IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 9, June 2026
Impact Factor: 8.2

Assessment of Safety Management Practices and Hazard Control Measures in Construction Projects Using Questionnaire Survey and Statistical Analysis

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Abstract: *The construction industry is one of the fastest-growing sectors in the world and plays a significant role in the economic development of developing countries such as India. Rapid urbanization, industrialization, and infrastructure expansion have resulted in a substantial increase in construction activities, including residential, commercial, and industrial projects. However, the construction sector is also recognized as one of the most hazardous industries due to the involvement of complex operations, heavy machinery, work at heights, electrical installations, excavation activities, and the use of various construction materials and equipment. Construction workers are frequently exposed to numerous occupational hazards that may result in injuries, fatalities, property damage, and significant economic losses. Therefore, effective safety management practices and hazard control measures have become essential components of sustainable construction project management. The present study entitled "Assessment of Safety Management Practices and Hazard Control Measures in Construction Projects Using Questionnaire Survey and Statistical Analysis" aims to identify and evaluate the major safety hazards prevailing in construction projects and to assess the effectiveness of existing safety management practices adopted by construction organizations. The study focuses on understanding the causes of accidents, unsafe acts, and unsafe conditions that contribute to occupational injuries and incidents in construction activities. Furthermore, it investigates the adequacy of hazard control measures and proposes suitable strategies for improving construction safety performance. The research methodology adopted in this study is based on a comprehensive questionnaire survey and statistical analysis. A structured questionnaire was developed after an extensive review of literature and consultation with industry professionals. The questionnaire consisted of various parameters related to safety management systems, hazard identification, risk assessment, accident causes, personal protective equipment usage, training and awareness programs, emergency preparedness, and implementation of safety regulations. The questionnaire was distributed to twenty-five active construction companies operating in different regions. Out of these, twelve companies responded with completed questionnaires, and the collected data formed the basis of the present study. To analyze the responses obtained from the survey, the Relative Importance Index (RII) technique was employed to determine the significance and ranking of various factors influencing construction safety. The RII method facilitated the identification of critical hazards and the prioritization of factors requiring immediate attention by management. Statistical analysis was further used to evaluate the relationships among safety practices, hazard occurrences, and accident causation factors. The study reveals that inadequate safety training, lack of management commitment, improper use of personal protective equipment, poor housekeeping practices, insufficient supervision, and non-compliance with safety regulations are among the most significant factors contributing to accidents in construction projects. The findings also indicate that falls from height, electrical hazards,*

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struck-by incidents, material handling accidents, and machinery-related injuries are the most common types of hazards encountered at construction sites. The analysis of accident causation demonstrates that a majority of accidents are preventable and are primarily associated with unsafe acts and unsafe working conditions rather than unavoidable circumstances. Based on the findings of the study, several hazard control and mitigation measures have been proposed. These include the development of an effective safety management system, regular safety training and awareness programs, strict implementation of safety standards and regulations, periodic safety inspections and audits, improved supervision, proper use of personal protective equipment, and the adoption of proactive risk assessment techniques. The study also emphasizes the importance of management commitment and worker participation in establishing a strong safety culture within construction organizations. The outcomes of this research are expected to provide valuable insights for construction companies, project managers, safety professionals, and policymakers in understanding the prevailing safety challenges in the construction industry and in developing appropriate strategies to minimize occupational hazards and accidents. The proposed recommendations can significantly contribute to improving workplace safety performance, reducing accident rates, enhancing productivity, and promoting sustainable construction practices in India and other developing countries

Keywords: Construction Safety, Safety Management Practices, Hazard Control Measures, Construction Hazards, Relative Importance Index (RII), Questionnaire Survey, Statistical Analysis, Occupational Safety, Accident Analysis, Risk Assessment etc

I. INTRODUCTION

The construction industry is one of the most important sectors contributing to the economic development of India and is considered the second-largest economic activity after agriculture. It provides employment opportunities to a vast workforce ranging from highly skilled engineers and technicians to unskilled laborers. Globally, construction workers constitute approximately 7–8% of the total labor force, and in some developing countries this figure may reach up to 20%. Despite its significant contribution to the economy, the construction industry is widely recognized as one of the most hazardous industries due to the complex nature of its activities.

Construction projects involve multiple operations being performed simultaneously in congested work environments where workers, heavy machinery, equipment, and materials operate at different levels and under strict time constraints. Such conditions significantly increase the probability of accidents and occupational hazards. According to the International Labour Organization (ILO), the construction sector has one of the highest accident rates worldwide. In India, the possibility of fatal accidents in construction activities is considerably higher than in manufacturing industries, with a substantial number of workers suffering injuries every year. These accidents not only result in loss of human life and property but also lead to project delays, increased costs, reduced productivity, and damage to the reputation of construction organizations.

Figure: 1 Construction site

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Safety in construction can be defined as the physical and mental preparedness of an individual to perform work without causing harm to oneself or others. Effective safety management is essential for reducing accidents, minimizing risks, and ensuring the well-being of workers. Safety is not merely a set of rules and regulations but a continuous process involving education, training, and the development of safe work practices. The implementation of safety programs through awareness campaigns, group meetings, posters, signs, and regular training sessions plays a vital role in creating a safe working environment.

Modern construction organizations adopt systematic approaches such as the Plan–Do–Check–Act (PDCA) cycle to manage occupational health and safety. The PDCA framework facilitates continuous improvement in safety performance by identifying hazards, implementing preventive measures, monitoring safety practices, and taking corrective actions. Effective hazard identification and risk assessment are therefore essential components of construction safety management.

Despite the availability of safety regulations and standards, many construction projects in India continue to suffer from inadequate safety measures and poor implementation of safety practices. Therefore, there is a pressing need to identify the major causes of accidents, evaluate existing safety management practices, and develop appropriate hazard control measures. The present study aims to assess safety management practices and hazard control measures in construction projects through questionnaire surveys and statistical analysis. The study further employs the Relative Importance Index (RII) method to identify critical safety factors and propose suitable mitigation strategies for improving construction site safety and minimizing occupational accidents.

II. LITERATURE REVIEW AND RESEARCH GAP

2.1 Literature Review

a. Construction safety management has been a major area of research due to the increasing number of accidents and occupational hazards in construction projects worldwide. Several researchers have investigated the causes of accidents, safety culture, hazard identification, and the effectiveness of safety management systems in construction industries.

b. Carcano and Franco Poot (2014) studied construction workers' perceptions of safety practices in Mexico and concluded that insufficient safety education and a poor safety culture significantly contribute to workplace accidents. Similarly, Memon et al. (2015) identified management commitment as the most critical factor affecting the successful implementation of construction safety programs in Pakistan.

c. Choudhry and Fang (2008) investigated unsafe work behavior among construction workers and found that lack of safety awareness, work pressure, and organizational factors encourage workers to engage in unsafe practices. Mohamed (2002) emphasized that safety management activities and organizational commitment have a direct impact on overall safety performance in construction projects.

d. Fang et al. (2004) developed benchmarking studies on construction safety management in China and reported that organizational, managerial, and financial factors significantly influence safety performance. Likewise, Chinda and Mohamed (2008) proposed a structural equation model for construction safety culture and highlighted the importance of leadership, communication, employee involvement, and resource management in achieving a positive safety culture.

e. Sunindijo et al. (2005) developed a causal model of construction accident causation and revealed that inadequate planning, poor site management, and unsafe worker behavior are the major causes of construction accidents. Hasle and Limborg (2006) demonstrated that effective occupational health and safety activities require strong management support, proper training, and worker participation.

f. Several researchers have also focused on hazard identification and risk management. Kartam (1997) emphasized that hazard identification is the foundation of construction safety management and that unidentified hazards pose the greatest risk to workers. Lu and Mills (2010) highlighted the potential of Building Information Modeling (BIM) in improving hazard identification and integrating safety considerations during the project planning stage.

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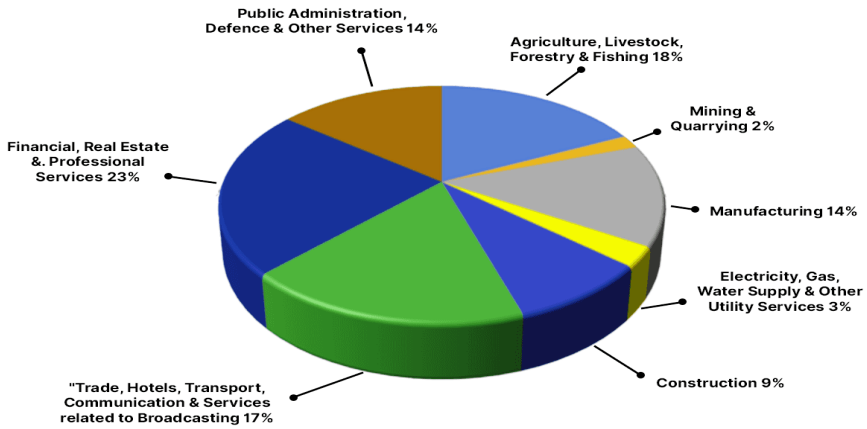

Figure:2.1 Construction Sector Growth In India 2026

Overall, the literature indicates that construction accidents are caused by a combination of unsafe acts, unsafe conditions, inadequate safety management practices, and poor hazard control measures. Questionnaire-based studies and statistical methods have been widely used to evaluate safety performance and identify critical safety factors in construction projects.

2.2 Research Gap

a. Although numerous studies have examined construction safety management practices and accident causation, several research gaps still exist, particularly in the Indian construction sector. Most previous studies have focused on developed countries such as Australia, the United Kingdom, China, and the United States, while limited research has been conducted on Indian construction projects using primary field data.

b. Furthermore, previous research has generally concentrated on individual aspects such as safety culture, worker behavior, or accident analysis, with comparatively less emphasis on the integrated assessment of safety management practices and hazard control measures. Limited studies have utilized questionnaire surveys combined with statistical techniques such as the Relative Importance Index (RII) to identify and rank critical safety factors in Indian construction projects.

c. In addition, there is a lack of comprehensive studies that evaluate both unsafe acts and unsafe conditions simultaneously and propose practical mitigation measures based on industry responses. Therefore, the present study attempts to bridge these gaps by conducting a questionnaire-based assessment of safety management practices and hazard control measures in construction projects and by identifying critical factors affecting construction safety using statistical analysis techniques.

III. PROBLEM IDENTIFIAVTION

3.1 Problem Identification

The construction industry is one of the fastest-growing sectors in India and contributes significantly to the country's economic development. However, it is also one of the most hazardous industries due to the complex nature of construction activities, involvement of heavy machinery, work at heights, electrical operations, and the employment of a large number of unskilled and semi-skilled workers. Construction projects frequently experience accidents resulting in injuries, fatalities, property damage, and financial losses.

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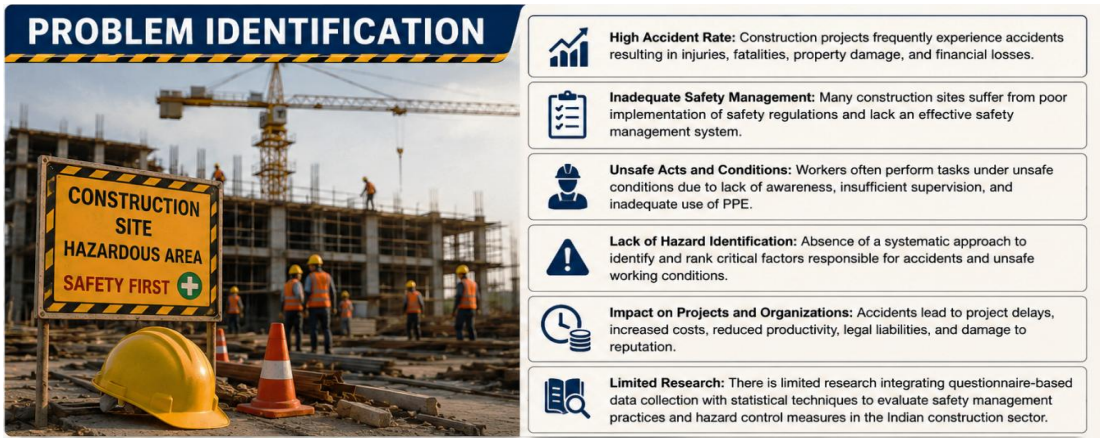

Figure:3.1 Problem identification

Despite the existence of various safety regulations, standards, and guidelines, many construction sites still suffer from poor implementation of safety management practices. Several construction organizations do not have an effective safety management system, adequate hazard identification procedures, or proper safety training programs. Workers often perform tasks under unsafe conditions and engage in unsafe acts due to lack of awareness, insufficient supervision, and inadequate use of personal protective equipment (PPE).

Another major problem is the absence of a systematic approach to identify and rank the critical factors responsible for accidents and unsafe working conditions. Most construction companies focus primarily on project cost and schedule, while safety management receives comparatively less attention. Consequently, accidents lead to project delays, increased costs, reduced productivity, legal liabilities, and damage to the organization's reputation.

Furthermore, there is limited research in the Indian construction sector that integrates questionnaire-based data collection with statistical techniques for evaluating safety management practices and hazard control measures. There is also a lack of comprehensive studies that simultaneously assess unsafe acts, unsafe conditions, and the effectiveness of existing hazard control measures.

Therefore, there is a need to systematically investigate the current safety management practices in construction projects, identify the critical factors contributing to construction hazards and accidents, and develop suitable mitigation measures. The present study addresses these issues through a questionnaire survey and statistical analysis to evaluate safety performance and recommend effective hazard control strategies for improving construction site safety.

IV. METHODOLOGY-DATA COLLECTION AND QUESTIONNAIRE SURVEY

4.1 Data collection

Safety in construction is to be ensured by careful planning of the location, design and layout of the project. Numerous accidents are reported as no suitable measures are taken initially at planning stage. Construction of industrial structure requires adherence to statutes and codes prescribed for safe job practices. For this, the Company and the contractors must be in harmony to establish interrelationship between statutory requirement and practical approach. The company must insist upon compliance with the provisions of safety and health regulations that pertain to the related construction work. Along with codes and standards, thorough supervision by a competent person is a must to work without incidents. Hence, with conception of any project, it is of a paramount importance that due care is taken in construction safety. Based on the study of various accidents and various literature 19 unsafe act and unsafe conditions are identified which effect the projects in India. The various factors and their explanation are presented below.

S.no.	Unsafe act unsafe condition	Explanation
1	Working at elevated place.	The main hazards associated with working at height are people falling and objects falling onto people below. These may occur as a result of inadequate edge

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		protection, or from objects in storage being poorly secured.
2	Improper earthing.	In an electrical installation or an electricity supply System an earthing System or grounding System connects specific parts of that installation with the Earth's conductive surface for safety and functional purposes.
3	Working on lines without taking proper safety precautions.	Work on new and existing energized (hot) electrical circuits is prohibited until all power is shut off and grounds are attached.
4	Unguarded floor openings, and excavations.	An excavation means any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal. Excavation and unguarded openings are one of the most dangerous hazards during construction. Often excavations and trenching may temporarily remain unguarded or un-barricaded, causing additional hazards.
5	Exposed live wires.	An electrical shock is received when electrical current passes through the body. You will get an electrical shock if a part of your body completes an electrical circuit by touching a live wire and an electrical ground, or Touching a live wire and another wire at a different voltage.
6	Improper illumination	Employers, the self-employed and people in control of nondomestic premises have a duty to ensure that lighting is safe and does not pose a health risk to employees and others who may use their premises.
7	Constrained location.	There are constraints in every working environment. However, there can be situations that we are unaware of the existence of the constraints, or, we tend to put more emphasis on the project goals.
8	Unsafe design and construction such as poor scaffolding, structure, platforms.	Falls of persons from height represent the most serious safety risk in the construction industry. Many of these falls are from unsafe working places, or from unsafe means of access to working place.
9	Working on transmission lines.	Some activities may cause interference with power lines
		Overhead power lines Operation of a crane, forklift, and other construction equipment Changing street lights Tree trimming Underground power lines Excavation
10	Emergency work, leading to hurried working.	Working hours are prescribed in the working hours' legislation. Local adjustments may also be made.
11	Opening and closing of switches without authority or warning	An electric shock hazard arises when a person touches an unprotected live electric wire or other live device. With high voltages it is not even necessary to touch; merely entering the danger area is enough to receive an electric shock.
12	Working unsafety such as throwing materials or tools at another worker.	Tools shall not be thrown from one worker to another, or to another working location.
13	Using unsafe equipment, wrong tools for the job or using hands instead of right	Hand tools are tools that are powered manually. Hand tools include anything from axes to wrenches. The greatest hazards posed by hand tools result from misuse and improper maintenance.

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	tools.	
14	Operating hoists and tracks without proper communication	The operator must not leave the controls while the load is suspended, except where to be held suspended for a period of time exceeding normal lifting operations. implements measure necessary to restrain the boom hoist and telescoping
15	Over confidence like working or live electrical	Electrical accidents are caused by a combination of three factors:
	equipment that could be conveniently re-energized	Unsafe equipment and/or installation, Workplaces madeunsafe by the environment, and Unsafe work practices.
16	Taking unsafe position or posture too close to openings and lifting in an unstable position	Taking unsafe position or posture too close to openings and lifting in an unstable position also converted in hazard
17	Distracting, teasing, joking, quarrelling, annoying	Practical joking and horseplay while on the job is strictly prohibited as it may lead to distraction of mind and may lead to accident or may compromise the safety of employees or the public.
18	Failure to use recommended safety protection equipment	All personal protective equipment should be safely designed and constructed, and should be maintained in a clean and reliable fashion. It should fit comfortably, encouraging worker use
19	Avoiding the use of guard rails and safety nets while working on higher stories.	Generally, fall protection can be provided through the use of guardrail systems, safety net systems, or personal fall arrest systems. OSHA refers to these systems as conventional fall protection.

Table 4.1. Unsafe act and unsafe condition

4.2 Questionnaire Description

A structured questionnaire has been developed to study the unsafe acts and unsafe conditions in construction projects. The objective of this questionnaire is to collect primary data from professionals working in the construction industry regarding safety practices, site conditions, and human behavior contributing to accidents.

The questionnaire is divided into three main sections. The first section focuses on the company profile, which includes basic information such as company name, contact details, nature of the organization (client, contractor, designer, consultant, etc.), and the age of the company. This information helps in understanding the organizational background and type of involvement in construction activities.

The second section deals with the respondent profile, which captures personal and professional details of the participant, such as name, designation in the organization (engineer, project manager, site coordinator, etc.), and total experience in the construction industry. This section ensures that responses are analyzed based on experience level and job responsibility.

The third section is the most important part of the questionnaire and focuses on safety-related aspects, particularly unsafe acts and unsafe conditions at construction sites. It includes questions related to safety training, use of personal protective equipment (PPE), presence of hazardous site conditions, safety inspections, safety signage, and reporting systems. It also identifies major causes of unsafe acts such as lack of training, time pressure, negligence, and poor supervision, as well as common unsafe conditions like poor housekeeping, improper scaffolding, electrical hazards, and unprotected edges.

The responses are collected using multiple-choice options to ensure easy understanding and uniformity in data collection. The collected data will further be used for statistical analysis to evaluate the level of safety management practices and to identify key areas of improvement in construction site safety.

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(Where VL = Very low, L=loo, M=medium, H=high, VH=very high)											
S.N O	Unsafe act and unsafe condition	Occurrence					Severity				
		VL	L	M	H	VH	VL	L	M	H	VH
1	Working at elevated place	1	2	3	4	5	1	2	3	4	5
2	Improper earthing	1	2	3	4	5	1	2	3	4	5
3	Working on lines without taking proper safety precautions	1	2	3	4	5	1	2	3	4	5
4	Unguarded floor openings, and excavations	1	2	3	4	5	1	2	3	4	5
5	Exposed live wires.	1	2	3	4	5	1	2	3	4	5
6	Improper illumination	1	2	3	4	5	1	2	3	4	5
7	Constrained location	1	2	3	4	5	1	2	3	4	5
8	Unsafe design and construction such as poor scaffolding, structure, platforms.	1	2	3	4	5	1	2	3	4	5
9	Working on transmission lines.	1	2	3	4	5	1	2	3	4	5
10	Emergency work, leading to hurried working	1	2	3	4	5	1	2	3	4	5
11	Opening and closing of switches without authority or warning	1	2	3	4	5	1	2	3	4	5
12	Working unsafety such as throwing materials or tools at another worker.	1	2	3	4	5	1	2	3	4	5
13	using unsafe equipment, wrong tools for the job or using hands instead of right tools	1	2	3	4	5	1	2	3	4	5
14	Operating hoists and tracks without proper communication	1	2	3	4	5	1	2	3	4	5
15	Over confidence like working or live electrical equipment that could be conveniently re-energized	1	2	3	4	5	1	2	3	4	5
16	Taking unsafe position or posture too close to openings and lifting in an unstable position	1	2	3	4	5	1	2	3	4	5
17	Distracting, teasing, joking, quarrelling, annoying	1	2	3	4	5	1	2	3	4	5
18	Failure to use recommended safety protection equipment	1	2	3	4	5	1	2	3	4	5
19	Avoiding the use of guard rails and safety nets while working on higher stories	1	2	3	4	5	1	2	3	4	5

Table 4.2 Questionnaire

DOI: 10.48175/IJARSCT-37146

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V. RESULT ANALYSIS

5.1 Relative Importance Index (RII) Technique

The Relative Importance Index (RII) technique is widely used to determine the relative importance of different factors affecting a particular phenomenon. In the present study, this technique has been adopted to evaluate the importance of various unsafe acts and unsafe conditions in construction projects based on responses collected from different stakeholders such as contractors, project engineers, safety personnel, and site supervisors.

The RII method helps in converting qualitative responses into quantitative values, enabling ranking of factors based on their severity or frequency of occurrence. In this study, a five-point Likert scale was used ranging from 1 (very low effect) to 5 (very high effect).

The Relative Importance Index is calculated using the following formula:

$RII = \Sigma W / A \times N$

Where:

W = Weight assigned to each factor by respondents (1 to 5)

A = Highest weight (5 in this case)

N = Total number of respondents

The value of RII lies between 0 and 1. A higher RII value indicates greater importance of the factor in causing unsafe conditions or accidents in construction sites.

5.2 Ranking of Unsafe Acts and Unsafe Conditions

Based on the calculated Relative Importance Index (RII), all identified unsafe acts and unsafe conditions were ranked to determine their relative severity in construction projects. The results are presented in Table 5.1.

S.NO	Unsafe act and unsafe condition	OI	SI	RII	RANK
1	Working at elevated place.	0.73	0.78	0.57	1
2	Improper earthing.	0.55	0.65	0.35	16
3	Working on lines without taking proper safety precautions.	0.58	0.75	0.43	8
4	Unguarded floor openings, and excavations.	0.55	0.83	0.45	5
5	Exposed live wires.	0.46	0.78	0.36	14
6	Improper illumination	0.53	0.75	0.4	11
7	Constrained location.	0.65	0.71	0.46	4
8	Unsafe design and construction such as poor	0.53	0.83	0.44	7
	scaffolding, structure, platforms				
9	Working on transmission lines.	0.48	0.76	0.37	13
10	Emergency work, leading to hurried working.	0.63	0.71	0.45	6
11	Opening and closing of switches without authority or warning	0.51	0.68	0.35	17
12	Working unsafety such as throwing materials or tools at another worker.	0.46	0.63	0.29	19
13	Using unsafe equipment, wrong tools for the job or using hands instead of right tools.	0.53	0.78	0.41	10

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14	Operating hoists and tracks without proper Communication.	0.53	0.7	0.37	12
15	Over confidence like working or live electrical equipment that could be conveniently de-energized	0.63	0.68	0.43	9
16	Taking unsafe position or posture too close to openings and lifting in an unstable position	0.61	0.78	0.48	3
17	Distracting, teasing, joking, quarrelling, annoying	0.61	0.58	0.35	15
18	Failure to use recommended safety protection	0.5	0.7	0.35	18
19	Avoiding the use of guard rails and safety nets while working on higher stories.	0.63	0.76	0.48	2

Table 5.1 Ranking of Unsafe Acts and Unsafe Conditions

5.3 Critical Factors Identification

From the ranking analysis, the top five most critical unsafe acts and unsafe conditions were identified and grouped as critical factors. The critical factors identified are:

Working at elevated places

a) Avoiding guard rails and safety nets while working at height
b) Unsafe posture near openings and unstable lifting positions
c) Constrained (confined) locations
d) Unguarded floor openings and excavations

These factors represent the most hazardous conditions in construction sites and require immediate attention for risk reduction and accident prevention.

S.NO	Unsafe act and unsafe condition	OI	SI	RII	RANK
1	Working at elevated place.	0.73	0.78	0.57	1
2	Avoiding the use of guard rails and safety nets while working on higher stories.	0.63	0.77	0.49	2
3	Taking unsafe position or posture too close to openings and lifting in an unstable position	0.62	0.78	0.48	3
4	Constrained location.	0.65	0.72	0.47	4
5	Unguarded floor openings, and excavations.	0.55	0.83	0.46	5

Table 5.2 Critical factor

5.4 Mitigation Techniques for Critical Factors

To reduce accidents and improve safety performance in construction projects, various mitigation measures are proposed for the identified critical factors.

5.5.1 Working at Elevated Places

Working at height is identified as the most critical hazard. Proper safety measures must be implemented to prevent fall-related accidents.

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5.5.1.1 Good Design

Safe working at height begins with proper planning and design of both the structure and access systems. Equipment used for access should be stable, tested, and suitable for the task.

FIGER 1.1 working at elevated place

5.5.1.2 Supervision and Planning of Work

Work at height should always be properly planned and supervised. Important considerations include:

- Use of fall protection systems
- Weather conditions (rain, wind, icy surfaces)
- Emergency and rescue arrangements

5.5.1.3 Avoidance of Extreme Weather Conditions

Work should be avoided during extreme weather conditions such as heavy rain, strong winds, or icy surfaces as they increase the risk of slips and falls.

5.5.1.4 Main Precautions

- Avoid unnecessary work at height
- Use safe working platforms with guardrails
- Provide proper personal fall protection systems
- Ensure emergency rescue plans are available

5.5.2 Constrained (Confined) Locations

Confined spaces pose serious risks due to limited ventilation and restricted movement.

5.5.2.1 Management Survey

All confined spaces should be identified by safety management before starting work.

5.5.2.2 Inspection

Proper inspection must be conducted before entry to ensure necessity and safety of work.

5.5.2.3 Hazard Identification

All potential hazards such as toxic gases, oxygen deficiency, and physical risks should be identified.

5.5.2.4 Job Hazard Analysis

Each task inside confined space should be analyzed step-by-step for safe execution.

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Figer 5.2 Job hazard analysis

5.5.2.5 Preparation of Confined Spaces

Proper ventilation, purging, and safety equipment should be arranged before entry.

5.5.2.6 Communication System

Continuous communication must be maintained between workers inside and outside the confined space.

5.5.2.7 Rescue System

A trained rescue team should always be available at the site for emergency situations.

5.5.3 Emergency Work Leading to Hurried Working

Figure 5.3 Emergency work

Emergency situations often lead to rushed work, increasing the risk of accidents. This can occur due to:

- Lack of prior safety measures
- Improper handling of emergency equipment
- Pressure to complete work quickly
- Proper emergency planning and training can significantly reduce such risks.

5.5.4 Unguarded Floor Openings and Excavations

- Excavation work is highly risky and requires strict safety controls.
- Important safety measures include:
- Proper slope and benching of excavation sides
- Maintaining safe distance from edges
- Avoiding heavy equipment near excavation edges
- Keeping excavations free from water accumulation
- Proper barricading and covering of open pits

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- Limiting number of workers inside excavation areas

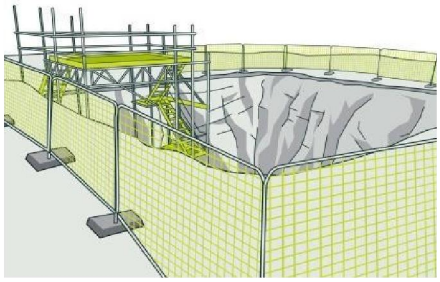

Figure 5.4 Covered excavation

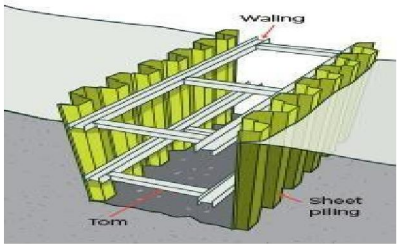

Figure 5.5 Excavation of house foundation

These measures help in preventing collapse and fall-related accidents.

5.55 Avoiding Guard Rails and Safety Nets at Height

Guard rails and safety nets are essential fall protection systems and should always be used when working at height. Safety measures include:

- Maintaining clean and dry working surfaces
- Removing loose materials and tools from work areas
- Ensuring proper lighting at workplaces
- Using slip-resistant flooring and footwear
- Regular maintenance of working platforms

Figure 5.6 Use of safety nets

Figure 4.7 Use of guard rails

These precautions significantly reduce slip, trip, and fall hazards at construction sites.

The analysis shows that working at elevated places has obtained the highest importance value and is ranked 1st, indicating it is the most critical unsafe condition in construction sites. Similarly, avoiding the use of guard rails and safety nets, and unsafe working postures near openings also appear as highly significant risk factors.

On the other hand, factors such as throwing tools at other workers and opening/closing switches without authorization received lower RII values and are ranked lower, indicating comparatively lesser but still significant safety concerns.

Overall, the ranking results clearly indicate that fall-related hazards and working at height are the most dominant safety risks in construction activities

VI. CONCLUSION AND FUTURE SCOPE AND RECOMMENDATION

6.1 Conclusion

1. Analysis of the collected data and a comparative study of the literatures available helped in obtaining 9 unsafe acts and 10 unsafe conditions.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 9, June 2026
Impact Factor: 8.2

2. The results from the thesis conclude the five critical factors in the field of building construction i.e. working at elevated place, avoiding the use of guard rails and safety nets while working on higher stories, confined space, unguarded floor openings and excavations and emergency work leading to hurried working, unsafe design in construction such as poor scaffolding, platform
3. Mitigation techniques were proposed for the above found 5 critical factors to minimize the hazards caused by them in the near future in the building construction field.

6.2 Future scope

Further factors can be identified through literature review and data collection through on-going projects. Case studies of on-going projects can be reviewed to identify different other factors. Other analysis methods can be employed like sensitivity analysis, scenario analysis and other related techniques. Also our focus of the thesis was on the hazards caused due to unsafe conditions on a building construction side. Using the thesis pattern point of observation and inspection can be changed like we in future dam construction sites bridges etc. can be used to calculate other mitigation technique

6.3 Recommendation

Based on the findings of this study, it is recommended that construction organizations should strengthen safety management practices through regular safety training, effective hazard identification and risk assessment, strict implementation of PPE and fall protection measures, continuous supervision, and adoption of systematic safety management systems to minimize accidents and improve overall construction site safety performance.

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Impact Factor: 8.2

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