

Improving Safety Management System & Workers Health and Safety In Construction Workplace: A Review

Jaimin B. Patel¹, Prof. Neetu B. Yadav²

¹ME Scholar, Civil Engineering Department, SNPIT & RC Umrakh, Gujarat, India

²Assistant Professor, Civil Engineering Department, SNPIT & RC Umrakh, Gujarat, India

Abstract - Health and safety is one of the most important considerations we should take before any construction project gets underway. Health and safety in construction has particularly important because the construction industry is prone to hazardous situation and can be dangerous at times. The safety management system (SMS) was introduced in the year 1980 to reduce the risk of fatalities, injuries and reduce material waste in the Construction industry. A detailed literature study was carried out to understand the causes of accidents, factors affecting on safety, preventive measures, and improve the implementation of Safety Management System at construction sites. The research methodology employed in this study was quantitative research method using questionnaires survey. The use of the questionnaire method saves time and provides a reliable approach for obtaining quantitative data. It is considered to be a key method among researchers in management. A questionnaire was designed for data collection and analysis based on the themes that emerged from the review of the relevant literature.

Key Words: Safety management system, Occupational Health & Safety, Safety performance, Hazard, Causes of accidents, Labour involvement, Implementation of SMS

1.INTRODUCTION

The Indian society and economy have suffering human and financial losses as a result of poor safety record in the Construction industry which has far from achieving a Zero-injury goal. Thus, effective safety management systems are critical ongoing efforts to improve safety [2]. Worker's health and safety is most important area in need of improvements within the construction domain despite the advancements in technological applications of robust occupational health and safety management systems [4]. Health and safety are one of the most important considerations we should take before any construction project gets underway. The construction industry has considering high-risk, and it involves dangerous and challenging activities, such as excavation, the erection of steel, and working at different heights. An SMS refers to a comprehensive system designed to manage its safety elements in the workplace. It includes policy, objectives, plans, procedures, organizations, responsibilities and other safety improvement measures [8]. Hazard is a kind of danger which can occur in any period of time [13]. Many of those who work in construction confront dangerous working environments and exploitative work practices. The role of health and safety is to address both the physical and psychological well-being of workers on construction sites and other persons whose health is likely to be adversely affected by construction activities [22]. Safety management must be through, and it has been applicable to all aspects of the job, from the starting phase of estimation to the project until to the last worker has left the premise at the completion of the project [28]. Safety is very vital in construction industry because it is a high hazard industry that consists of residential construction, alteration, repairing, bridge erection, roadway paving, excavation, demolition, waterproofing, large scale painting commissioning, de-commissioning, dismantling, and fitting out [30]. Establishing a risk-free work site and reducing environmental pollution are important aspects of the system [40].

2.METHODOLOGY

The researcher applied the step in identifying the barriers and strategies to improve the implementation of Safety Management System at construction sites. This study was carried out by conducting questionnaire survey among various Construction related workers such as project manager, Safety Manager and so on to identify barriers in the implementation of Safety management system in their Construction firms. The responses were collected and analyzed using SPSS Software [2, 17].

The researcher reviewed the legal H&S regulations for the prevention of occupational hazards in construction, which establishes the basis for the integration of health and safety in a BIM. The H&S techniques begin with a BIM of the architecture, structure, and facilities. The tasks and information collected to the risk assessment are as follows: structure of the project navigator, risk parameters, BIM H&S objects, and work plan. From this, the approach for introducing the risk assessment process and its management in the BIM platform into the model is developed [3].

The researcher discussed the interface with system modelling has been investigated to identify correlations between the two, and opportunities for improving project performance metrics such as quality, productivity, and cost. Focus of this work is to investigate the relation between safety risk management and system modelling with focus on contemporary methods of simulation and optimization developed in the past 20 years [4].

The researcher applied a system theory approach to a construction project risk assessment. They used a System-Theoretical Process Analysis (STPA) based on System-Theoretic Accident Model and Processes (STAMP). Questionnaires were conducted on five selected project team members to get their point of view on the application of STPA [9].

The researcher giving a ranking of the KSF on the implementation of work safety programs on construction projects. Data is obtained by survey by giving questionnaires to the experts of the construction actors involved. The Analytical Hierarchy Process (AHP) method will be applied in this study is because there are several criteria or factors or safety elements that need to be considered in the selection of the most dominant KSF [10].

The researcher examines safety drivers based on input from subject matter experts on an OE (operational excellence) model. The weighting of the elements was achieved by conducting a survey, data collection, data validation and data analysis. AHP was the method utilized to establish weights for each safety driver in the model. The collected data was entered into a comparison matrix in Microsoft Excel to perform the weighting calculations [11].

The author applied a newly developed hazard perception test was used to determine if students and design practitioners are able to identify hazards in designs and to establish if site experience impacts hazard identification. A hazard perception test was developed using a purpose-made design with numerous designs, construction, spatial and maintenance hazards incorporated [21].

The researcher used sequential mixed approach of both qualitative and quantitative methods was used in this study to achieve two objectives. To achieve the first objective of identifying the main strategies for improving the safety and health of EM workers, a qualitative approach in the form of semi structured interviews was performed [29].

The researcher designed the questionnaire in order to explore the performance of SMSs adopters and non-adopters. The analysis performed on data collected can be summarized into two main steps, first, confirmatory factor analysis (CFA) was performed on questions belonging to Section 4 of questionnaire, to ensure unit dimensionality of items used and to reduce them to a limited number of factors to be tested [38].

3.BARRIERS IN THE IMPLEMENTATION OF SMS

The researcher has studied out and finalizes the most effective barriers which affect the implementation of whole safety management system. Below the table show the main factors and sub factors [2].

Table -1: Factors

Main factors	Sub factors
Cost related	1. Lack of expertise 2. OSHA investment
Time related	1. Tight project deadlines 2. Training and education time
Management related	1. Safety meetings 2. Clear and realistic goal 3. Allocation of safety in-charge
Personal related	1. Safety communication 2. Positive safety attitudes
Incentive related	1. Safety rewards and appreciation 2. Maintenance of records of accidents
Resource related	1. PPE 2. First aid and control system

There are considerable barriers in how SMS are designed and implemented. The design of SMS is influenced by (1) views adopted by stakeholders about the connection between hazards and causes of accidents; (2) the division of responsibility for risk management between different parties but principally worker, employer, designer, owner, regulator and society at large; (3) levels of financial, scientific and human resource capability in the organization, and (4) considerations about the cost vs. benefits of particular approaches and practices, on a risk weighted basis[37].

4.VARIATION IN SAFETY GUIDELINE FOR DIFFERENT INFRASTRUCTURE PROJECTS

Table – 2: Guidelines of Papers

SR.NO	NAME OF PAPERS	GUIDELINES/CHECKLIST
1	<ol style="list-style-type: none"> Understanding worker perceptions of common incidents at road works in Queensland[41] Safety Measures and Safety Warning Signs of Road Construction Projects: An Assessment[42] Beyond the Barriers: Road Construction Safety Issues From the Office and the Roadside[43] Investigation into Road Construction Safety Management Techniques[44] 	<ul style="list-style-type: none"> Traffic signs are visible from afar. Warning signs are understandable from afar. Are there sufficient warning signs displayed to ensure no accident would occur? Are there sufficient safety barriers to separate the area from passing motorists? From your perception, is it convenient if there is traffic management implemented to control the flow of traffic passing through? Is the traffic signs noticeably reflect from your point of view? Are the warnings signs noticeably reflect from your point of view?
2	<ol style="list-style-type: none"> Occupational Health And Safety In Dam Construction Sites[45] Health and Safety in the Lesotho Highlands Dam and Tunnel Construction Program[46] 	<ul style="list-style-type: none"> Review of past data Visual inspection (field examination) Report preparation Owner education Report submittal to Central Dam Safety Organization (CDSO) or State Dam Safety Organizations (SDSO), as required
3	<ol style="list-style-type: none"> Risk Analysis of Bridge Construction Projects in Pakistan[47] Safety Assessment of Existing Highway Bridges and Viaducts[48] 	<ul style="list-style-type: none"> Site shall be clean and in orderly condition. 5-10 minutes cleaning before end of work is recommended. A doctor should be assigned for the construction sites on remote areas as needed. Health condition of workers should be checked timely. If health condition of worker is bad, medical check-up should be provided as soon as possible. Medical check-up (e.g., blood pressure, heart beat) should be prepared for workers who are assigned for high-place or underwater work before commencement of work. First Aid Box should be prepared at every construction site.

Table – 3: Safety Guideline

SR. NO	IS CODES FOR SAFETY	CONTENT FOR GUIDELINE
1	IS 3696 (Part 1) : 1987 (Part 2) : 1991	Safety code for scaffolds and ladders: Scaffolds Ladders
2	IS 3764 : 1992	Code of practice for excavation work (first revision)
3	IS 4082 : 1996	Recommendations on stacking and storage of construction materials and components at site (second revision)
4	IS 4130 : 1991	Safety code for demolition of buildings (second revision)
5	IS 4912 : 1978	Safety requirements for floor and wall openings, railing and toe boards (first revision)

6	IS 5121 : 2013	Code of safety for piling and other deep foundations (first revision)
7	IS 5916 : 2013	Safety code for construction involving use of hot bituminous materials (first revision)
8	IS 7205 : 1974	Safety code for erection of structural steel work
9	IS 7969 : 1975	Safety code for handling and storage of building materials
10	IS 8989 : 1978	Safety code for erection of concrete framed structures
11	IS 13415 : 1992	Safety code for protective barrier in and around buildings
12	IS 13416 (Part 1) : 1992 (Part 2) : 1992 (Part 3) : 1994 (Part 4) : 1994 (Part 5) : 1994	Recommendations for preventive measures against hazards at work places: Falling material hazards prevention Fall prevention Disposal of debris Timber structures Fire protection
13	IS 13430 : 1992	Code of practice for safety during additional construction and alteration to existing buildings
14	IS 16601 : 2016	Guidelines for habitat and welfare requirements for construction workers
15	is:18001:2007	OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT SYSTEM REQUIREMENTS WITH GUIDANCE FOR USE
16	SP 62 : 1992	Handbook on building construction practices (excluding electrical works).
17	SP 70 : 2001	Handbook on construction safety practices., may also be made

5.SAFETY MANAGEMENT SYSTEM

Safety management is the procedure which is used to recognize Health and Safety risks and implementation to reduce the possibility of a risk materializing and to diminish the potential consequences of Identified project Health and Safety risks [2].

SMS is a framework; it can help to manage health and safety. Safety Management System (SMS) was introduced to the construction industry in 1980 which aimed at reducing the number of injury cases, eliminating harmful conditions to workers and preventing material damage at work [17].

Safety management system does not implies only input of labour hours, money, and other resources but also firm can eliminate site safety hazard, and that will prevent losses of time, properties, and lives. He also discussed some key elements like, Safety policy, Safe work practices, Safety inspections, Emergency preparedness, etc. which provides specific guidelines on how construction firms should organize and manage their sites to ensure the safety of their personnel and the public [19].

safety management practices and systems of practices provide for developing and executing processes oriented toward the “safe” planning, controlling, performing and checking of work, based on the fact that workers actually have to implement these processes, the level of worker engagement associated with man-aging or working within a system of safety management practices and processes may be very important to their safety performance success [33].

The safety management plays an important role for prevention of construction casualty. The analysis of accidents shows that most accidents are caused by various Reasons, about 85% of which are closely related to management [34].

A SMS is a set of activities that have been selected and instituted by the organization to help it achieve its safety goals. The SMS goes beyond addressing any single factor or the most immediate compelling factor related to accidents. Rather, it ensures that the effort is multi-faceted, targeted at issues rather than exigencies and is persistent throughout the duration of the project in spite of personnel changes [37].

Although the concept of SMS has become popular in recent years suggest that there is no consensus on what a SMS exactly is and on the corresponding scope. For instance, suggests a SMS to be defined as a set of policies, strategies, practices, procedures, roles and functions associated with safety [38].

Safety management systems are generally considered to be an integration of ISO 9000, ISO 14000, and ISO 18000 regulations. They are an approach to doing business that attempts to maximize the competitiveness of an organization through the continual improvement of its product, services, people, and environment by emphasizing customer focus long-term commitment, and teamwork [40].

6.OCCUPATIONAL HEALTH AND SAFETY

The researcher identifies factors related to the barriers to good OHS practice by various construction companies. Through an extensive literature review, the major issues likely to be related to the barriers to good OHS practice by construction companies are proposed [2].

According to OHSAS 18001; 2007 OHS Management system: A management system that is set of interrelated elements used to establish policies and objectives and to achieve those objectives [10].

The author explained about the Injuries in the workplace is caused by a combination of hazardous exposures and unsafe worker actions. OSHA found that the inability of workers to identify hazards and respond appropriately is a principal cause of worker injuries [15].

In India, Occupational Safety and Health developed in IS OHS 2000. This standard give necessities for an OHS to allow an organization to prepare a policy and objectives, description of lawmaking needs and information about major threats and risks, which can be controlled by the organization to guard its workers and others. The entire standard necessities are required to be included into any OH&S management system and also provide essential direction on the use of the condition [18].

The researcher gives the importance of OHS, Occupational health and safety is an area concerned with the development, promotion, and maintenance of the workplace environment, policies, and emotional well-being of employees [24].

Occupational health and safety (OHS) has been continues to be, a priority area for policy-makers, managers and workers. Occupational injuries and diseases result in significant costs to employers and impact on the private and social lives of individuals. He also discussed some leading indicators of OHS like, Systems for OHS (policies, procedures, and practices), Prioritization of OHS, and Accountability for OHS, Management commitment and leadership [25].

Prevention is not receiving the priority warranted by the scale and severity of the occupational disease epidemic. ILO (International Labour Organization) emphasized that a good national OHS system is critical for the effective implementation of national policies and programs to strengthen the prevention of occupational diseases [26].

Studies on occupational health and safety (OHS) management have tended to cluster in certain areas during historical periods of time, focusing on, for example, policy and practice, individual characteristics and social relationships, events and incidents of injuries and accidents, and management control and industrial relations [36].

7.SAFETY PERFORMANCE

Improving worker's safety and productivity are amongst main concerns in safety performance in the construction industry, where organizations are under continuous pressure to produce more efficiently within a safer working environment [4].

Safety performance measurement provides information to support decision-making on preventive measures, anticipate threats and identify opportunities for improvement. A common problem in construction companies is that metrics are chosen simply because they are easy to collect or to compare with metrics from other similar companies, rather than based on their relevance to support decision-making on critical processes [6]. Great care needs to be taken when using safety indicators to evaluate organizational safety policy and practices. The total recordable injury rate (TRI-rate) was assessed to be the only reliable quantitative injury indicator with which to indicate safety performance [7].

KSF is relevant with the actual safety performance in the Project. One of the standards to measure the safety performance based on the value of the Frequency Rate (FR) and Severity Rate (SR). This section is intended to measure work safety performance on projects based on the value of the Frequency Rate (FR) and Severity Rate (SR) calculated [10].

Construction labours injuries significantly impact projects beyond the loss of the individual's time. Injuries typically lead to delays, productivity losses, revenue losses and other negative outcomes that affect overall safety performance directly and indirectly [11].

The most influential factor driving safety performance in the construction industry is the organisation's policy towards safety. Safety issues and concerns are perceived as a joint responsibility of workers and management [20].

A common approach to the measurement of OHS performance is the separation of leading indicators from lagging indicators. This has emerged in response to the heavy reliance in many OHS organizational initiatives on lagging indicators such as injury rates. Lagging indicators are measures of OHS outcomes or outputs and provide a measure of past performance [25].

In general, there are several items which influence the safety performance. Accidents are the direct results of unsafe activities and conditions, both of which can be controlled by management [28].

Safety performance has been measured by such metrics as the Occupational Safety and Health Administration (OSHA) recordable injury rate (RIR); days away, restricted work, or transfer (DART) injury rate; or the experience modification rating (EMR) on workers' compensation. The characterize leading indicators of safety performance as consisting of a set of selected measures that describe the level of effectiveness of the safety process. Leading indicators measure the building blocks of the safety culture of a project or company [35].

8. CAUSES OF ACCIDENTS

Different causes of accident related to different numbers of the injuries to person. There are three main root causes of accidents: failure to identify an unsafe condition that exists before or after the start of an activity, carry on a work in unsafe condition, and decide to perform regardless unsafe site conditions. He discussed some points related to causes of accidents and root cause which must be needed to improve [28].

8.1 CAUSES OF ACCIDENTS

- struck by moving, including flying/falling, object
- injured while handling, lifting or carrying
- falls from a height
- exposure to, or contact with, a harmful substance
- acts of violence
- other kind of accident

8.2 ROOT CAUSES

- lack of proper training
- lack of safety equipment
- unsafe methods
- unsafe site conditions
- poor attitude toward safety

The statistic of accidents at construction sites gives us a picture that construction industry is one of the critical sectors that need a huge and fast overhaul from the current site safety practices. Accident don't just happen, they are caused. According to 99 percent of the accident are caused by either unsafe acts or unsafe conditions or both. As such, accidents could be prevented. The unsafe condition is a hazardous physical condition or circumstances which could directly permit the occurrence of an accident. Most accident results from a combination of contributing causes and one or more unsafe acts and unsafe condition [39].

9.LABOURS INVOLVEMENT IN SAFETY

Labours involvement is a workplace approach designed to ensure that employees are dedicated to their organization's values, motivated enough to contribute to work aligned with organizational prosperity, and able to improve their own sense of happiness and comfort at the same time [11].

There are lots of efforts to maintain reasonable health and safety standards for employees on-site, but conditions off-site, particularly those of migrant employees on fixed-term labour contracts, are difficult. Unpaid wages and lack of welfare facilities contribute to physical and psychological stresses that are linked to impaired on-site performance, lack of motivation, lack of productivity and a lack of interest in adhering to health and safety guidelines [22].

Employee's involvement is a vital factor in the organization safety program used to reduce injuries and accidents. Employee's involvement is the extent employees could influence and control OHS management issues at the workplace. In other words, employee's involvement into safety management process involves upward communication flow among individuals or groups and decision-making process within the organization because employees use to make suggestions about safety improvements, especially when new technologies and materials were introduced [27].

Construction projects carried out in large scale are following good safety measures as a separate safety department is available in these companies. But small-scale projects taken up by local contractors are not aware of the safety requirements that could prevent construction site accidents. Preventing labour accidents, occupational illness, and injuries should be a primary concern of all employers [31].

In addition, where work is being conducted, there is a human, who is capable of error, connecting that work with the safety management system. Active errors occur at this sharp edge, where the safety management system touches the worker and the worker touches the work to be performed. it is an important motivational concept with great potential to improve understanding of the mechanism through which contextual perceptions and behavioural tendencies ultimately influence behaviour and performance [33].

10.HAZARD IDENTIFICATION ON SITE

Hazard recognition is regarded as one of the most effective approaches to proactive accident prevention. While unsafe behaviour has been shown to account for 70–80% of offsite accidents, it has been argued that failure to recognize hazards directly precedes accidents. Proper detection and reporting of hazards are considered to significantly improve workplace safety [1].

Construction safety management risk modelling often relies on past injury records to indicate the likelihood and severity of potential accidents for a specific construction work task or project [4].

The identification and effective monitoring of hazards provides managers with the ability to put in place strategies to ensure peoples safety. He has mentioned some points related to hazard recognition which is it is demonstrated that the process of analysing hazard records can be automated by combining deep learning and text learning; hazards are able to be visualized using a systematic and data driven process [5].

Hazard is a kind of danger which can occur in any period of time. Identification of hazards is one of the most important parts of industries' strategies, in which all possible hazards are identified and ranked based on a hazard matrix. There are different kinds of hazards required to be considered: hazards to people like hazards associated with occupational diseases, property damages or environmental loses. Actually, any incidents related to health, safety and environment are considered in a hazard matrix [13].

several factors have to impact the construction personnel perception towards hazards and safety-related matters, in particular on-site implementation of SMS, site conditions and characteristics, position and years of experience, past incidents, and self-motivation, were mentioned below [14]:

- 1) Not all addressed before in one research effort, as is the case of the present study
- (2) Not all taken into consideration when analyzing a survey dealing with the on-site workforce rather than other construction individuals

According to accidents are caused due to poor safety awareness, lack of training, lack of organizational commitment, poor technical supervision, uncontrolled operation, unwillingness to input resources for safety, shortage of skilled labour, unsafe equipment, lack of first aid facilities, lack of safety regulations, lack of personal protective equipment, lack of innovative technology, and poor information system [28].

11. KEY SAFETY FACTORS FOR IMPLEMENTATION SMS IN INDIAN CONSTRUCTION

Roles and responsibilities were found to be “necessary” for high safety performance. The results indicated that two types of roles were important for high safety performance. First, that OHS was to a large degree a management responsibility with active project leaders. Second that at least one of the roles with specific responsibilities for OHS (coordinator for the execution stage, OHS-leader, OHS-coordinator etc.) was very active in the OHS activities and Coordination [7].

There are four essential elements can be grouped into categories: directive, operational, review and promotional. For directive purposes, company’s top management committed in safety in terms of safety policy and safety organisation structure while competent safety practitioners assist in devising the in-house safety and health rules, organising and conducting training programme and executing the emergency preparedness plan. For better operation purposes, it is necessary to have well-organised safety inspection programme, hazard control programme and accident/incident investigation programmes for the routine operation of the construction project [8].

For countries with mandatory requirements of development, implementation and maintenance of SMS, framework and guideline of the execution of SMS were usually offered. He is suggested four elements that Labour Department and contractors can decide the appropriate time to force these elements into operation after implementation of SMS [17]. points are: 1) Evaluation of job-related hazards 2) Safety and health awareness programme which promoted, developed and maintained safety and health awareness in a workplace. 3) Accident control and hazard elimination programme 4) Occupational health assurance programme.

It is reasonable to assume that many UK designers fail to appreciate the benefits of design for safety (DfS). Researchers have said that many designers do not recognise the impact on safety that they, as designers, can make. Several barriers for designers have been suggested, including lack of resources and time, cost, client requirements and a lack of tacit knowledge [21].

In construction industries has numbers of workers with different nationalities, several different languages may be spoken. Misunderstandings may arise from language differences between supervisors and migrant workers. To improve safety communication. Adequate provision for training and education on health and safety is recognized as one of the most critical factors in reducing and preventing injuries [29].

The main causes include working on a scaffold or platform without guard rails, or without a safety harness correctly attached, and fragile roofs and ladders that are badly maintained, positioned, and secured. Slips, trips, and falls are the largest cause of accidents in all sectors [31].

12. BIM & OTHER TOOLS FOR SMS

The research applied an analysis of the legal H&S regulations for the prevention of occupational hazards in Spain, which establishes the integration of health and safety in a BIM. The H&S technician begins with a BIM of the architecture, structure, and facilities. The tasks and information obtained prior to the risk assessment are as follows: structure of the project navigator, risk parameters, BIM H&S objects, and work plan. From this, the approach for introducing the risk assessment process and its management in the BIM platform into the model is developed. BIM can be applied using different modelling, management, and planning software. The software gives some codification risk which is related to BIM. BIM reinforces the benefits of other digital techniques as it adds large amount of parametric information and allows collaborative work between the technicians involved in the project [3].

Sr. No.	Name
1.	People falling to another level
2.	Object falling owing to collapse
3.	Falls by detached objects
4.	Shocks against stationary objects
5.	Shocks against moving objects
6.	Exposure to extreme environmental temperatures
7.	Thermal contact
8.	Exposure to electrical contacts
9.	Explosions
10.	Fires
11.	Misuses or impacts with vehicles
12.	Physical load
13.	Psychosocial factors
14.	People falling to another level
15.	Contact with caustic and/or corrosive substances

13.SUMMARY

From the review of the existing literature, it is clear that workers health and safety is most important consideration in construction. And also, development and improvement of safety management system is important for maintain safety in construction site. It is also used for finding different hazard and risk occurs during execution of work. Occupational health and safety are also important aspect to manage and understanding the health and safety of workers in work place. There are different methods are applied by literatures to evaluate, examine, and reduce the risk and improve the safety of workers and discussed the key element or factors for safety management. The literature applied different methodology for improvement of SMS like; Questionnaire survey, Delphi techniques, Hazard assessment matrix, SPSS, AHP, models etc.

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