

# Advancements and Challenges in Safety Management in Building Construction: A Comprehensive Review

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**Abstract** – The construction industry continues to grow as the demand for infrastructure, homes, and office spaces grows by the day. Since the construction industry is so dynamic, it is vulnerable to a range of health risks. As a result, protection is a top priority in the construction sector to ensure a healthy working environment. Safety experts have determined that risky behaviours cause the majority of workplace injuries, and that controlling these behaviours is one of the keys to effective accident prevention and a low accident rate on construction sites. Safety in construction industry is much more important. This project is about to increase safety in the building industry performance. The study's primarily is to define the critical success factors that affect the implementation of construction safety management. This analysis is to recognize and solve major problems in the building sector with various solutions related to work situations that affect project safety performance. Statistical analysis was performed by using IBM SPSS v26. tool package.

Key words: IBM SPSS, construction industry, critical success factors, and Statistical analysis.

## 1. INTRODUCTION

The building industry is essential for the social and economic growth of all nations. Multiple studies have verified the significance and function of the construction sector in a nation's economy. In profit-oriented businesses, it is typical for construction stakeholders, such as owners, contractors, sub-contractors, or suppliers, to solely prioritize completing projects to satisfy quality standards, with a greater emphasis on finishing them within the designated timeframe and budget. Safety is commonly regarded as a subordinate concern. The absence of drive in promoting a culture of safety has led to a subpar safety track record, especially within the construction sector.

The construction industry poses health and safety risks due to its fragmented structure, the uncertain and technically complex nature of construction work, the uncontrollable production environment, employment practices, and the financial and time pressures faced by project participants.

The construction industry comprises various entities that have both direct and indirect impacts on the construction process. The construction industry encompasses a wide range of organizations, such as property developers, architects, engineers, quantity surveyors, accountants,

lawyers, management contractors, engineering contractors, civil engineering contractors, labourers, sub-contractors, and specialty tradespeople. Similar intricacy can be observed at construction sites. Workplace construction procedures encompass activities such as working at elevated levels, physical labour, contact with dangerous substances, demolition, assembly of structures, lifting operations, scaffolding, and ground preparation. These processes also require managing diverse workforce and frequent relocation of worksites.

### 1.1 Problem Identification

The construction industry is widely regarded as one of the most perilous sectors compared to others. Undoubtedly, safety is a significant concern in the construction industry. The construction industry is a significant component of a country's economy, particularly in terms of its capacity for generating jobs. However, accidents, incidents, injuries, and fatalities persist without any reduction on construction sites worldwide, maintaining a consistently high frequency (Hinze 1997). The construction industry's inadequate safety record has consistently been emphasized. The safety management system in the construction industry has been neglected and not pursued systematically. The main cause of the high injury rates is essentially the absence or insufficiency of safety management systems. It is imperative to establish comprehensive safety management systems for building sites and enforce safety standards to prevent accidents.

### 1.2 Research Objective

- ✓ To analyze the major factors that affect safety with respect to construction industry in India.
- ✓ To create an innovative framework for the administration of safety systems in the construction industry.
- ✓ To create a novel framework for evaluating safety performance, including both positive and negative performance indicators.
- ✓ To create a novel electrical safety audit approach that is carefully conceived, strategically planned, and effectively executed.
- ✓ To investigate the causes of accidents in building sites.
- ✓ To investigate the strategies employed by Indian enterprises to ensure workplace safety.
- ✓ To investigate the optimal implementation of safety management methods in the construction industry.

## 2. REVIEW OF LITERATURE

Syed M et al. (2000) Several studies suggested that, many that work on construction sites every day have a unique view point, one in 300 chance of dying at work. A safety audit is a method of systematically measuring and evaluating an organization's health and safety programme against a set of unique and attainable standards. The site safety plan is discussed in this paper. In addition, a questionnaire on site safety management will be provided.

Rukmunnisa Sulthana & Naveen Kumar, (2020) To regulate and minimize construction workers' health and safety, the authors conducted a study to identify and evaluate security management in building projects. It was used to collect a wide range of perspectives from experienced individuals who had worked on a variety of building projects. In that poll, ten percent of respondents worked for customers, fifteen percent for consultants, twenty percent for higher education, fifty percent for contractors, and five percent for the educational and humanitarian (governmental) directorates. The following are the responsibilities that respondents played in their organizations: Site engineers made up 55%, project managers made up 20%, designers made up 10%, principal designers made up 5%, and others, like construction team leaders, made up 10%. 44% of respondents had 5–10 years of experience, 22% had 1–5 years, 20% had 10–15 years of experience, 10% had 15–20 years of experience, and 5% had more than 20 years of experience.

Golaviya et al., (2018) The authors investigated safety management in the construction industry by gathering data from general contractors who work on several projects. They gathered information on the organization's safety policy, training, meetings, equipment, inspections, safety incentives and penalties, and workers' attitudes toward safety legislation, as well as many other criteria that indicate inadequate safety management. Workers were found to be uneducated, inexperienced, and unaware of the safety precautions and equipment in use.

Thanaraj & Priya, (2019) The authors sought to identify and evaluate safety management in construction projects in order to reduce and control construction worker health and safety (H&S). They discussed the numerous safety and control procedures for accidents in construction projects, as well as how to use sensor-based technologies to reduce them. They used a survey-based methodology to acquire the data. They discovered that surveying with the use of questionnaire would be the most efficient method after doing a literature review. They analyzed the collected data statistically using IBM SPSS Statistics software. According to them, the leading causes of worker death are 56% falls from height, 21% trapped by something collapsing or

overturning, 10% struck by a moving vehicle, 5% contact with electrical discharge, 4% struck by flying/falling object during machine lifting of materials, 3% contact with moving machinery or material being machined, and 1% exposure to a hot or harmful substance. Sensor-based technology, such as Ultra-wideband (UWB), a wireless positioning approach, has also been discussed.

Prabakar Rajendran & Karthigaipriya, (2019) authors investigated the most prevalent construction-related fatalities. With the use of a questionnaire survey, they were able to determine the level of adaptation of safety measures in the local construction industry. According to the poll, most construction sites have failed to adapt to safety measures, and fatalities are caused by four different sorts of deadly accidents: falls, being struck by an object, electrocutions, and being caught between two objects. They discovered that falling is one of the most dangerous hazards on the job site, with falling from a height accounting for one-third of all construction-related fatalities. Unsafe acts, unsafe working circumstances, and communication impediments are the most common causes of this sort of mishap.

Priyanka M K & Bhavya K, 2020 Carried out research to identify the safety factors affecting the local construction projects and to analyze them. They have found that to maintain its effectiveness, the safety management system in the construction project must be improved and monitored on a regular basis. The eight aspects of safety management include safety policy and standards; safety organization; safety training; inspecting hazardous conditions; personal protective programs; plant and equipment; safety promotion; and management behavior. To Small construction companies should be given special treatment by the government in order to establish a systematic construction safety management system, and workers should be provided free Green Book training.

Rakul P & Ramadhasan, (2020) the authors of this study focused on examining critical components influencing construction project safety and quality management. For data collection, they used a qualitative and quantitative technique. The results of this study show that management commitment, safety knowledge of top management practices/procedures/reviews, and errors in judgement or carelessness are all important safety issues. The most important quality elements influencing safety and quality management were project supervision, staff involvement/attitude, and expertise knowledge/training. They found that PPE plays a vital part in construction industry safety with the help of the study.

Saeed, (2017). The author conducted research to identify and evaluate safety management practices in construction projects in order to reduce and control construction worker health and safety (H&S). He had created a questionnaire and used it to gather a variety of opinions from experienced professionals working on various building sites in order to

compare them.

Bhatuk & Patel, (2021) Authors have examined the evaluation of various parameters such as accident analysis, accident causes, and types of accidents in a construction working environment. Based on the study of various accidents and various literature, they have found 19 unsafe act, conditions and 22 reasons for the accidents and injuries which affects the projects in India. With the help of the questionnaire through relative important index technique, they have identified the critical factors to deal with their possible solutions by mitigation technique.

Lakshmanan et al. (2020) studied the critical success variables that determine the adoption of safety management in building projects. SPSS programs were used to analyze the questionnaire survey findings. According to the study's results, there are various safety hazards in the construction industry, including a lack of awareness of the need of having an earth connection for power tools and a lack of understanding of how to safeguard cables from mechanical damage.

**Current Safety Management Practices:** The implementation of safety management systems (SMS) is a fundamental approach to managing safety in construction projects. These systems typically include risk assessment, hazard identification, safety training, and the establishment of safety protocols and procedures. However, despite the widespread adoption of SMS, construction sites continue to experience accidents and fatalities, indicating gaps in existing safety practices.

**Regulatory Framework:** Government regulations and industry standards play a crucial role in shaping safety management practices in building construction. Regulatory bodies such as the Occupational Safety and Health Administration (OSHA) in the United States and the Health and Safety Executive (HSE) in the United Kingdom set forth guidelines and requirements for ensuring workplace safety. Compliance with these regulations is essential, but challenges such as enforcement, lack of resources, and varying standards across jurisdictions can impact their effectiveness.

**Technological Innovations:** Advancements in technology have the potential to revolutionize safety management in construction. Building Information Modeling (BIM), wearable sensors, drones, and virtual reality (VR) are among the tools being utilized to improve safety practices. BIM facilitates the identification of safety risks during the design phase, while wearable sensors can monitor workers' health and detect hazards in real-time. Integrating these technologies into safety management systems can enhance risk mitigation efforts and promote proactive safety measures.

#### **Challenges and Solutions**

**Safety Culture:** Cultivating a strong safety culture is essential for fostering a safe working environment in construction. However, achieving buy-in from all stakeholders, including management, contractors, and

workers, can be challenging. Promoting safety awareness through training programs, leadership commitment, and incentivizing safe behavior can help in still a positive safety culture across construction projects.

**Risk Management:** Construction sites are inherently dynamic environments with numerous inherent risks. Effective risk management involves identifying potential hazards, assessing their likelihood and consequences, and implementing controls to mitigate risks. Adopting a proactive approach to risk management, such as conducting regular site inspections, encouraging worker participation in safety initiatives, and leveraging technology for risk assessment, can help prevent accidents and improve overall safety performance.

**Resource Allocation:** Adequate resource allocation is critical for implementing robust safety management practices. This includes allocating sufficient budget, manpower, and time for safety training, equipment procurement, and monitoring activities. Investing in safety pays dividends in the form of reduced accidents, lower insurance premiums, and improved project outcomes. Collaboration between stakeholders to prioritize safety and allocate resources accordingly is essential for achieving positive safety outcomes.

Safety management in building construction is a multifaceted endeavor that requires collaboration, innovation, and a commitment to continuous improvement. While significant strides have been made in enhancing safety practices through regulatory measures, technological advancements, and cultural initiatives, challenges persist in achieving optimal safety outcomes. Addressing these challenges requires a holistic approach that encompasses regulatory compliance, technological innovation, risk management, and a strong safety culture. By prioritizing safety, allocating resources effectively, and embracing innovation, stakeholders can create safer construction environments that protect workers and promote sustainable development.

The current study project focuses on safety inspections, which are regarded as one of a safety manager's primary responsibilities.

- To avoid accidents, construction site safety must be thoroughly examined. UAVs (Unmanned Aerial Vehicle) can detect important threats and immediately implement accident prevention actions.
- A substantial advantage of using drones on job sites comes both before and during construction.
- Planners and designers can help to prevent accidents and make building sites safer for workers.
- The essence of safety inspections is direct monitoring on a construction site, such as excavation trenches, specific locations, employees, floors, and so on.

**3. METHODOLOGY**

The study utilized a questionnaire survey to uncover the fundamental characteristics that influence safety in building projects. Surveys conducted using questionnaires were deemed to be effective due to the relative ease of acquiring standard data suitable for accomplishing the goals of this investigation. From the literature cited, a range of factors were chosen. The study was done by creating a questionnaire and gathering the replies from construction companies. The survey questionnaires were designed to discover the critical factors. The set of questions were prepared based on the past studies and inspection from construction sites. Below is a Questionnaire with five-point Likert scale questions regarding safety management in construction work. Participants can choose a response ranging from "Strongly Disagree" to "Strongly Agree" on a scale of 1 to 5, where:

1 - Strongly Disagree 2 - Disagree 3 - Neutral 4 - Agree 5 - Strongly Agree

**Factor: 1 Communication of Safety Policies:**

1. The safety policies and procedures in our construction site are effectively communicated.
2. There is clear communication about the consequences of not following safety protocols.
3. Workers are aware of emergency procedures in case of accidents.

**Factor: 2 Training and Awareness:**

1. Construction workers receive sufficient training on safety measures.
2. Regular safety awareness programs are conducted on the construction site.
3. Workers feel adequately prepared to handle potential safety hazards.

**Factor: 3 Safety Equipment and Tools:**

1. The construction site provides appropriate safety equipment for all tasks.
2. Workers are trained in the correct usage of safety tools and equipment.
3. Safety equipment is regularly inspected and maintained.

**Factor: 4 Supervision and Accountability:**

1. Supervisors actively monitor and enforce safety measures on the construction site.
2. Workers are held accountable for violating safety protocols.
3. There is a culture of reporting unsafe conditions without fear of reprisal.

**Factor: 5 Incident Reporting and Investigation:**

1. Procedures for reporting safety incidents are well-defined and accessible.
2. Incidents are thoroughly investigated to identify root causes.
3. Lessons learned from safety incidents are communicated to prevent future occurrences.

**Factor: 6 Emergency Preparedness:**

1. There are clearly marked emergency exits and evacuation routes on the construction site.
2. Emergency response drills are conducted regularly.

Workers are familiar with the location of first aid kits and emergency response equipment.

**Factor: 7 Safety Leadership:**

1. The leadership on the construction site prioritizes safety over speed.
2. Safety is considered an integral part of project planning and decision-making.
3. Workers feel comfortable raising safety concerns with management.

The sample size chosen for this investigation was 45. The following factors have been found to be most influential after doing a statistical analysis of this study. Table 1 provides a comprehensive list of factors together with their corresponding Relative Important Index (RII). The Relative Importance Index (RII) is a statistical technique employed to ascertain the relative significance of different components in a study, using survey data or other quantitative metrics. It aids researchers in comprehending the components that exert the most impact on the desired outcome.

**Table 1 Factor analysis**

FACTOR	RII	RANK
The safety policies and procedures	0.91	1
Lessons learned	0.90	2
Clear communication	0.89	3
Regular safety awareness programs	0.85	4
Aware of emergency procedures	0.84	5
Safety hazards.	0.84	6
Safety equipment	0.83	7
Emergency Preparedness	0.81	8
Safety protocols	0.80	9
Identify the root causes of accidents	0.76	10

#### 4. RESULTS AND DISCUSSION

In the analysis of safety management factors in construction, several key elements emerged as highly influential in ensuring a safe working environment. These factors include safety policies and procedures, lessons learned, clear communication, regular safety awareness programs, awareness of emergency procedures, safety hazards, safety equipment, emergency preparedness, safety protocols, and identifying the root causes of accidents. Each of these factors contributes significantly to the overall safety performance on construction sites.

**Safety Policies and Procedures:** Establishing comprehensive safety policies and procedures is foundational to effective safety management in construction. Clear guidelines help ensure that all workers understand their responsibilities regarding safety practices, which reduces the likelihood of accidents and injuries. Adhering to established protocols fosters a culture of safety and accountability throughout the organization.

**Lessons Learned:** Learning from past incidents and near misses is essential for improving safety performance. By analyzing the root causes of accidents and implementing corrective actions, construction companies can prevent similar incidents from occurring in the future. Incorporating lessons learned into safety training programs and regularly reviewing safety protocols ensures continuous improvement in safety management practices.

**Clear Communication:** Effective communication is crucial for conveying safety-related information and promoting awareness among all stakeholders involved in construction projects. Clear communication channels enable workers to report hazards, raise concerns, and seek assistance when needed. Regular safety meetings, toolbox talks, and signage also facilitate communication of safety protocols and emergency procedures.

**Regular Safety Awareness Programs:** Continuous reinforcement of safety awareness through regular training programs and workshops is vital for maintaining a vigilant safety culture. By keeping workers informed about potential hazards, safe work practices, and updates to safety policies, construction companies empower their employees to prioritize safety in their daily activities.

**Awareness of Emergency Procedures:** Preparedness for emergencies such as fires, medical incidents, or natural disasters is critical for minimizing harm and facilitating timely responses. Ensuring that all workers are familiar with emergency procedures, evacuation routes, and the location of emergency equipment enhances overall safety readiness on construction sites.

**Safety Hazards:** Identifying and mitigating safety hazards is a proactive approach to risk management in construction. Conducting thorough risk assessments,

hazard identification surveys, and job safety analyses enable companies to anticipate potential dangers and implement controls to prevent accidents.

**Safety Equipment:** Providing appropriate safety equipment and personal protective gear is essential for safeguarding workers from hazards present in construction environments. Ensuring that equipment is properly maintained, fitted, and utilized according to manufacturer guidelines enhances its effectiveness in protecting workers from injury.

**Emergency Preparedness:** Establishing emergency response plans and conducting drills to practice response procedures are essential components of emergency preparedness. By simulating various scenarios, construction companies can evaluate the effectiveness of their plans and identify areas for improvement, thereby enhancing their ability to respond effectively to emergencies.

**Safety Protocols:** Implementing standardized safety protocols for tasks such as working at heights, handling hazardous materials, or operating heavy machinery helps mitigate risks and ensure consistency in safety practices across construction projects.

**Identifying Root Causes of Accidents:** Conducting thorough investigations into the root causes of accidents allows construction companies to address underlying issues and implement preventive measures. By identifying systemic weaknesses in safety management systems, companies can implement corrective actions to reduce the likelihood of future accidents.

#### 5. CONCLUSION

In conclusion, the analysis of safety management factors in construction underscores the importance of a multifaceted approach to ensuring a safe working environment. Safety policies and procedures, lessons learned, clear communication, regular safety awareness programs, awareness of emergency procedures, safety hazards, safety equipment, emergency preparedness, safety protocols, and identifying the root causes of accidents are all critical elements that contribute to effective safety management. By prioritizing these factors and integrating them into their operations, construction companies can minimize risks, protect workers, and promote a culture of safety that extends throughout the organization. Ongoing commitment to continuous improvement and adherence to best practices in safety management are essential for achieving and maintaining optimal safety outcomes in construction projects.

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