

Gap Analysis of Hazard identification & Risk Assessment (HIRA) System for JH Construction and Engineer's Company

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Abstract- This study examines the effectiveness of Hazard Identification, Risk Assessment, and Control (HIRA) practices in a large-scale construction project, where complex activities, heavy machinery usage, and multiple stakeholders significantly increase occupational safety risks. The research focuses on identifying gaps between established safety standards and their actual implementation on site, with the aim of improving overall safety performance and compliance with occupational health and safety frameworks. A mixed-method approach was used, combining site observations, structured interviews, document reviews, and quantitative risk assessment techniques across key construction activities such as excavation, earthwork, material handling, asphalt laying, and traffic management. The collected data were evaluated against international safety standards to assess deficiencies in hazard identification, risk evaluation, and control implementation. The gap analysis revealed several critical weaknesses, including incomplete hazard identification in high-risk operations, inadequate documentation of risk assessments, limited worker involvement in safety processes, and inconsistent application of the hierarchy of controls. The study also identified shortcomings in training effectiveness, safety communication, audit frequency, and monitoring systems. These deficiencies collectively increase the likelihood of accidents, injuries, and operational disruptions. To address these issues, the study recommends implementing a standardized HIRA framework, strengthening training programs, integrating safety planning into project design and scheduling, and enhancing continuous monitoring and auditing mechanisms. The adoption of digital tools for real-time risk assessment and improved reporting systems is also suggested to support proactive hazard management. Overall, the study highlights that systematic gap analysis is a valuable method for evaluating and improving safety management systems in construction. By aligning current practices with established standards, organizations can significantly enhance workplace safety,

reduce risks, and promote a stronger safety culture within construction projects.

I. INTRODUCTION

JH construction and engineers is a fast-growing company executing projects in all over India in the field of Civil work and electrical work execution having registered office at a New Delhi. Company has completed many diversified projects. It is India's one of the infrastructure construction companies have been certified for an Integrated Management Systems. Company has an experience of 15 years in the construction industry works mainly in engineering and construction projects such as:

- Drainage or sewage-related project
- Construction of Divide Bund of Ash Dyke and Raising / Other development Work in refinery Project.
- Installation of sprinkler network, fire hydrants, firefighting pumps, and alarm system
- Civil Construction work
- Installation of Carbon steel (CS) and polyethylene (PE), LNG transmission pipelines.
- Earthwork
- Structure Steel Fabrication and Erection etc.

About Hazard identification and risk assessment (HIRA)

Construction projects are inherently high-risk due to dynamic work environments, heavy machinery, work at heights, and multiple subcontractors operating simultaneously. Hazard Identification and Risk Assessment (HIRA) is a systematic process used to

identify potential hazards, evaluate associated risks, and implement control measures.

HIRA Gap Analysis compares existing safety practices with required standards (legal, organizational, or international best practices) to identify deficiencies and areas for improvement.

A Wide range of tools is available for this purpose, from simple qualitative approaches to advanced quantitative techniques. Using multiple analysis methods is often recommended since each has its own strengths and limitations. Some of the most widely used risk assessment methods include:

Check list, JSA – Job Safety Analysis, Failure Modes and Effects Analysis (FMEA), Hazard and Operability Studies (HAZOP), Fault Tree Analysis (FTA), Event Tree Analysis (ETA), Bow tie analysis, Gap analysis – Fish bone diagram

II. LITRATURE REVIEW

In the construction industry, Hazard Identification and Risk Assessment (HIRA) is a systematic process used to recognize potential sources of harm and evaluate the likelihood and severity of associated risks. It forms a core component of occupational health and safety (OHS) management systems and is essential for preventing accidents, injuries, and occupational illnesses.

A Gap Analysis study in the context of HIRA is a structured method used to compare an organization's current hazard identification and risk assessment practices with established standards, regulatory requirements, and industry best practices. The purpose is to identify deficiencies (“gaps”) and develop corrective strategies to enhance safety performance.

The important element of any safety and health program is the identification, assessment, removal and or control of potential risks within the worksite. The objective of this work is to pick out the capacity hazards arising out of a typical construction site, examine the risks to decide their capacity to cause an accident, evaluate the risk

This analysis is typically conducted against recognized safety standards and company project HSE document such as:

- Company procedure, Manual, and safety programme .and its safety management system related hazard identification and risk and associated activities
- ISO 45001 – Occupational Health and Safety Management Systems
- Occupational Safety and Health Administration (OSHA) Regulations
- International Labour Organization (ILO) Safety Conventions
- OHSAS 18001 — an older international OH&S standard that included HIRA concepts before being replaced by ISO 45001
- National Building and Construction Safety Codes
- Project safety manual, Accident statics, Policy and Procedure, GAP analysis document etc.

These standards provide structured guidelines for hazard identification, risk assessment, and risk control implementation.

In construction environments—where activities are dynamic, high-risk, and constantly evolving—Gap analysis serves as a critical diagnostic tool to strengthen the effectiveness of the HIRA framework. I have studies along with the Project team construction site safety and found out the severity and number of incidents, near misses and Observation, which involving working at height, working on Scaffolding, Lifting operation, Electrical work, cluttered walkway due to poor housekeeping are higher when compared to other operations like Bore Hole Survey, Drilling, Blasting, etc. and established fatal categories and causes of accidents and control strategies are discussed and evaluated to increase hazard awareness.

Existing studies indicate that digital technologies can significantly enhance overall construction safety performance, with particularly notable benefits for vulnerable groups such as migrant workers. However, the effectiveness of these tools is often limited to specific operational domains rather than being embedded within a comprehensive safety

management framework. In a similar vein, Construction Safety Management Information Systems (CSMIS) have been shown to support regulatory compliance and facilitate systematic risk monitoring. Despite these advantages, their implementation remains relatively limited in CASP construction projects, thereby constraining their potential impact

Integrated Management Systems (IMS) contribute to improved sustainability outcomes and risk mitigation through mechanisms such as real-time monitoring, data integration, and timely intervention. Nevertheless, existing IMS frameworks are not specifically designed to address the distinct safety challenges associated with JHH commissioning activities, where operational complexity and hazard profiles differ substantially from conventional construction processes

Although traditional preventive measures—such as guardrails, safety nets, safety training, site supervision, and the use of Personal Protective Equipment (PPE)—remain fundamental components of accident prevention strategies, falls from height continue to constitute one of the leading causes of injuries in construction environments. Moreover, the current body of research inadequately addresses construction-specific hazards, including cryogenic exposure, confined space entry, and oxygen-deficient atmospheres. These risks introduce additional layers of technical and operational complexity that are insufficiently captured in generalized construction safety models. Organizational determinants—including resource allocation, project complexity, and the prevailing management structure—exert substantial influence on safety strategy formulation, risk assessment practices, and risk control effectiveness. These factors are central to achieving robust construction safety performance. Furthermore, disparities between developing and developed countries are evident in the context of Occupational Health and Safety (OHS) compliance. Limited financial resources, workforce shortages, and underdeveloped regulatory frameworks constrain effective implementation of safety systems in many developing regions.

Overall, the reviewed literature demonstrates that while numerous studies address general construction safety and risk management, there is a lack of comprehensive, structured frameworks specifically tailored to JHH construction projects. In particular, the commissioning phase represents a critical yet insufficiently examined stage in relation to integrated risk mitigation and safety governance.

Construction safety performance is fundamentally shaped by leadership commitment and management strategy, typically implemented through a top-down governance approach. Effective safety implementation therefore requires both executive-level commitment and operational-level competence in planning, target setting, and performance monitoring. However, this strategic and leadership-driven dimension of construction safety remains inadequately addressed in the existing body of knowledge.

The absence of specialized safety and risk management models tailored to construction environments highlights a clear research GAP. Consequently, there is a compelling need to develop an industry-specific, integrated framework capable of systematically managing safety risks from project inception through commissioning and completion. Such a framework would not only enhance construction safety performance but also improve overall project sustainability, reliability, and operation.

III. REASCHER ELOBORATION

3.1. Assessing Project Hazards

A list of high hazardous activities in building construction projects for facilitating hazard assessments are as follows:

- Demolition works;
- Struck by Falling Objects
- Noise
- Excavation works;
- Scaffolding and ladder
- Erection of structural frameworks;
- Crane operation/ Lifting operation
- Welding and cutting works

- Electrocution
- Confined space hazard
- Construction machinery and tools
- Working At Height

3.1.1. Demolition works

Demolition is one of the high-risk activities of the construction industry with a fatal and major injury incidence rate of about 17 times of that for the whole of the construction industry. Approximately 10% of all fatal accidents each year in the construction field occur in the demolition sector. Demolition workers face a variety of hazards viz: Falling from heights., Being hit or trapped by falling objects., Excessive noise from hand-held tools, demolition balls, pneumatic drills, explosives and falling parts, Vibration from hand-held pneumatic tools, Respiratory hazards from dust which may contain toxic constituents such as asbestos and silica; Flying particles, Fires and explosives,

3.1.2. Struck by Falling Objects

Struck by falling objects (SBFO) is a common hazard across all industry sectors and had resulted in many cases of workplace injury. Falling objects from height can strike persons on the head and cause serious or even fatal injuries. People who work on the site as well as members of the public may be at risk of SBFO if workplace safety is not managed well. Common causes - Inadequate securing, Poor housekeeping, Improper storage, Human error, Equipment failure, Environmental factors, Insufficient safety measures, A lack of guardrails, toe boards, or safety nets to catch falling objects

3.1.3. Noise Hazard at Construction Site

Noise is one of the most common physical hazards on construction sites. It is caused by heavy machinery, power tools, vehicles, and ongoing construction activities. Continuous or excessive exposure to noise can lead to serious health effects and reduced work efficiency. Sources of Noise in Construction are - Jackhammers, concrete mixers, and drilling machines, Bulldozers, excavators, and cranes, Cutting, grinding, and welding operations, Transport vehicles and generators, Pile driving and demolition activities

3.1.4. Excavation hazards

Davies and Tomasin (1996) classify excavations into three main types: trenches, basements/wide excavations, and pits or shafts. All types expose workers to similar hazards, and excavation work—especially in utilities like water and sewer—has a higher injury and accident rate than other heavy construction work. According to OSHA (2002), excavation work has a fatality rate 112% higher than general construction. Common excavation hazard includes trench collapses, falling materials, falls by people or vehicles, collapse of nearby structures, and hazards from underground services such as electrocution, explosions, gas leaks, or flooding. Other risks include dangerous atmospheres, workers falling into excavations, tripping hazards, unstable adjacent structures, and being struck by or buried under falling or poorly placed materials.

3.1.5. Working on scaffolding and its hazard

Working on scaffolding involves using temporary elevated platforms for construction, maintenance, or repair, allowing workers to reach high areas safely. The primary hazards include falls, scaffold collapse, falling objects, and electrocution, Ladders slip when users are climbing, Users overbalance when carrying materials or tools, when defective ladders are used which are addressed through proper training, inspection, and the use of fall protection systems

3.1.6. Crane hazards

Crane hazards in India's construction sector stem from high-risk factors like overhead power line electrocution, falling loads, improper rigging, and crane tipping. Over 40% of site accidents involve lifting equipment, driven by poor maintenance, operator inexperience, and, occasionally, extreme weather, leading to numerous, sometimes fatal, collapses.

Key Crane Hazards in Indian Construction:

Overturning of Crane, Contact with Overhead Power Lines or Structures, Falling Loads, Poor Visibility & Blind Lifting, Crane Boom Failure or Structural Collapse, Struck-by Accidents, Fire and Explosion Risk (Critical in Refineries), Ground Instability, Weather Hazards, Human Error & Communication Failure

3.1.7. Welding and cutting work hazards

Welding is a construction and fabrication process where two pieces of metal (or thermoplastics) are joined together by applying very high heat, sometimes with pressure or filler material. The heat melts the materials at the joining point, and when it cools, they fuse into a strong, permanent joint. Hazards of welding in construction are- Exposure to Fumes and Gases, Fires and Explosions, Electric Shock, Noise Hazards, Exposure to UV and IR Radiation, Burns

3.1.8. Electrocution

Electrocution hazards in construction include contact with overhead power lines, contact with live circuits, and contact with faulty equipment. Other risks are improper use of tools and cords, wet conditions, and poor maintenance of electrical systems, which can lead to shock, burns, or falls.

3.1.9. Hazard inside the confined space

According to the Occupational Safety and Health Administration (OSHA) standards, a confined space has three defining characteristics: 1) It's large enough for an employee to enter and perform tasks 2) it has limited or restricted means of entry or exit 3) It's not designed for continuous occupancy. These spaces are often uncomfortable and potentially dangerous due to their design and the type of work performed within them. Confined space examples include the following works done in: Pipelines, pressure vessels, reactors, vessel, tunnels, hopper, tanks, sewers, storage bins, elevator fits, exhaust ducts, and any trench or pits that have a depth equal to or greater than 4 ft, Tank, Manhole, Well, Cold storage, Pipeline, Silos Hopper. Confined space works are commonly done during plant turnaround or shutdown maintenance period. Hazards inside the Confined Space are - Lack of oxygen, Too much oxygen, Toxic atmosphere, Hazardous chemical exposure, Extreme temperature, Fire and explosion, Uncontrolled energy, A flow of solid or liquid, slips trip and fall hazards, Fall., Falling object., Struck by an object, Electric shock, Excessive heat.

3.1.10. Working at Height

Working at height refers to any task where a person could fall from one level to another and be injured without proper safety measures. In construction, it

includes work on scaffolds, ladders, roofs, elevated platforms, formwork, and near edges or openings. Safety standards like OSHA and HSE also include risks from falling into pits, openings, or weak surfaces, not just high elevations. Major Hazards Related to Working at Height - Fall from Height, Falling Objects, Fragile Surfaces, Unstable or Improperly Installed Scaffolding, Weather Conditions, Improper Use of Personal Protective Equipment (PPE), Unsafe Access etc.

3.2. Hira Methodology

STEP 3.2.1. Classify and Define Activities

Break down all workplace tasks (routine and non-routine) into manageable components to understand exactly what is happening in the facility.

i.e. Excavation, Scaffolding, Confined space entry, Dewatering,, Grading and levelling, Compaction Piling, Concrete mixing and pouring, Shuttering and reinforcement, Crane operations, welding grinding, Material hauling, Lifting and hoisting, Trenching, Installation of underground utilities, Equipment fueling, Safety inspections etc.

STEP 3.2.2. Hazard Identification

The first step of the HIRA process, as the HIRA full form in safety suggests, is hazard identification. A hazard is any cause of potential damage or harm on something or someone.

Identifying hazards in workplace allows us to understand what could cause harm to your employees and allows you to take steps to prevent accidents before they happen.

Type of hazards

Physical Hazards	Noise, vibration, radiation, temperature extremes
Biological Hazards	Bacteria, viruses, fungi
Ergonomic Hazards	Poor posture, repetitive movements
Electrical Hazards	Live wires, faulty equipment
Mechanical Hazards	Moving machinery, rotating parts

STEP - 3.2.3. Assessing the risks that may result
 Because of the hazard

Once you have identified hazards, the next step is to estimate how much risk each hazard poses. It is a systematic and structured process whereby hazards present in workplace, or arising from workplace activity, are identified, risks are evaluated

Commonly used methods to assess risks include:

1. Qualitative Risk Assessment:

This method uses descriptive terms like "high," "medium," or "low" to categorize risks based on experience and judgment.

2. Semi-Quantitative Risk Assessment:

- 0 Zero possibility
- 1 < 1 every 10,000 operations 1 every 10 years operating
- 2 < 1 every 10,00 operations 1 every operating year
- 3 < 10 every 10,00 operations 1 every month operating
- 4 < 10 every 100 operations 1 every week operating
- 5 Incident most likely will happen 1 every day operating

This approach assigns numerical values to both the likelihood and severity, providing a more detailed risk ranking than qualitative methods.

3. Quantitative Risk Assessment:

This method uses numerical data and statistical techniques to calculate risk levels. It's often used for more complex or high-stakes environments where precise risk estimation is critical.

The second step is to work out which hazards need attention first. The risk associated with each hazard must be assessed. The method of assessing risk is as follows.

For each of the risks:

- Estimate the likelihood of an incident occurring at the workplace, bearing in mind existing control measures. Using the descriptive scale in the risk priority chart

(below), nominate the likelihood of an incident occurring at the workplace.

- Estimate the consequences of an incident occurring at the workplace, bearing in mind existing control measures. Using the descriptive scale in the risk priority chart, nominate the consequences of an incident occurring at the workplace.
- Determine the "risk score" by plotting consequences and likelihood estimates on the risk priority chart.

Using the scores obtained for the risks; develop a prioritized list of workplace risks requiring action
 Risk Priority Chart

Risk Assessment Mathematical Model: For quantifications of the risk the following mathematical models is used

Severity Factor: - (S)

0	No impact	Upon persons, environment or property
1	Minimal impact	First aid, minor equipment damage
2	Moderate impact	Non lost time accidents (ITA), damage requiring outside help or minor delay
3	Serious impact	LTA or serious injuries possible, damage /suspension of operations
4	Major impact	Life threatening, major equipment or operational damage
5	Catastrophic impact	Loss of person (s), severe structural or environmental damage

Probability Factor: - (P)

0	Zero possibility	
1	< 1 every 10,000 operations	1 every 10 years operating
2	< 1 every 10,00 operations	1 every operating year
3	< 10 every 10,00 operations	1 every month operating
4	< 10 every 100 operations	1 every week operating
5	Incident most likely will happen	1 every day operating

RISK = S x P (Severity X Probability)

Risk Score:

Risk matrix						
Probability	Very likely -5	4	10	15	20	25
	Likely -4	4	8	12	16	20
	Possible -3	3	6	9	12	15
	Unlikely -2	2	4	6	8	10
	Very unlikely-1	1	2	3	4	5
	1	2	3	4	5	
	Negligence	Slightly	Moderate	High	Very high	
	Severity					
Risk	Risk Level	Condition				
1 to 6	Low	May be accepted table but review task to see if risk can be reduced further				
8 to 12	Medium	Task should only be executing with appropriate management authorization after consulting with specialist personnel				
15 to 25	High	Task must not process until adequate action taken.				

Table 3.1. Risk priority chart

STEP 3.3.4. Risk control

Control is the elimination or inactivation of a hazard in a manner such that the hazard does not pose a risk to workers who have to enter into an area or work on equipment in the course of scheduled work.

After assessing the risks, the next step is to put in place measures to eliminate or control them. Risk control involves selecting appropriate methods to reduce the likelihood of a hazard causing harm or to minimize the severity if it does occur.

Implementation of risk control

The Hierarchy of Control in construction safety is a system used to minimize or eliminate exposure to hazards. It ranks control methods from most effective to least effective.

Here's the hierarchy (from most effective → least effective

- 1) Elimination: Removing the hazard entirely from the workplace. For example, discontinuing the use of a dangerous chemical.
- 2) Elimination: Substitute the hazard with something less dangerous. For instance, using a less toxic cleaning agent
- 3) Engineering Controls: Isolating people from hazards through physical means like guards or ventilation systems.
- 4) Administrative Controls: Changing the way people work through policies, procedures, or training to reduce exposure to hazards.
- 5) Personal Protective Equipment (PPE):

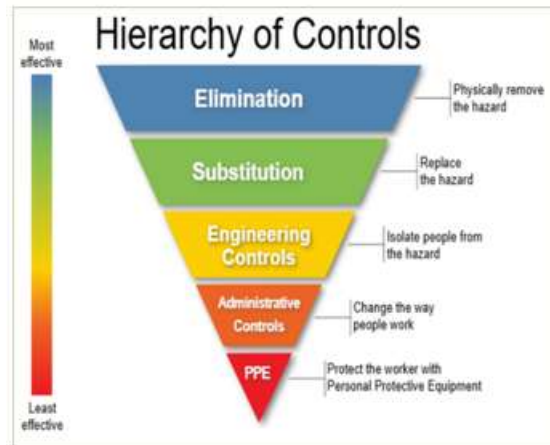


Figure 3.2. - Hierarchy of control implementation step (Source creativesafetysupply.com)

STEP 3.3.5. Documentation, monitor and review

The final step in the HIRA process is to document and Continuous monitoring and review are integral to the HIRA process. This step involves evaluating the effectiveness of implemented controls, identifying any new hazards, and ensuring compliance with safety standards. Regular reviews help in maintaining a proactive approach to risk management

1. Monitor and Review

The final step in risk assessment is to monitor and review the effectiveness of the implemented controls. This involves:

- Regular Inspections: Conduct periodic inspections to ensure that control measures are in place and functioning correctly.
- Reviewing Incident Reports: Continuously review incident and near-miss reports to identify any new hazards or recurring issues.
- Updating Risk Assessments: Regularly update risk assessments to reflect changes in the work environment, new equipment, or updated safety regulations.

Engaging Workers: Solicit ongoing feedback from workers about the effectiveness of control measures and any new hazards they may encounter

Monitoring and reviewing the risk assessment process ensures that it remains effective and relevant, adapting to changes in the construction environment and continuously improving safety standards.

3.4. OTHER SPECIFIC TOOLS & TECHNIQUES FOR HIRA PROCEDURES

3.4.1. Checklists and inspection forms

Great for routine areas and repetitive tasks. A good checklist turns “don’t forget” into “can’t forget.” Keep items short, include photo fields, and update them when equipment, layout, or materials change. Best for quick, consistent coverage across many sites.

3.4.2. Risk register

A Risk Register for a construction project is a key project management document used to identify, assess, and manage potential risks that could affect the project’s cost, schedule, quality, or safety. Below are a template and example of a comprehensive Construction Risk Register.

3.4.3. Job Safety Analysis (JSA/JHA)

Ideal for task-level reviews. Break the job into steps, list the hazards at each step, and note the controls. Do it with the people who actually perform the work. JSAs work well for non-routine tasks (setups, cleaning, changeovers) where risk often creeps in.

3.4.4. Failure Modes and Effects Analysis (FMEA)

Failure Modes and Effects Analysis (FMEA) is a systematic approach to identifying potential failure modes in a system and analysing their effects on

overall performance. It is widely used in engineering, manufacturing, and maintenance.

Key Features of FMEA

Purpose: To identify and prioritize failure modes based on their severity, occurrence, and detection.

Methodology: Examining each component or subsystem to identify failure modes, their causes, and effects.

Outcome: A prioritized list of failure modes with recommendations for mitigation.

Applications

FMEA is used in design, manufacturing, and maintenance phases to improve reliability and reduce the likelihood of failures

3.4.5. What-if Analysis

In construction, "what-if" analysis is a risk management technique used to brainstorm potential problems and assess their impact on a project's timeline, budget, and safety.

It involves asking hypothetical questions to identify risks, evaluate consequences, and develop contingency plans, ensuring more informed decision-making and smoother execution. This can range from simple brainstorming sessions to more complex simulations to understand how changes to project variables will affect the outcome.

The overall methodology for the What “if” analysis is depicted in below Figure.

Figure: What “if” analysis Methodology

3.4.6. Hazard Operability Analysis (HAZOP)

HAZOP is a systematic and detailed methodology used to analyse processes and systems for deviations from their intended design. It is widely regarded as one of the most effective tools for identifying hazards and operability issues.

Key Features of HAZOP

Purpose: To identify deviations from design intent that could lead to hazards or operational inefficiencies

1. To identify what can go wrong in a process.
2. To analyze the causes and consequences of deviations.
3. To suggest corrective or preventive actions to reduce risks

It is usually performed:

1. During the design phase of a new process plant.
2. Before commissioning a new system or modification
3. During periodic safety reviews of existing plants

Methodology: A team-based approach using guidewords (e.g., "more," "less," "no," "reverse") to explore potential deviations. A typical HAZOP team includes:

- Team Leader / Facilitator – guides the discussion.
- Process Engineer – explains process design.
- Instrumentation Engineer – focuses on control systems.
- Operations/Production Representative – gives practical insights.
- Safety Officer – ensures compliance and risk awareness.

Outcome: Identification of risks, their causes, consequences, and recommendations for mitigation.

Applications

HAZOP is typically conducted during the detailed design phase or for existing systems undergoing modifications. It ensures that processes operate safely and efficiently under all conditions.

Example

In a chemical plant, a HAZOP study might identify a deviation such as "more flow" in a pipeline, which could lead to overpressure and equipment failure. Recommendations might include installing pressure relief valves or flow control systems

3.4.7. Fault Tree Analysis (FTA)

A fault tree is a detailed analysis using a deductive logic model in describing the combinations of failures that can produce a specific system failure or

an undesirable event. An FTA can model the failure of a single event or multiple failures that lead to a single system failure.

Applications

- Risk assessment: FTA helps identify safety and design weaknesses early in the development process.
- Root cause analysis: It is used to find the fundamental reasons for a system failure after it has occurred.
- Troubleshooting: It provides a roadmap for diagnosing problems in complex systems.

Reliability and maintenance: It can be used to calculate the probability of a system failure and to guide maintenance priorities. Diverse industries: FTA is used in fields such as aerospace, nuclear power, chemical processing, healthcare, and manufacturing.

How it works

Define the top event: The analysis starts with a single, undesirable event, such as a machine failure, and works downward.

Identify contributing events: The process breaks down the top event into immediate causes, then further breaks those down into secondary causes, and so on, until basic events (root causes) are reached.

Use logic gates: The relationships between events are represented by logic gates:

- OR gates: The output event will occur if any of the input events occur.
- AND gates: The output event will occur only if all of the input events occur.

Create the fault tree diagram: The connections between events and gates form a tree-like diagram that visually maps the failure logic

FTA example showing the basic structure.

3.5. Methodologies and tools applied in conducting HIRA gap assessments

For this Gap Analysis I have use three widely accepted and academically strong tools for hazard identification are Document review, and

Questionnaire Survey Both Site are highly effective tools for hazard identification in construction projects. Using these tools together enables construction managers to systematically identify risks, implement appropriate control measures, and improve workplace safety.

3.5.1. Document review

Document review is a systematic evaluation of project-related documents to identify potential hazards, compliance requirements, and existing safety measures. For the Hazard Identification and Risk Assessment (HIRA) study of the construction project, various technical, safety, and regulatory documents were reviewed. The purpose of this review was to understand the project scope, identify inherent risks in construction activities, and evaluate the effectiveness of existing control measures.

Types of Documents Reviewed

1. Project Planning Documents,

These documents provide information about the overall project scope, construction methodology

2. Construction method statements

Purpose - To identify hazards related to structural design, construction sequence, and site layout.

3. Health, Safety and Environmental (HSE) Management Documents

These documents describe the organization's safety policies, procedures, and risk management systems.

- HSE policy and objectives
- Safety management plan
- Hazard Identification and Risk Assessment (HIRA) records
- Standard Operating Procedures (SOPs)
- Permit to Work (PTW) procedures

Purpose - To evaluate the safety management framework and hazard control procedures.

4. Regulatory and Legal Compliance Documents

These documents ensure that the project complies with applicable national and local safety regulations.

- Occupational Safety and Health regulations

Purpose - To ensure compliance with legal and regulatory safety requirements.

5. Safety Records and Incident Reports

Historical safety data helps identify recurring hazards and risk trends.

- Accident and incident reports
- Near-miss reports
- Safety audit reports
- Inspection records
- Corrective and preventive action reports

Purpose - To analyze past incidents and identify high-risk activities.

6. Training and Competency Documents

These documents verify whether workers and supervisors have adequate safety training.

- Safety training records
- Toolbox talk records
- Worker competency certificates
- Equipment operator licenses

Purpose - To evaluate workforce competence and safety awareness.

Results Of Document Review

Identification of Key Hazardous Activities

The document review identified several high-risk construction activities including:

- Working at height
- Working on scaffolding
- Levelling work
- Excavation work
- Lifting operations using cranes
- Electrical installation work

These activities require strict safety control measures.

Key Findings

The document review highlighted the following findings:

- Certain high-risk construction activities lack detailed task-specific risk assessments.

- Safety documentation is available but not always consistently updated.
- Incident reporting mechanisms exist but near-miss reporting needs improvement.
- Worker training programs require more frequent refreshers.

3.5.2. HIRA Safety observation (SO)
 Safety Observation and HIRA (Hazard Identification and Risk Assessment) are common risk assessment tools used in workplaces such as construction, factories, oil & gas, power plants, and manufacturing. They help identify hazards early and prevent accidents.

STEP

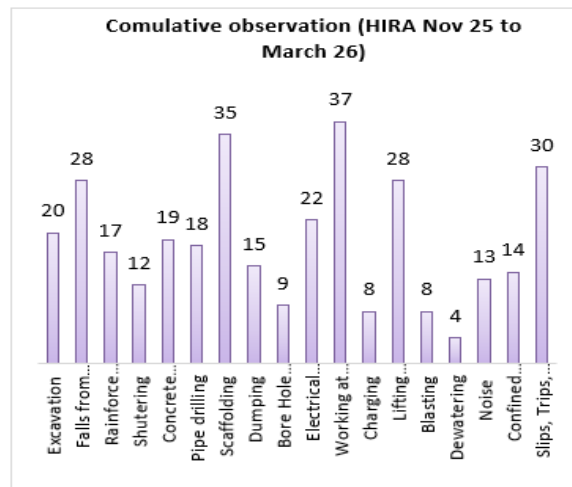
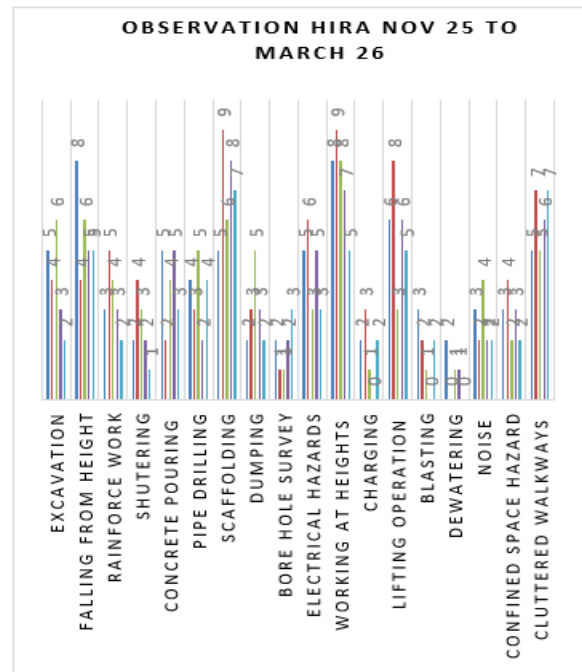
- Observe the workplace
- Identify unsafe acts or condition
- Record the observation
- Classify the observation
- Take corrective action
- Close the observation

Observation Analysis

Overall site condition is found satisfactory. However, there are some concerns such Excavation, cluttered walkways, Electrical hazard, working at height, lifting operation related risk were very poor. All above needs to be improved or corrected.

Activity	Hazard	Risk Level	Possible Consequence	Control Measures
Excavation	Trench collapse	High	Worker burial	Shoring, barricades
Fall from height	Unguarded edges	High	Fatal injury	using fall arrest systems (harnesses, nets).
Electrical work	Exposed cables	High	Electrocution	Earthing, LOTO
Working at scaffolding	Falling object	High	Fatal injury	securing tools
Working at height	Fall from scaffold	High	Fatal injury	Harness, guardrails

Lifting operation	Load drop	High	Crushing injury	Lifting plan
Cluttered walkways	Slip trip and fall	High	Causing injuries such as fractures, head trauma, and sprains. Consequences include severe injury, fatality	proper footwear, housekeeping, and improved lighting



3.5.3. HIRA Site survey / Questionnaire Survey
A survey was conducted to evaluate the level of hazard awareness, safety practices, and risk management among workers and supervisors in the JH construction and engineer's company. The objective of the survey was to identify major hazards and assess how effectively risk control measures are implemented.

1. Total respondents: 142
Participants: Engineers, supervisors, safety officers, and construction workers Production workers, Management representative
2. Survey method: Questionnaire and site observation
3. Location: Fabrication yard & Construction project site

Survey topics:

- Hazard identification awareness
- Risk assessment Practices / awareness
- Work place hazard
- Training/Competence
- Risk Assessment Measure

3.5.4. Survey Results and Analysis
Overall responses from the workers were fine. Majority of the workers filled the question papers appropriately and few are not. Total 142 answer sheets (6 Nos. from Managers, 14 Nos. Engineers and 17 Nos. Supervisors and 105 Nos. from Workers), nearly 95 % of questionnaire were returned. see the below result

Section 3.5.4.1. Hazard Identification
Response - Fully aware 57%, partially aware 29%, Not Aware 14%, not responded 9%

Interpretation:
Most workers are aware of hazards, but a significant percentage still lack complete knowledge. This indicates the need for continuous safety training and awareness programs

Section 3.5.4.2. Risk Assessment Awareness
Responded 38%, Not response 19%, Not sure 23%, Sometime 20%
Interpretation:

Most workers are aware of hazards, but a significant percentage still lack complete knowledge. This indicates the need for continuous safety training and awareness programs

Section 3.5.4.3. Workplace Hazards
Risk assessment finding based on the risk assessment matrix
Interpretation
Responded 41%, Not response 27%, Not sure 17%, Sometime 15%
Working at height – High, Electrical hazard – Low, Material handling – High, Excavation – High, Lifting operation – High, Housekeeping issue – Low. etc.
High risk hazard Required immediate control measure

Section 3.5.4.4. Training/Competence
Training status – Regular Training 76%, Specific training 16%, Occasional Training 20%, Not training 5%
Interpretation:
Training programs are implemented but not consistently across all departments.

Section 3.5.4.5. Risk Control Measures
Always 33%, sometime 15%, Rarely 22%, Never 30%
Interpretation: evaluating and explaining how safety measures reduce or manage risks.

3.6. Key Findings of conducting HIRA gap assessments
Construction activities involve multiple high-risk hazards.

1. Working at height, working at scaffolding, cluttered walkways and Excavation hazards, Electrical, slip trip, and fall are the most critical risks.
2. PPE usage is good but not fully compliant.
3. Safety training programs exist but need improvement and regular scheduling.
4. Risk assessment procedures are implemented but not always documented properly.

3.7. Data Visualization by bar chart

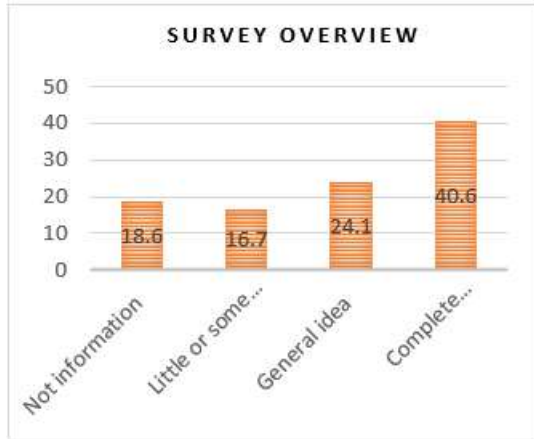


Figure 3.3. Data visualization by bar chart for questionnaires survey overview

3.8. Based on the study, the following recommendations are proposed

The study recommends improving workplace safety by providing regular training, enforcing PPE use, conducting Job Safety Analysis (JSA), strengthening supervision, and improving safety communication. It also highlights the need for proper warning signs and emergency drills to help prevent accidents and improve readiness for emergencies.

IV. RESULTS AND FINDING

The main aim for carrying the GAP analysis was to find out the deficiencies in HIRA of, JH Construction and engineer Company

In the initial stages of our research work we have studied the current scenario of accidents in these projects.

Data were collected through site inspections / Observation, safety audits, questionnaires survey worker interviews, and review of project safety documentation.

The construction activities analysed included: Excavation scaffolding, Electrical work, Scaffolding, working at height, crane operation / Lifting, dumping, levelling, pipe handling and laying, shuttering, curing, drilling, reinforcement work, etc. and reveals those high-risk activities like falling from heights, excavation/ Trench collapses, and electrical

hazards- Exposed cable, slip trip and fall are common, largely due to unsafe acts and conditions

A risk matrix method was used to determine the level of risk by assessing likelihood (probability) and severity (consequence) of each hazard. The risk rating was calculated using the following formula:

$$\text{Risk Rating} = \text{Likelihood} \times \text{Severity}$$

The risk levels were categorized

The hazard identification process revealed multiple hazards associated with typical construction activities. The major hazards identified

The analysis shows that Excavation, working at height and Excavation hazards, Electrical, Cluttered walkway and fall highest risk score percentage, indicating a critical hazard requiring immediate control measures

Distribution of Risk Levels

Based on the HIRA assessment conducted across different construction activities, the distribution of risks was Extreme Risk, High Risk: 35%, Medium Risk: 40% Low Risk: 10%

The results indicate that 50% of the hazards fall within high or extreme risk categories, highlighting the need for strong safety management systems at the construction site.

Observation Analysis - Overall site condition is found satisfactory. However, there are some concerns such Excavation. Levelling Electrical hazard, working at height, lifting operation related risk were very poor.

Survey Results and Analysis

The major findings from the hazard identification and risk assessment study are:

- Working at height, working at scaffolding, cluttered walkways and Excavation hazards, Electrical, slip trip, and fall are the most critical risks.
- PPE usage is good but not fully compliant.
- Safety training programs exist but need improvement and regular scheduling

- Risk assessment procedures are implemented but not always documented properly

Key Results and Discussion Points:

- Major Hazards Identified: Common high-risk areas include working at heights, electrical work, falling objects, excavation, and structural failures.
- Risk Evaluation (HIRA): Hazards are analysed using qualitative/quantitative methods, prioritizing risks as high, medium, or low based on likelihood and severity.
- Causes of Accidents: Unsafe acts (e.g., ignoring safety protocols) and unsafe conditions (e.g., Jack hammer was not secure).
- Impact of Mitigation: Implementing HIRA frameworks consistently reduces accidents, injury rates, and property damage, while increasing productivity.

V. CONCLUSIONS

The present study demonstrates that Hazard Identification and Risk Assessment (HIRA) play a fundamental role in strengthening Occupational Health and Safety

Management Systems within construction and industrial work environments. The survey findings reveal that, although a moderate level of hazard awareness exists among employees, significant gaps remain in formal training, periodic risk assessment reviews, and consistent implementation of control measures. These gaps may increase the likelihood of occupational incidents and negatively affect overall workplace safety performance.

The investigation identified working at height, electrical operations, excavation activities, material handling, machinery operation, slip–trip–fall conditions, fire and explosion risks, and ergonomic stressors as the most critical hazards encountered across the surveyed workplaces.

While organizations have adopted essential preventive measures such as Personal Protective Equipment (PPE), safety training programs, machine guarding systems, safety signage, and emergency

preparedness plans, the effectiveness of these controls is often limited by inconsistent compliance, inadequate monitoring, and insufficient worker engagement.

The findings further emphasize that an effective HIRA system requires a systematic and continuous approach involving hazard identification, risk evaluation, implementation of appropriate control strategies, and regular performance review. The successful integration of the hierarchy of controls, combined with active participation from management, supervisors, safety professionals, and workers, is essential for developing a proactive and sustainable safety culture.

To improve occupational safety performance, organizations should prioritize continuous HIRA training, periodic revision of risk registers, enhanced worker participation in safety initiatives, and more rigorous safety audits and inspections. Furthermore, integrating HIRA into routine operational planning and decision-making processes can significantly improve hazard control effectiveness and reduce workplace incidents.

In conclusion, the study confirms that effective implementation of Hazard Identification and Risk Assessment substantially contributes to accident prevention, risk reduction, regulatory compliance, and improved organizational productivity. A proactive and continuously improving HIRA framework not only safeguards employees and assets but also supports the development of a safer, healthier, and more sustainable working environment aligned with international occupational safety standards

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