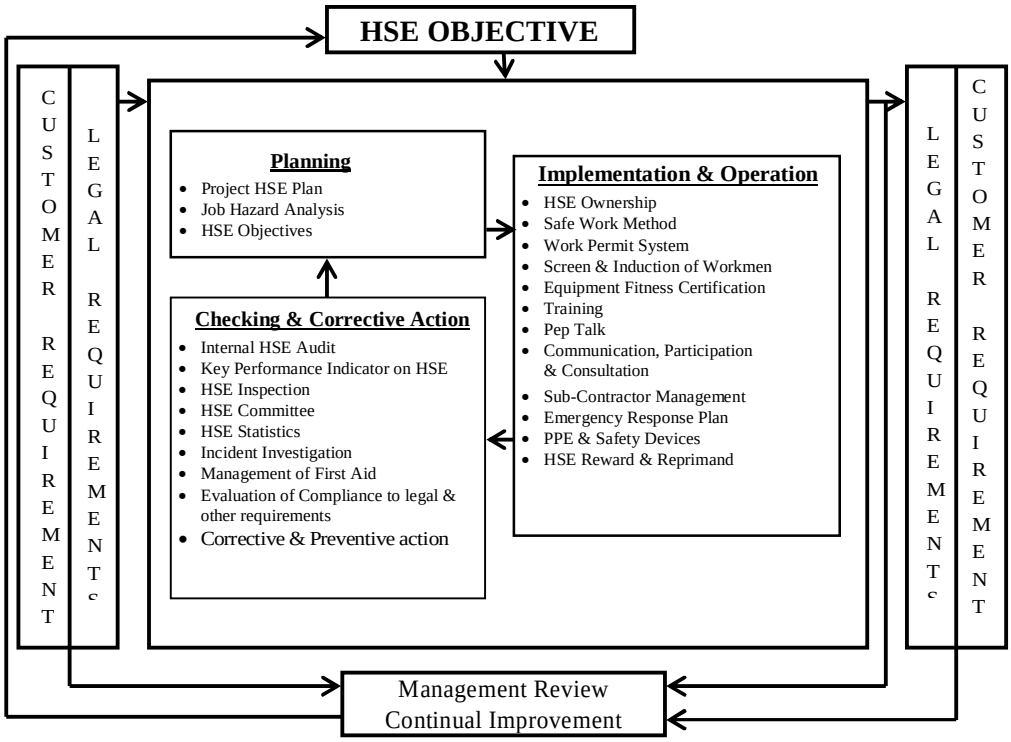

Figure 1. Total safety managment model

Phase 2. *Identification and Assessment Phase*: This phase consists of developing safety goals and objectives, management training and strategic decision making on safety management techniques.

Phase 3. *Execution and Improvement Phase*: The final phase of the TSM implementation model (as shown in Figure: 1) is the execution and improvement phase. At this stage, the new culture must be incorporated in the mix, employee-training programs must be launched, and all safety performance closely monitored to promote continuous improvement.

5. CONCLUDING REMARKS

Owing to increase in complexity of operations, the construction industry has become more dangerous than ever before. Construction organizations are faced with the challenge of having to closely monitor their safety management systems to minimize occupational hazards, while

simultaneously trying to sustain profits in a competitive marketplace. In the United States, government agencies such as OSHA have done their part to promote a zero injury environment. However, in India effective safety construction management is not available. Moreover, the key to proper safety execution is not necessarily through strict guidelines and standards, but through an effective total safety management initiative, first supported by an organizations senior management, then integrated via specific safety management implementation tools/ systems, and finally by continuous follow up and monitoring to ensure quality and continuous improvement. Construction organizations interested in maximizing safety and competitiveness must look to TQM initiatives for inspiration. Quality focus, total commitment, and continual improvement must be the mantra of choice. Only those companies that take on an aggressive safety management approach will sustain profit margins and achieve world-class competitiveness.

The proposed TCSM acts as a catalyst for maintaining a safe project, contractor top management should formulate strategies and develop policies that nurture a safe culture. The authors would like to conclude that the single most important determinant of the success of an organization in implementing TCSM is its ability to translate, integrate, and ultimately institutionalize TCSM behaviors into everyday practice on the job.

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