HIRA in Construction Site

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Abstract— Construction activities have made a great breakthrough in the last two decades on the back of increase in development activities, and public demand. Still occupational health and safety issues have become major concern to construction organizations. The world society and economy have suffered financial and human losses as a result of poor safety management in the construction industry. The impact is however more in developing countries. The purpose of this study is to explore major safety provisions and also a detailed study has been conducted on safety management procedures in construction sites. Different types of accidents occurring in construction sites and measures taken to control these accidents are also analyses in this paper. Data's have been collected through various site visits, literature review and from various construction safety standards including BIS and OSHA (Occupational Safety and Health Administration). The paper has been concluded after putting forward a set of recommendations for construction organizations to improve the occupational safety in the construction sites.

Keywords: HIRA, BIS, OSHA

I. INTRODUCTION

Construction industry is considered as one of the most hazardous industries in the world. There has been an increase in the number of buildings which are built for commercial, residential and office purposes every year. The construction market continues to expand due to the day by day increase in need of infrastructure facilities, homes, office spaces etc. The construction industry is very complex and hence it is prone to numerous health hazards. Therefore, safety is a vital concern in the construction industry to result in a hazardous free environment. Safety professionals have analyzed that the major workplace accidents are initiated by unsafe behaviors and that their control is one of the keys to successful accident prevention resulting in low accident rate in construction sites. The number of fatal accidents in construction sites is not easy to quantify as information on this issue is not available for most countries. The main concern is completing projects at the required quality with minimum time and cost. Carelessness has been considered as the major reason for accidents and hazards happening in construction sites. With the change in timings and schedules along with the change of men themselves combined with the nature of the construction jobs makes the construction industry as one with accident risks. Hence the major aim of this research is to minimize the accidents occurring in construction sites. More than 3 million working days were lost due to hazards and accidents in the sites. Falls from elevated positions is the major cause of accidents and deaths in construction sites. Unexpected accidents which occur affect the overall plan of the projects which leads to production loss, lagging of works and interruption of production flow. Even though accidents cannot be completely erased, the affects of those accidents on workers can be controlled. Occupational health and safety issues have become a major concern in construction organizations. Due to lack of enforcement of applicable legislations, most of the construction organizations are forced to opt for implementation Occupational Health Safety Assessment series (OSHAS) to improve safety performance. It has been accepted that the construction workers have a high risk of work related illness and accidents than in any other public sector. Therefore, there is an urgent need to reduce risk reduction by implementing a site safety management.

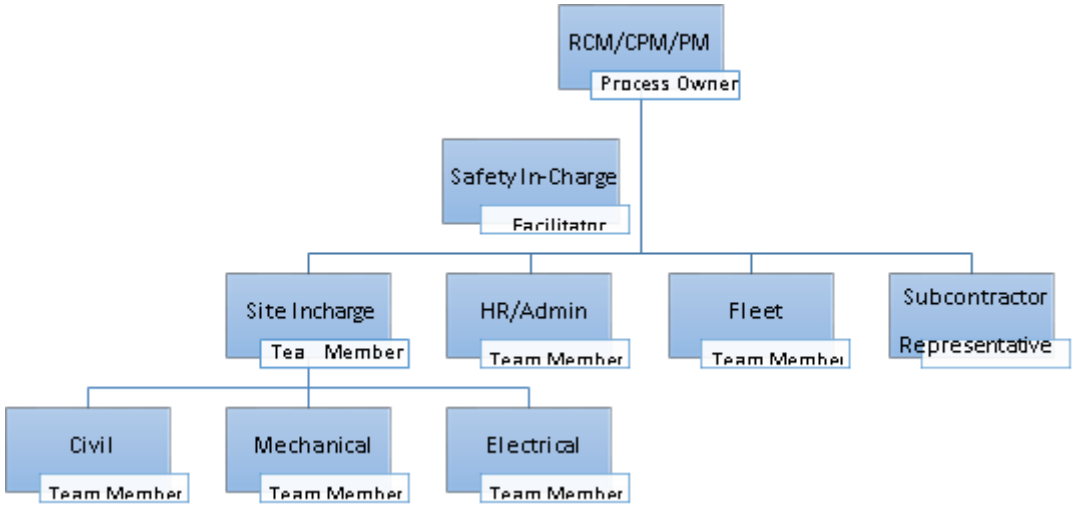
Construction safety management is a method which is used to control safety activities in order to ensure a safe working environment in the construction site. Safety during the construction project is also influenced to a great part by decisions made during planning and design process. Construction safety can be branched into four groups which are panning for safety, employee training for safety, first aid and medical measures and safety policies by the management.

II. LITERATURE REVIEW

Various literatures were studied in order to gain a clear view on safety management and safety practices in construction industry. The study examined safety management in construction industry including organizational safety policy, safety training, meeting, inspection, penalties and worker's attitude towards safety. The study concludes that a focused dedication inwards safety is needed and also the owners of large projects can more actively participate in construction safety management. Implementation of various safety management strategies in construction sites was studied. The proper practice and evaluation of safety management can improve the occupational safety in construction site. The study investigate how effective is the safety policy taken by the Australian organizations. A relationship between safety management and safety practices was found out. This paper aims at exploring current safety practices in the construction industry of Lebanon. The study found out the existence of construction safety law but the safety problems are due to the absence of its enforcement. Even though the laws are maintained the proper practice of these laws in the construction sites are missing. The study examines how the project owners, contractors and sub-contractors are related in safety management. They concluded that for proper implementation of safety management in construction sites, the owner, contractor, sub-contractors and labours should work together and follow the safety practices. This study examines the effect of three types of institutional pressure on safety environment in construction. This journal proposes that at the planning stage itself the major issues on safety should be erased completely. Early planning of construction processes can be promoted in order to improve safety. This paper explores the importance of workplace risk assessments (WRA). The implementation of WRA is considered strictly in European Union countries. The implementation and practices of WRA were studied in this paper. In this paper a multi criteria analysis was done in order to make a mathematical model. It has a hierarchal structure with four

phases of lifecycle of buildings. The paper concludes that the implementation of proper health and safety criteria can improve the sustainable value of projects.

III. HIRA ORGANIZATION STRUCTURE



IV. RESPONSIBILITIES OF HIRA TEAM

S.No	Person	Responsibility
1	RCM/CPM/PM	RCM is process owner. To form a HIRA Cross functional team along with Site In-charge/Engineer (Civil, Electrical, Mechanical), Safety In-charge, Fleet, HR/Admin and subcontractor representative. Any material to be required as per the Precautionary measures and proposed control measures need to arrange To review the updated HIRA and approve it.
2	Site In-charge	To prepare Method statement of each activity. To participate in preparing HIRA. To incorporate all the Hazard & appropriated precautionary measures as per the site environment, to bring down the risk level to acceptable risk and communicate down the level. Before issuing PTW ensure all precautionary measures are in place. Ensure HIRA talk by site supervisor before starting the activity.
3	Safety In- charge	Work as Facilitator to prepare HIRA based on the method statement. Ensure all concern person are available for preparing HIRA. To incorporate all the Hazard & appropriated precautionary measures in HIRA format along with responsibility. Communicate updated HIRA to all concern for implementation and ensure all precautionary measures are in place. The same shall be communicated to SBG SHE Head and Corporate SHE Team. To ensure safety supervisor shall monitor for any deviation. If any deviation, escalate to Site In-charge, RCM/CPM/PM and SBG SHE Head.
4	Sub-contractor Representative	Follow the precautionary measure as per the HIRA

V. HAZARD IDENTIFICATION & RISK ASSESSMENT (HIRA)

HIRA: To manage risk, hazards must first be identified, and then the risk should be evaluated and determined to be tolerate or not. The earlier in the life cycle that effective risk analysis is performed, the more cost effective the future safe operation of the process or activity is likely to be. The risk understanding developed from these studies forms the basis for establishing most of the other process safety management activities undertaken by the facility. An incorrect perception of risk at any point could lead to either inefficient use of limited resources or unknowing acceptance of risks exceeding the true tolerance of the company or the community. A Hazard Identification and Risk Assessment (HIRA) assist emergency managers in answering these questions. It is a systematic risk assessment tool that can be used to assess the risks of various hazards.

There are three reasons why a HIRA is useful to the emergency management profession:

- It helps emergency management professionals prepare for the worst and/or most likely risks.
- Allows for the creation of exercises, training programs, and plans based on the most likely scenarios.
- Saves time and resources by isolating hazards that cannot occur in the designated area.

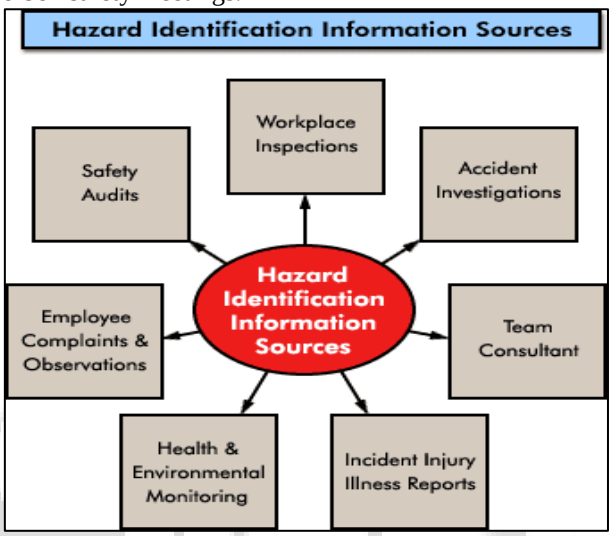
VI. Objectives of HIRA Study

- Carryout a systematic, critical appraisal of all potential hazards involving personnel, plant, services and operation methods.
- Identify the existing safeguards available to control the risks due to the hazards.
- Suggest additional control measures to reduce the risk to acceptable level.
- Prepare a Risk register that will help in continuously monitoring these risks, detect any changes and ensure the controls are effective.

HIRA PROCESS

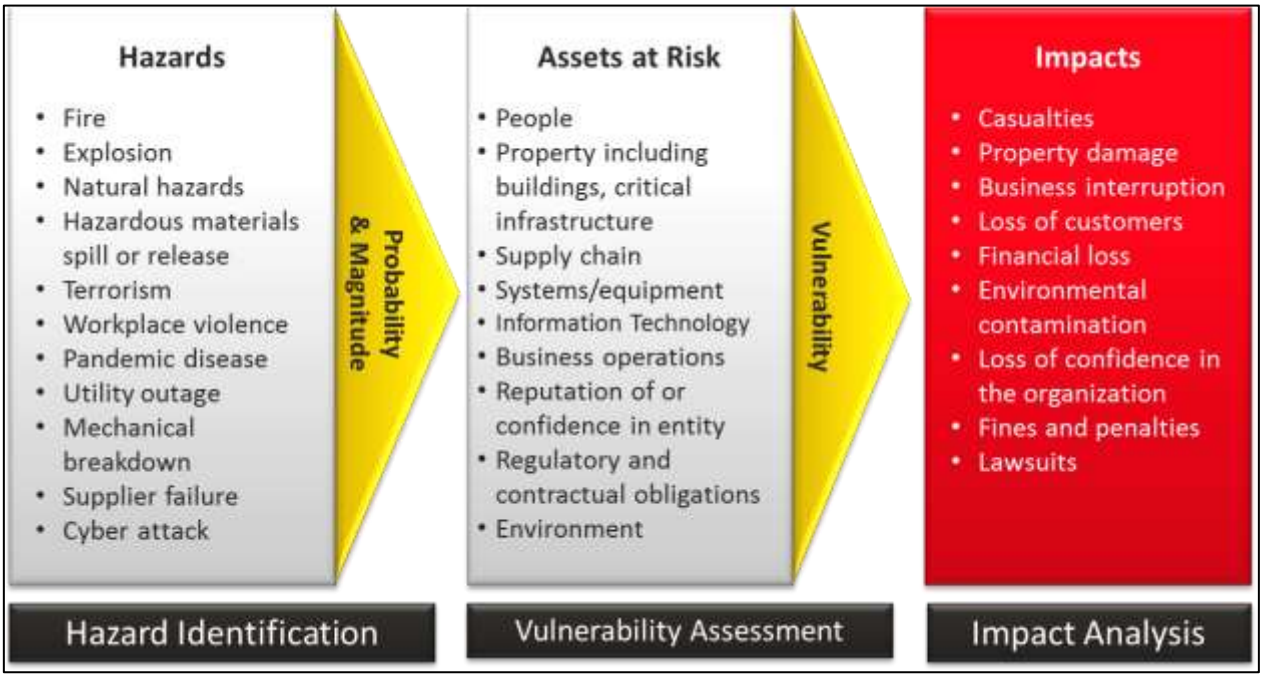
VII. Hazard Identification

Workplace hazards can be identified in a number of ways. Inspections provide a system of recognizing hazardous conditions so that those conditions can be corrected. The data collected while performing inspections will be used to identify hazards and barriers to working safely and in an environmentally protective manner so that they can be addressed such as procedure changes or purchasing different PPE. The data also will be tracked as a protective measure of acceptable HSE behavior on the site. reports and safe work observation information will be shared with employees at toolbox safety meetings.



HAZARD IDENTIFICATION

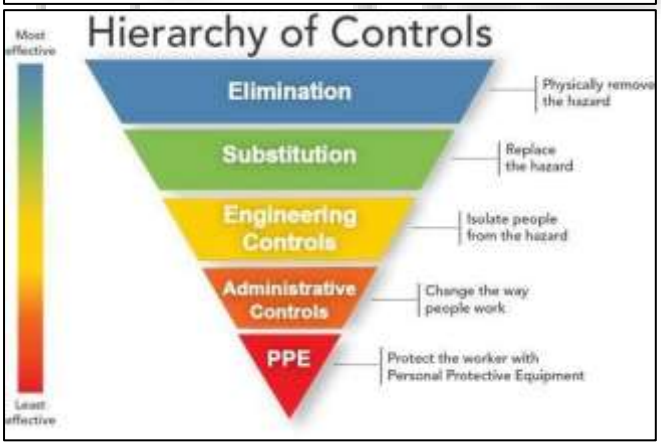
VIII. Risk Assessment



RISK ASSESSMENT

Once the hazard has been identified, it is necessary to assess what risk they pose to employees in the workplace. In this way we can establish a measure of the risk and determine what priority they should have for corrective actions. The risk assessment step is that part of the process that assesses the probability (likelihood) and consequences (severity) of hazard that have been identified. Once we have estimated the probability and consequences for each hazard then we can allocate it a priority for corrective action. Generally, risk assessment is estimating: what are the chances (probability) of an accident happening, and if it does happen, what are the chances that someone will be hurt? What will be the extent of equipment or environmental damage, and how bad will it be (severity)? The level of risk is dependent on the exposure to the hazard and the probability and consequences of an event occurring.

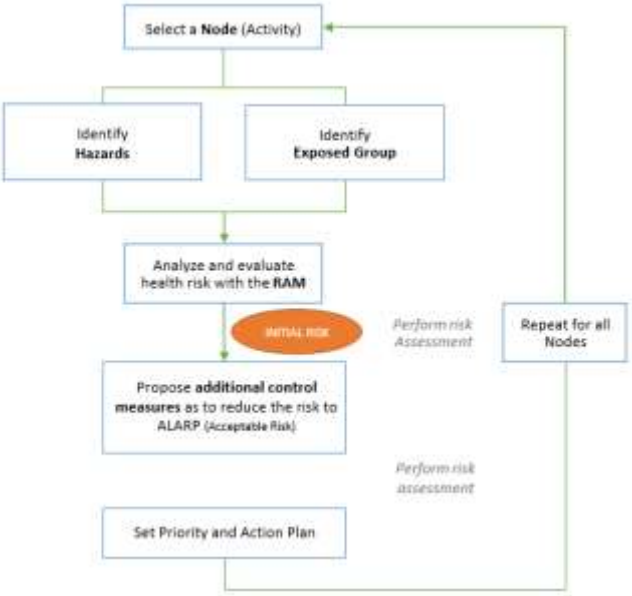
IX. RISK ANALYSIS



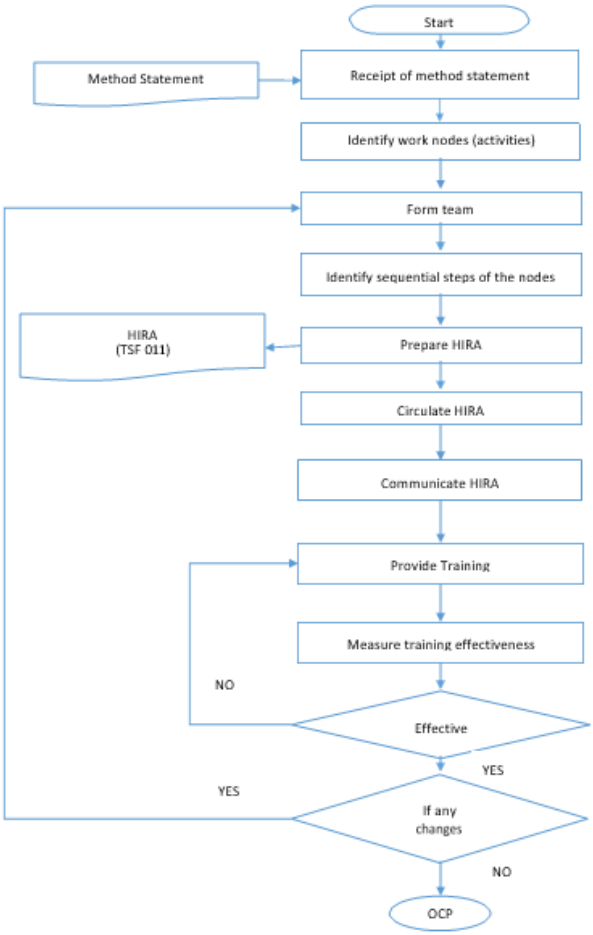
RISK ANALYSIS

The risk analysis determined the frequency and potential impact of hazards on business operations, community, associated stakeholders, related infrastructure, and the environment. Historical occurrences, changing circumstances, outside influences and similar occurrences happening elsewhere are examined when analyzing risks.

X. HIRA METHODOLOGY



XI. HIRA FLOWCHART



Steps of HIRA review is summarized as follows:

- Classify work/assessment units or work activities during construction phase (based on Work Method Statement).
- Identify the hazards associated with work activities.

- List out the Consequence of the hazard involved in the activity.
- List out present controls (preventive and recovery).
- Assess the risk based on present controls.
- Reassess the medium and high risk to bring it down to acceptable risk.
- Verify compliance to regional Regulation, Project Specifications, and applicable international codes and standards.

A. Risk Assessment Matrix (RAM)

RISK MATRIX						
PROBABILITY	Very Likely - 5	5	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*
		Negligible	***Slight***	***Moderate***	***High***	***Very High***
		SEVERITY				

Risk	Risk Level	Action
1 to 6	Low Risk	May be acceptable but review task to see if risk can be reduced further
8 to 12	Medium Risk	Task should only be undertaken with appropriate management authorization after consultation with specialist personnel and
15 to 25	High Risk	Task must not proceed. It should be redefined or further control measures put in place to reduce risk. The controls should be

XII. Risk Assessment Matrix

For each of the identified hazard, the level of risk is assessed based on the Risk Assessment Matrix during HIRA review. Risk ranking is firstly performed based on the unmitigated risk for each hazard, and then the level of risk is re- evaluated after taking into consideration of the existing prevention/mitigation measures and controls.

XIII. Control Measures

XIV. Effectiveness

- Present Risk reduced to Acceptable Risk
- Reduction of incident
- Reduction in repetitive observation
- Improvement in Behavioral Safe

XV. EXCAVATION

Sub-Activity	Potential Hazard	Consequence	Present Control	Base Risk			Proposed Control	Residual Risk		
				Probability (1 to 5)	Severity (1 to 5)	Risk (1 to 25)		Probability (1 to 5)	Severity (1 to 5)	Risk (1 to 25)
Removal / cleaning of Surface encumbrances i.e. Electrical lines, trees, heap of soil, existing buildings, existing roads and other existing structures	Work near to the moving Vehicles / equipment. Manual cutting & material handling Fall from height Electrocution while using power tools Presence of underground / overhead services / utilities; Use of sharp hand tools.	Fatality / severe injury due to hit by the moving vehicles / equipment. Fall from height and may result into multiple injuries / fatality. Cut injuries while doing manual material handling Shifting / pulling / pushing. Electrical burn/fatality	Barricading the work area. Engaging the competent operators. Taking approval from relevant authorities and ensure PTW. Imparting the HIRA talks before start of work. Avoiding the manual material handling as much as possible and introducing mechanical material handling for the removal of surface encumbrances.	2	4	8	1. Engage competent / experienced personnel for handling /operating hand tools / power tools during tree cutting.	1	4	4
Surface levelling (general cutting / filling)	Work near to the moving Vehicles / equipment. Topple of vehicle due to uneven ground surface. Presence of overhead / underground utilities.	1. Fatal / severe injury due to hit by the moving vehicles / equipment.	Barricading the vehicle movement area and define pedestrian movement area separately. Ensuring that vehicle movement area is levelled and well compacted. Prior information to the concern departments of utility services and ensure de-energize / isolation of source.	2	4	8	1. Administrative control measures are to be developed for vehicle fitness and engagement of competent operators.	1	4	4

Sub-Activity	Potential Hazard	Consequence	Present Control	Base Risk			Proposed Control	Residual Risk		
				Probability (1 to 5)	Severity (1 to 5)	Risk (1 to 25)		Probability (1 to 5)	Severity (1 to 5)	Risk (1 to 25)

Blasting operation for hard rock cutting	Fly rock Vibration	Injury due to flying rock, Neel finger Hand-Arm Vibration Syndrome (HAVS)	Imparting HIRA talks on blasting operation before start of work. Sufficient number of rubber mats / sand bags are placing on the charging holes for minimizing the flying rock. Delays are providing in-between every two holes WARNING SIGNAL - a one-minute series of long audible signals 5 minutes prior to blast signal; BLAST SIGNAL- a series of short audible signals 1 minute prior to the shot. ALL CLEAR SIGNAL- a prolonged audible signal following the inspection of blast area. Warning signs and flags shall be posted at all access points...	2	4	8	Follow OCP-30: "Hard Rock Blasting" for ensuring its close compliance / execution.	1	4	4
Surveying	Presence of poisonous reptiles/inspects	Loss of consciousness / heart attack / fatal	Ensuring proper supervisor & using safety stick (wooden) Ensuring use of appropriate PPE's (high ankle safety shoes) & avoiding loose clothing Ensure proper housekeeping/ use of protective tools Create awareness among the workforce and staff/ monitoring.	2	4	8	Use of pesticide / bleaching powder / carbolic acid Ensure availability of emergency vehicle and contact details/ tie up with local hospitals	1	4	4

Sub-Activity	Potential Hazard	Consequence	Present Control	Base Risk			Proposed Control	Residual Risk		
				1 to 5 Probability	1 to 5 Severity	1 to 25 Risk		1 to 5 Probability	1 to 5 Severity	1 to 25 Risk
Surveying	Improper Access / working on uneven ground surface;	Slip / trip/ fall may result injury to the personnel.	Ensuring general levelling of surface for vehicle movement Deployment of flagman Ensuring barricades to the work location at valley / steep access / ramps are existing.	2	3	6				
Surveying	Working near to the moving vehicles / construction vehicles	Hit by the vehicles.	Ensuring competent driver. Displaying sign boards / caution boards. Providing training / awareness & close monitoring Using high visibility clothing.	2	4	8	1. Provide rigid barricades for defining the vehicle movement & pedestrian walkways separately.	1	4	4

Surveying	Presence of live electrical cables near survey work.	Cardiac arrest / burns due to electric shock.	Using Insulated tools and keeping minimum distance of 3 meters. Using rubber gloves. Tie-up with local hospitals. Providing HIRA talks to the workforce before start of work.	2	4	8	Use wooden / fiber levelling staffs wherever electrical lines are existing. Ensure emergency vehicle availability till the completion of job.	1	4	4
Surveying	Working in extreme climatic conditions	Sun stroke due to de-hydration. Injuries / fell in sick due to adverse weather.	Ensure availability of drinking water Provide temporary rest sheds Avoiding the work during extreme climatic conditions e.g. Excessive cold/hot.	2	3	6				

XVI. SCAFFOLDING

Sub-Activity	Potential Hazard	Consequence	Present Control	Base Risk			Proposed Control	Residual Risk		
				1 to 5 Probability	1 to 5 Severity	1 to 25 Risk		1 to 5 Probability	1 to 5 Severity	1 to 25 Risk
Mobilization, Handling (loading / unloading) & stacking of scaffold material.	Fall of material due to handling while unloading from truck. Improper Stacking	1. Injury due to hit by the swinging material 2.Injury due to collapse / shift of stacked material.	Do not lift the materials with bundle ties and to be unloaded with suitable lifting equipment's. Quality of scaffolding material shall be checked by the competent person as per the requirement. Scaffolding materials should be stacked in stable manner and less than shoulder height. It must be barricaded. Tag line must be used while loading & unloading of scaffold materials. Experienced rigger must be engaged at the time of loading & unloading. Sleepers must be placed underneath the scaffold materials. Side support must be provided at stacking of materials.	3	2	6	Mobilization of scaffold material inside shall be done only after clearance from SHE department. Follow OCP-2:scaffolds (Erection / dismantling)	2	2	4

Erection of scaffolding	Fall from height Collapse of scaffold Fall of material	Personnel injury due to: Fall from height Collapse of scaffold Fall of material	Scaffolding should be erected as per the drawing/scheme. Before installation of scaffolding soil condition must be checked and verified. Ground soil must be compacted. Scaffolding shall be installed and modified under the competent supervision with competent scaffolders only as per scaffolding procedure. After installation scaffolding tag system is being followed. Scaffolding shall not be used without authorization of scaffolding inspector/supervisor.	3	3	9	To follow OCP-2:scaffolds (Erection / dismantling)	2	3	6

Sub-Activity	Potential Hazard	Consequence	Present Control	Base Risk			Proposed Control	Residual Risk		
				1 to 5 Probability	1 to 5 Severity	1 to 25 Risk		1 to 5 Probability	1 to 5 Severity	1 to 25 Risk
Working on scaffolding at height	*above hazards plus*: 1. Missing of scaffold members such as railings / bracings / ledgers / base plate / sole plate. 2. Insufficient width of scaffold work platforms 3. Unsupported / unsecured scaffold with permanent structure.	Injury / fatal due to: Fall of person from height Collapse of scaffold Fall of material	Scaffolders must undergo for medical test and vertigo test. PTW system must be followed. Activity shall be carried out by competent scaffolders. Shall be used full body harness with scaffolding hook and double lanyard harness and other basic PPEs. All tools shall be carried in a tool bag or with adequate arrangement means hand tools must be tied with tag line. Surrounding must be barricaded. Weather condition and speed of wind shall be taken in consideration before working at height on scaffold. HIRA Talk is compulsory before start of activity. Maintain tag system for scaffold while working on the scaffold.	3	3	9	To follow OCP-2: scaffolds (Erection / dismantling) Ensure dynamic HIRA precautionary measures are in place	2	3	6

Working on mobile scaffold	Working at height Pulling / pushing of mobile scaffold Failure of caster wheels & unlocked wheels. Failure of out rigger supports. Missing of mobile scaffold parts.	1.Injury due to fall from height 2. Injury due to collapse of scaffold while passing / pulling	Adequate access ladders shall be fixed; suitable work platform shall be provided with toe boards. Caster wheels shall be armed with breaks. Scaffolding tags inspection shall be followed. Mobile scaffold shall not be moved while workers on it. Sufficient out riggers supports shall be provided. Loose materials shall not be kept at the edges left on the scaffolding platform.	3	3	9	To follow OCP-2: scaffolds (Erection / dismantling) Ensure dynamic HIRA precautionary measures are in place	2	3	6

Sub-Activity	Potential Hazard	Consequence	Present Control	Base Risk			Proposed Control	Residual Risk		
				1 to 5	1 to 5	1 to 25		1 to 5	1 to 5	1 to 25
				Probabilit	Severity	Risk		Probabilit	Severity	Risk
Scaffold dismantling	Erection scaffolding hazard including: Unstable scaffold Handling / dismantling by incompetent personnel Presence of workmen nearby the dismantling work 4. Unavailability of anchoring arrangement for personnel working at height on scaffold.	Injury due to collapse of scaffold / fall of person / fall of material on workmen nearby scaffold.	Scaffolding dismantling shall be carried out under supervision of competent scaffolder. Scaffold tag system shall be strictly followed. Dismantling activity must be done sequentially (From top to bottom). Dismantling scaffold material shall not be thrown from height. If possible life line must be provided at the time of dismantling. PTW system must be followed up. Materials must be stacked properly. Dismantling of scaffold shall be done only after arrangement of barricades & signage.	3	3	9	To follow OCP-2: scaffolds (Erection / dismantling) Ensure dynamic HIRA precautionary measures are in place	2	3	6

XVII. RESULT AND DISCUSSION

Construction is a high hazard industry that comprises a wide range of activities involving construction, alteration or repair. Examples include residential construction, bridge erection, excavations, demolitions and large scale painting jobs. Hazard identification and risk analysis is carried for identification of undesirable events that can leads to a hazard. The analysis of hazard mechanism by which this undesirable event could occur and usually the estimation of extent, magnitude and likelihood of harmful effects.

As the part of the work, hazard identification and risk analysis was carried out for construction and the hazards were identified and risk analysis was carried out. The different activities were divided into high, medium, and low depending upon their likelihood and consequences. The high risk

activities have been marked in red color are un-acceptance and must be reduced. The risk which are marked in yellow color are tolerable but efforts must be made to reduce risk without expenditure that is grossly disproportionate to the benefit gained. The risk which are marked in green color have the risk level so low that it is not required for taking actions to reduce its magnitude any further. The risk rating calculations were carried out by a qualitative, semi-qualitative, quantitative method.

XVIII. CONCLUSION

The first step for emergency preparedness and maintaining a safe workplace is defining and analyzing hazards. Although all hazards should be addressed, resource limitations usually do not allow this to happen at one time. Hazard identification and risk assessment can be used to establish priorities so that the most dangerous situations are addressed first and those least likely to occur and least likely to cause major problems can be considered later. The study also revealed that systematic methods were used and risk was assessed by brainstorming, checklist and health and safety regulations. Working at height, and manual handling observed to be most critical hazards in Indian Industry construction site.

Regular inspections, penalties and compliance certificates issued by regulatory institutions influence risk management more. Furthermore, the organizational culture of safety is another factor influencing risk management. It is observed that construction firms with a safety culture considered health and safety when employing the site manager, the safety coordinator and safety officer. Knowledge of health and safety is a criterion for employment. Meanwhile firms with a safety culture provide resources for site workers, such as PPE and training. Additionally, individual characteristics such as experience of those working on construction sites, their educational background and knowledge of health and safety matters also influence health and safety risk management. It was observed that risks were assessed based on experience and educational background. Furthermore, the study revealed that the work environment such as site layout and location, the nature and the size of the work, working methods and working team influence health and safety risk management.

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