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Research Article

Operational Risk Analysis of Common Activities of Building Construction Project

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Abstract
The Paper aims to analyse operational risk of Brick work, Plaster works, Plumbing works and Painting works of different high rise building construction projects within Kathmandu , Nepal. The data were collected from the workers and the site management team through questionnaire survey and direct observation. Data were analysed, interpreted and presented using simple descriptive statistics, tables, bar charts and pie charts.
Risk level of Painting works was the highest with risk score of 18.0 among all four types of job under study. Brick works and plaster works was the highest with 16 and 13.125 risk score respectively. So, both considered as "High risk". Plumbing works had been found to have the highest risk score of 9.75 and having risk rating level of "Moderate". Risk level of activity, working on scaffolding had been revealed as the highest for painting works, brick works, and plaster works with activity risk score of 18.0, 16.0, and 13.125 respectively having risk rating level of "High" but for plumbing works it was "moderate risk level with risk score of 8.25. The riskiest activity for plumbing work had been revealed as Working in narrow space/ voids with risk score of 9.75 having risk rating level of "Moderate". Lifting up of construction materials to working platform had been revealed as another common activity for painting works, brick works, and plaster works with respective risk score of 12.25, 14.0, 12.25 having risk level rating of "High". Storing materials over platform of scaffolding had been revealed as the another common activity with respective risk score and risk level 11.375 "Moderate" for painting works, 13.125 "High" for brick work, and 9.75 "Moderate" for plaster works. Painting in required pattern, use of faulty tools, sanding/ scrubbing wall surface for painting, blending of paints were another activities in painting works with "Moderate" risk level rating and respective risk score of 10.5, 9.0, 8.0, and 6.0. For brick work in high-rise building, cutting/ breaking/ drilling, using faulty tools, and brick laying in line were the another activity in with "Moderate" risk level rating and respective risk score of 11.25, 9.0, and 6.9. For plaster work in high-rise building, plastering in required line and level, cutting/ breaking/ drilling, using faulty tools, were the another activity with "Moderate" risk level rating and respective risk score of 10.50, 9.0, and 8.0.
The management commitment to the job safety along with worker participation is essential for successful construction project. Preventive and control measures should be planned and implemented as per the risk level assessed for prevailing hazards.

Keywords: Occupational health and safety, High rise, Brick work, Plaster works, Plumbing works, Painting works, High, Moderate and Low

1.INTRODUCTION:

Nepal is a Developing country and high-rise building construction project is widely growing inside the country mostly in Kathmandu. Knowledge, awareness, proper job implementation method, losses analysis on failure, proper safety practice in high-rise building construction is new to Nepali construction industry and is found in very poor level of implementation standards (Based on site visit of different High-rise building construction site). Professionals and academicians also not seriously undertake it. Accidents due to the ignorance of proper safety requirements may lead to human fatal losses, which cannot be recovered by any cost. Even the losses is non-fatal, the cost associated with safety can be huge, as direct cost or indirect cost. High-rise building construction is one of the very dangerous sector in construction engineering there are many hazard present, as construction activities considered for study as supposed to be performed at even much higher level from the ground level on support of temporary constructions, there is always very high risk of slip and fall hazard which is mostly fatal. According to Sawacha et. al (1999)[1], Saveral factors were identified and Sharestha (2017)[2] highlighted general practice of health and safety at Kathmandu showing need of great improvements. Job safety Analysis is a widely accepted simple tool for safety management through selecting a job, breaking into parts, assessing hazards and adopting precautions.

Practice of identifying occupational hazards existing for different jobs, providing scores for different risk levels of existing hazards, and providing necessary prevention and control mechanism to control accident and diseases in different jobs while construction of high-rise building is at poor level needs serious attention. One of the major performance indicators of a successful project is safety. Based on the safety practice and its trend in existing high-rise building construction projects within the Kathmandu considered here in for study could be documented as a lesson for further improvement of safety assurance in upcoming building construction of such types. We rarely find proper and systematic construction job safety procedure for such types of building construction activities for such types of projects which could be very useful and helpful for controlling accidents and fatal/non-fatal injuries and save time, huge cost of accidents and human lives as well.

Risk free construction site is not possible but systematic operation can assure preparedness resulting into reduced losses. ‘‘Analysis of Job Safety” (CJSA), is a lean approach to safety management as a proactive approach. Beside various types of work involved in construction of high-rise building, the common types of work selected are; Brick Work, Plaster work, Plumbing Works and Painting Works

Three high-rise building of commercial and hotel types within the Kathmandu has been selected for the study of above listed works so that they can provide more précised results on different cases. The above listed works for CJSA has been selected for study through operation Risk scoring as these works are more commonly involved in all types of building and are more labor intensive and less mechanized.

2. OBJRCTIVES:

The focus of the research is to analyze the operational risk of Brick work, Plaster works, Plumbing works and Painting works of different high rise building construction projects within Kathmandu , Nepal.

3. LITERATURE REVIEW:

Occupational Accident

Accidents are the spontaneous and accidental function which causes hurt. Occupational accidents, more often than not happens because of absence of appropriate investigation and control on Occupational perils existing at work place. Accident causes death toll, financial misfortunes; resolve down of laborers at last diminishing profitability of laborers. Accident comprises of many immediate just as circuitous costs misfortunes. Development exercises include bunches of risky materials, plant and hardware, instruments, labor and so forth because of which mishap happens at work places.

By and large, significant accident occurs because of hardware and software based causes. Hardware based causes include instruments and hardware, materials, measure, physiological state of laborers, brain research of laborers, drinking liquor and ingesting medications, unsatisfactory just as ill-advised individual defensive gear. Software based causes incorporate deficient arrangement and program, ill-advised security plan, absence of preparing, absence of signage and signs, inappropriate preparing materials, blunders, slip-ups and carelessness.

Risk Assessment

Risk Assessment is the joined effort of: recognizing and taking apart potential capacities that may conflictingly influence individuals, assets, just as the environment. Danger Assessment is portrayed as the path toward looking over the threats related with all of the hazards recognized so the possibility of the peril can be seen. This fuses the possibility of the mishap that may result from the peril, the earnestness of that hurt and the likelihood of this incident (Western Sydney University, 2015)[4].

As a part of managing the prosperity and security of our business, we should control the threats in our workplace. To do this we need to consider what may make hurt people and pick whether we are figuring out how to thwart that hurt. This is known as Risk Assessment and it is something we are lawfully important to do. If we have under five delegates, we don't have to record anything. A Risk Assessment isn't connected to making titanic proportions of work area work, yet rather about perceiving sensible measures to control the perils in our workplace. We are apparently beforehand figuring out how to guarantee our laborers, anyway our threat examination will help us with picking whether we have gotten all we need to. For specific risks, various rules require explicit control measures. Our assessment can empower us to recognize where we need to look at explicit threats and these particular control measures in more detail. These control measures don't should be assessed freely yet can be considered as an element of, or an expansion of, our overall threat examination (HSE, 2014)[5].

Western Sydney University (2015)[4], had outlined the danger evaluation system in the accompanying manners:

Step 1: Identify Hazards

All potential hazards at work place should be well identified consulting with all involved agencies which may get affected by hazard or may be harmed. Working condition such as Equipment and materials, acts of performer which depends on motivation and ability and Work design and management are the exemplary likely to be hazards.

To distinguish dangers coming up next are suggested:

(I) Past episodes/mishaps are inspected to perceive what occurred and whether the occurrence/mishap could happen again through gatherings or danger register.

(ii) Employees be counseled to discover what they consider are wellbeing issues,

(iii) Work zones or work destinations be investigated or inspected to discover what's going on at this point. Recognized perils ought to be recorded to permit further activity. The workplace, instrument and gear just as errands and strategies ought to be inspected for dangers to WHS.

(iv) Information about gear (for example plant, working directions) and Material Safety Data Sheets be explored to decide pertinent wellbeing precautionary measures.

(v) Welcome imaginative contemplating what could turn out badly happens, for example what risky occasion could occur here?

Step 2: Assess Risks

Evaluating hazard guarantees seriousness of a danger, adequacy of existing control measures, errand to be performed and desperation of undertaking.

A danger evaluation ought to include:

(I) Identify factors that might be adding to the danger,

(ii)Review wellbeing and security data that is sensibly accessible from a definitive source and is pertinent to the specific peril,

(iii)Evaluation of how extreme the mischief could be. This incorporates taking a gander at the kinds of wounds/diseases/hurt/harm that can result from the peril, the quantity of individuals uncovered, conceivable chain impacts from openness to this risk.

(iv)Evaluation of how a peril may cause hurt. This incorporates analyzing how work is finished, regardless of whether existing control measures are set up and whether they control the damage, taking a gander at rare/irregular circumstances just as standard working circumstances. A chain of occasions identified with a danger may should be thought of.

(v)Determining the probability of damage happening. The degree of danger will improve as the probability of mischief and its seriousness increments. The probability of mischief happening might be influenced by how frequently the errand is finished, in what conditions, the number of individuals are presented to the danger and for what term.

(vi) Identify the activities important to dispose of or control the danger; and

(vii)Identify records that it is important to keep to guarantee that the dangers are disposed of or controlled.

(viii)The work premises and the work space, including their format and condition,

(ix)The ability, expertise, experience and period of individuals normally attempted work,

(x) The frameworks of work being utilized; and

(xi) The scope of sensibly predictable conditions.

The way toward evaluating the danger is attempted by auditing any accessible data about the risk (for example enactment, Australian Standards, Industry Code of Practice or direction material about the peril) and by utilizing your own work insight about what sort hurt the risk could make and how likely this is occur. While deciding how likely it is that an individual could be presented to a peril, thought should be given to these "openness factors":

(I) Whether there are some other danger factors that improve the probability of openness?

(ii) How frequently is the individual uncovered (recurrence)?

(iii) Or how long is the individual uncovered (term)?

(iv) what number individuals are uncovered?

(v) The probably portion to which the individual is uncovered?

(vi) Any administrative or suggested openness levels needed by legal specialists.

Step 3: Controlling Risks

On completion of risk rating, Evaluation of Control Effectiveness should be done for identifying additional needs through Table 1.

Table 1; Evaluation of Control Effectiveness Table

Design of control		**Effectiveness of implementation**	
3	Improvement requires	3	Deficient
2	fulfilled	2	Marginal
1	well	1	Effective

Hierarchy of Controls

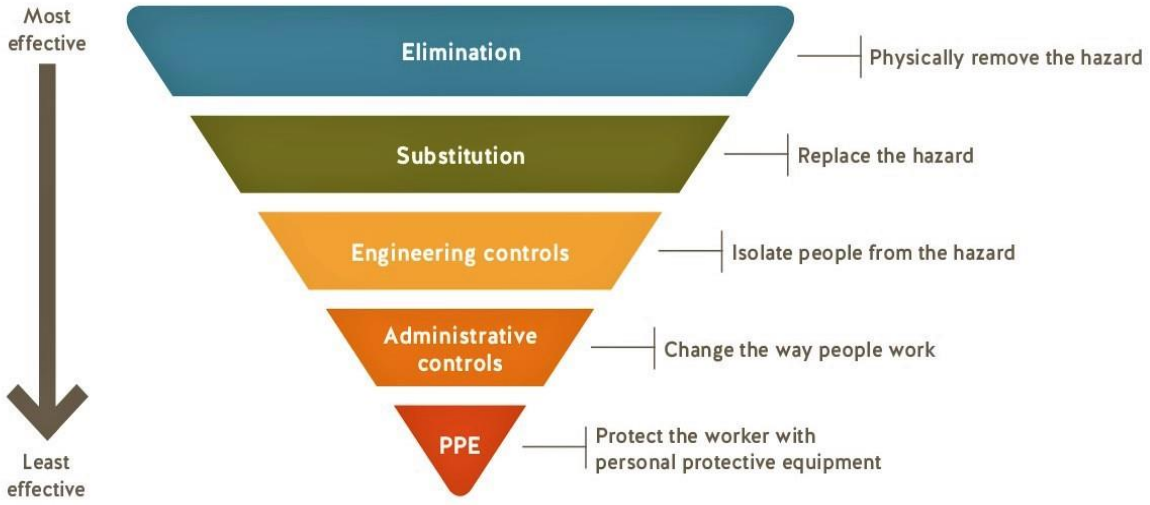

Figure 1 Hierarchy of Control: Source (Work Safe BC cited in Mishra and Sharestha, 2017)[6]

Step 4: Monitor and Review

Monitor and review is the continuous process of analyzing the effectiveness of control mechanism of risk due to hazards. Danger ID, risk examination and control is an on-going cycle. Consequently, reliably review the reasonability of your danger assessment and control measures. Guarantee that you embrace a threat and risk examination when there is a change to the workplace including when work structures, devices, equipment or stuff change. Outfit additional administration when new delegates with diminished fitness levels or data are familiar with the work space. The ampleness of control measures can be checked through customary studies similarly as meeting with workers.

Keeping up records of the threat the main cycle helps when undertaking coming about reviews or peril assessments as it shows dynamic cycles and teaches how controls were relied upon to be completed.

Job Safety Analysis

"Job safety analysis (JSA) results in less labour injuries and sicknesses; more secure, more powerful work techniques; empowering higher profitability yield and decreased labour compensation" – (OSHA, 2002)[7].

JSA aims to help to classify and remedy the most serious safety issues faced during the particular situation. It is a method of screening jobs at beforehand as a method of assessing hazards before accidents or injuries takes place. Identification of association of the labours, jobs, equipments and working conditions and acts. For taking further action to eliminate or accept or transfer risk (OSHA, 2002)[7].

2.9.1 Importance of JSA

To know about all the risks related with each position in an association.

- To forestall business related fatalities, wounds, or sicknesses by annihilating or controlling the danger level of risks recognized.

- To guarantee that all the workers have the correct employment methodology to guarantee their own security.

- To guarantee all the representatives have the correct preparing, gear and supplies to manage their responsibilities securely.

As per Chao and Henshaw (2002)[8], the cycle JSA incorporates following methodology:

1. Identification – picking a specific work or development and isolating it into a course of action of stages, and thereafter, perceiving all possible loss-of-control scenes that may occur during the work.

2. Assessment-evaluating the overall level of risk for all the recognized scenes.

3. Action-controlling the threat by taking sufficient measures to lessen or discard it.

4. RESEARCH METHODOLOGY:

Study Area

The study area of the research was under construction high rise buildings inside Kathmandu with undergoing brickwork, plasterwork, plumbing work, and painting works. Three numbers of high rise building of six or more stories projects had been selected mainly based on accessibility, co-operation and co-ordination as required of research. The responding projects details are as follows in Table 2:

Table 2 Responding Projects under study

SN	Name of Project	Location	Contractor	Consultant	Client	Status
1	Max International Project	Putalisadak, Kathmandu	Synergy Builders Pvt.	Design Cell Pvt. Ltd.	Max International	Finishing works

			Ltd.		Pvt. Ltd.	going on.
2	Hotel Thamel Plaza Project	Thamel, Kathmandu	Himalayn Builders Pvt. Ltd.	Bastu Kalla Pvt. Ltd.	Barahi Housing and Leasing Company	Finishing works going on
3.	Hotel Lhasa International	Lazimpat, Kathmandu	Himalayan Builders Pvt. Ltd.	Design Cell Pvt. Ltd.	Hotel Lhasa International	Finishing works going on

Study Population and Sample Selection

In this research the entire building blocks of projects under study, the workers, clients, consultants, engineers, contractor's supervisors, site engineers, foreman, safety in charge, is the study population and key informants has been selected as per requirement during site visit for information collection on project past progress. Purposive sampling method has been used for the sample selection who were directly involved in selected jobs for the construction of selected high-rise building project under study as shown on Table 3.

Table 3 Tentative Number of Study Population

S.N.	No. of Building Projects	Items of work considered in each project	Project Manager/ Supervisors/ Engineers/ Foreman (Common Key Informants) sample size formula $n_o=z^2pq/e^2$					Total Population
1	3	4	4					3*(12+4) **=48 out of** 3*(24+4)**=84**
			B/W worker	Plaster worker	Plumbing worker	Painting Worker	Total Worker	
			3 out of 6	3 out of 6	3 out of 6	3 out of 6	12 out of 24	

All the projects of the selected high-rise building projects under study are private owner project and are under construction. In this research, samples were taken by purposive method.

N=84
n =67.27/ (1+ (67.24-1)/84) = 37.6
Therefore, minimum sample size had to be taken above 38 as per calculation.
The sample selection has been done by the purposive method. Sample of 48 individuals' respondent as per calculation of sample size and maintaining systematic in sample selection among the client, consultant, contractor, construction supervisor, foreman and skilled workers directly involved in respective jobs under study in selected high-rise building construction project were taken into consideration for primary data collection.

Primary Data Collection

Questionnaire Survey

The questionnaires were distributed to the selected respondent such as consultants, client's representatives, Project Manager, engineers, construction supervisor, foreman and other personnel related with the study. The entire questionnaire was distributed by visiting them on construction site.

Key Informants Interview (KII)

For the cross reference of the data obtained from questionnaire survey, The KII was conducted for the validity and reliability of the questionnaire. Key informant interview (KII)were led with the undertaking director (customer/specialists) of chose building projects. Three specialists were picked for the KII and every one of them had insight of over ten years in the high-rise building construction sector.

Field Observation

Field observation has been considered as one of the very effective data collection technique. Construction job safety management system and techniques applied on construction site, hazard control mechanisms adopted, and assessing risk level has been studied by site visit.

Literature Review

Most of the secondary data has been collected from literature review. The study was reviewed on related published articles. Similarly, secondary data and information were taken from the similar studies conducted in Nepal or in other countries. Secondary data had also been obtained from published reports, newspaper, documents, books and other available information sources.

Data Analysis

The main aim of this study is to assess and analyze the job safety practice being implemented for jobs under study and identify the types of occupational hazards, level of risk, prevention and control mechanism existing in each types of job.
The data collected from both primary source and secondary source will be tabulated and shorted by the help of Microsoft office tools and Microsoft Excel. The collected data were coded, tabulated, classified and necessary statistical values such as mean, medium, etc. will be determined from software program tool and interpretation along with tabular form, chart, graphs and diagrams.

Risk Score

Risk/Danger scoring for various kinds of the current danger related with every one of the perils recognized in chosen elevated structure ventures has been determined by consequences (C) and likelihood (L) as appeared in hazard rating. The rating of results (1-5) for various dangers have been given dependent on the reactions of respondents, reactions from poll overview, perceptions from site visit and past records of medical conditions because of specific risk just as dependent on judgment and forecast that how seriously somebody could be harmed because of that specific peril. Also, the rating of probability (1-5) for various dangers have been given dependent on the reactions from poll overview for and past records of recurrence of event, in view of judgment and expectation that how likely the outcomes are just as KII with specialists for specific peril.

Risk level rating

In the wake of computing the danger scores of various word related perils winning, they have been put in invert sequential request to give the danger level rating. According to establishment stone-of-OHSAS-18001, hazard level of 20-25 is utilized for extraordinary danger/basic danger, hazard level of 12-18 for high danger, 6-10 for moderate danger and danger score 1-5 is utilized for okay

LEVEL OF RISK						
LIKELIHOOD		CONSEQUENCES				
		Minor	Moderate	Major	Severe	Catastrophic
		1	2	3	4	5
Almost Certain	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
Rare	1	1	2	3	4	5

LEGEND		
20-25	EXTREME RISK	Immediate action required. If possible, the activity should be ceased immediately
12-18	HIGH RISK	Notify supervisor and safety and health representative and implement immediate action to minimize injury. remedial action required within two working days
6-10	MODERATE RISK	Implement immediate action to minimize injury e.g. Signs; supervisor remedial action required within five working days
1-5	LOW RISK	Remedial action within one month (if possible), supervisor attention required

Figure 2; Risk assessment matrix (OHSA 18001)[9] as cited in Lama et al [10]

5. RESULTS AND DISCUSSION:

Risk Assessment and Accident

Surface Cause of Accident in High-Rise Building

Table 4 summarizes the response on surface cause of accident in high-rise building by selected job workers and site management team. Fall from scaffold or ladder is mentioned by 67% of brick worker, 78% of plaster worker, 44% of plumbing worker, 22% of painting worker, and 67% of the site management team. Similarly, Lack of guardrail and railing on platform is mentioned by 33% of brick worker, 44% of plaster worker, 11% of plumbing worker, 22% of painting worker, and 8% of the site management team. Similarly, Slip, trip and fall from stairways is mentioned by 22% of brick worker, 11% of plaster worker, 22% of plumbing worker, 22% of painting worker, and 42% of the site management team. Along with these miss handling of solvent/paint/ chemicals were marked by 22% of plumbing worker, 44% of painting worker, and 50% of the site management team. Unguarded opening in floor and roof were marked by 11% of brick worker, none of the plaster worker, 22% of plumbing worker, 22% of painting worker, and 8% of the site management team. Similarly, working in narrow space/voids were mentioned by 33% of plaster worker, 89% of plumbing worker, none of the painting worker, and 25% of the site management team. In addition to it Anchor/ support fail was marked by 67% of painting worker and 50% of the site management team. During observation and discussion, It was revealed that noise and vibration, electrical shock, fall from height and high wind pressure are the major physical hazard. Dust from different sources, different admixtures 'PVC/CPVC solvent, paints and thinner are common chemical hazards. Slippery surface, Materials falling from height, In-adequate tools, In-adequate scaffolding, In-adequate ladder/fall arrester, Narrow space and void are prevailing mechanical hazard. Wrong working position, repetition, lifting of material and prolonged duty hour are observed physiological hazard.

Table 4 Surface cause of accident in high-rise building

Response	Brick Worker		Plaster Worker		Plumbing Worker		Painting Worker		Manager	
	No.	%	No.	%	No.	%	No.	%	No.	%
Fall from scaffold/ ladder	6	67	7	78	4	44	2	22	8	67
Lack of guard and railing on platform	3	33	4	44	1	11	2	22	1	8
Slip, trip and fall from stairways	2	22	1	11	2	22	2	22	5	42
Miss-handling of solvent/ paint/ chemicals	0	0	0	0	2	22	4	44	6	50
Unguarded openings in floor and roof	1	11	0	0	2	22	2	22	1	8
Lack of proper safety netting	2	22	2	22	4	44	0	0	1	8
Working in narrow space/ voids	0	0	3	33	8	89	0	0	3	25
Anchor/ support fail		0		0		0	6	67	6	50
Total	9		9		9		9		12	

The questionnaire survey reveals about the health problem to workers due to physical hazards in different construction jobs at construction site. 56% of the brick workers, 67% of the plaster worker, 33% of plumbing worker, 78% of painting workers, and 33% of site management team mentioned that eye strain was major health problem. Beside that 11% of plaster worker and 22% of plumbing workers mentioned electric shock as another types of health problem. None of the worker or the site management team marked for hearing loss and partially paralyzed as health problem. Similarly, about the health problem to workers due to chemical hazards in different construction jobs at construction site. 11% of the brick workers, 11% of the plaster worker, none of the plumbing worker, 33% of painting workers, and 25% of the site management team mentioned that eye problem was major health issue. Beside that 22% of the plumbing worker and 11% of the painting workers only but none of the site management team mentioned skin as another types of health problem. None of the health problem exists at site due to chemical hazard was marked by 89% of the brick worker, 89% of the plaster worker, 78% of the plumbing worker, 67% of the painting workers, and 75% of site management team.

Root Cause of Accident in High-Rise Building

Table 5 summarizes the response on root cause of accident in high-rise building by selected job workers and site management team. Lack of Skill/ knowledge is mentioned by 22% of brick worker, 33% of plaster worker, 33% of plumbing worker, 33% of painting worker, and 50% of the site management team. Similarly, Lack of proper plan is mentioned by 44% of brick worker, 33% of plaster worker, 22% of plumbing worker, 44% of painting worker, and 17% of the site management team. Similarly, Lack of job safety checklist is mentioned by 33% of brick worker, 22% of plaster worker, 33% of plumbing worker, 33% of painting worker, and 17% of the site management team. Along with this Lack of safety policy were marked only by 33% of plumbing worker, and 22% of painting worker. Lack of training/ orientation were marked by 67% of brick worker, 56% of the plaster worker, 78%% of plumbing worker, 56% of painting worker, and 25% of the site management team. Similarly, violating of discipline were mentioned by 22% of the brick worker, 33% of the plaster worker, 44% of plumbing worker, 44% of the painting worker, and 100% of the site management team.

Table 5 Root cause of accident in high-rise building

Response	Brick Worker		Plaster Worker		Plumbing Worker		Painting Worker		Manager	
	No.	%	No.	%	No.	%	No.	%	No.	%
Lack of skill/knowledge	2	22	3	33	3	33	3	33	6	50
Lack of proper plan	4	44	3	33	2	22	4	44	2	17
Lack of Job safety checklist	3	33	2	22	3	33	3	33	2	17
Lack of safety policy	0	0	0	0	3	33	2	22	0	0
Lack of training/ orientation	6	67	5	56	7	78	5	56	3	25
Discipline	2	22	3	33	4	44	4	44	12	100
Total	9		9		9		9		12	

Most Risky Activities of Selected Construction Job at Site

The figure 3 reveals about the response on riskiest activities during selected construction jobs at construction site. 78% of the brick workers, 67% of the plaster worker, 67% of the plumbing worker, 78% of the painting workers, and 83% of the site management team mentioned that working on scaffolding / platform is high risky activities. Beside that 11% of plaster worker, 33% of the painting workers, and 25% of the site management team mentioned that handling of chemical and paints is also risky activities. In addition, 44% of the brick workers, 44% of the plaster worker, 44% of the plumbing worker, 22%

of the painting workers, and 33% of the site management team mentioned that Lifting/ shifting of materials is also the risky activities. Similarly, 11% of the brick workers, 11% of the plaster worker, and 67% of the site management team mentioned that using of faulty tools is risky. Further, 22% of the brick workers, 44% of the plaster worker, 89% of the plumbing worker, 44% of the painting workers, and none of the site management team mentioned that working in required line and level are risky activities.

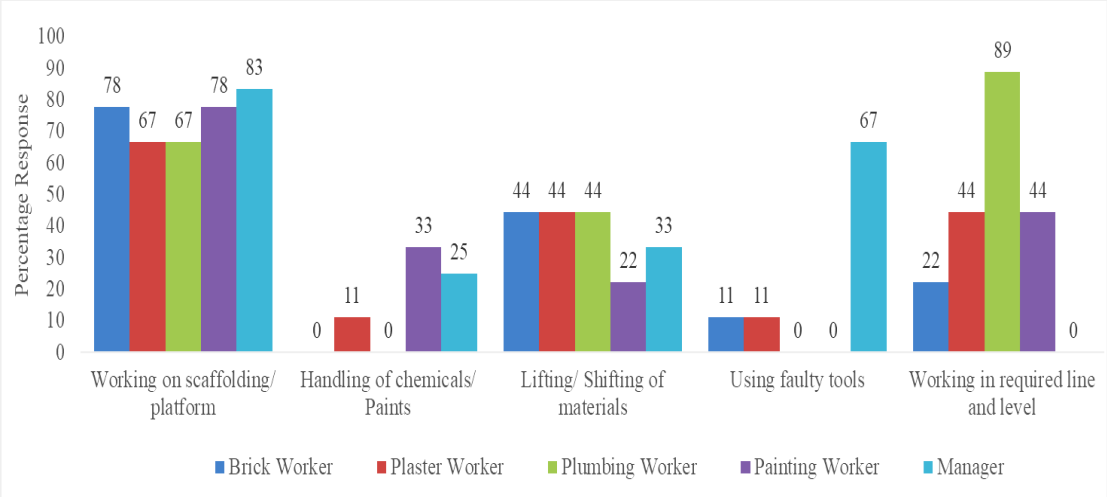

Figure 3: Most risky construction job activities

Most Hazardous Job Regarding Risk of Accident

The response on most hazardous job regarding risk of accident at high-rise building construction site. The result shown here is based on the marked opinions of the site management team for four different jobs under study. As per their response, 58% marked painting works as most risky job whereas brick work marked by 42% is second most risky job. Plaster works marked by 33% is third most risky job and plumbing works marked by only 25% of the site management team was least risky job among the selected jobs under study.

Risk Rating Matrix for Different Four Jobs under Study

Table 6; Risk rating matrix for jobs under study

Risk Score = Consequences (C) x Likelihood (L)					
S.N.	**Hazards in Job**	**Consequences (1-5)**	**Likelihood (1-5)**	**Risk Score**	**Risk level Rating**
1	Brick Work	4.0	4.0	16	High
2	Plaster Work	3.75	3.5	13.13	High
3	Plumbing Work	3.0	3.25	9.75	Moderate
4	Painting Work	4.5	4.0	18.0	High

Risk Rating Matrix in Reverse Chronological order

Table ; 7 Risk rating matrix in reverse chronological order

Risk Score = Consequences(C) X Likelihood (L)					
S.N	**Hazards in Job**	**Consequences (1-5)**	**Likelihood (1-5)**	**Risk Score**	**Risk level Rating**

1	Painting Work	4.5	4.0	18.0	High
2	Brick Work	4.0	4.0	16.0	High
3	Plaster Work	3.75	3.5	13.13	High
4	Plumbing Work	3.0	3.25	9.75	Moderate

Table 6 presents the danger rating grid for various positions under investigation in converse sequential request. Danger score has been determined by duplicating the results by probability. Need of preventive and control measures ought to be offered by the progressive system of danger level for example according to the rating of danger level.

Painting work perils in elevated structure appears to have the most significant level of High degree of danger among occupations under examination. Thus, preventive and control estimates should be applied inside 1-2 days. The undertaking ought not continue except if the danger is surveyed and control alternatives chose dependent on the Hierarchy of Controls. If there should be an occurrence of painting work perils, appropriate inflexible framework, legitimate port focuses for adaptable platform, providing appropriate fall arrester/bridle, legitimate security stepping stools with paint holding stage and blockade should be applied to make painting at significant levels safe. Paint mixing and moving to required tallness ought to be made protected by giving legitimate trainings and hardware required.

Block work and Plaster work are additionally occupation of significant degree of danger as demonstrated in table 4.5 above. Thus, preventive and control estimates should be applied inside 1-2 days. The undertaking ought not continue except if the danger is surveyed and control choices chose dependent on the Hierarchy of Controls. For both of the works control of danger from fall perils and struck by objects mechanical risks ought to be applied by giving legitimate platform, hindrance, all around security netting and appropriate housekeeping.

Plumbing works have the moderate danger level as demonstrated in above table. Along these lines, activity is needed inside seven days to wipe out or limit the danger utilizing the Hierarchy of Controls. Giving legitimate lighting office, appropriate wellbeing netting, satisfactory platform, and more that all appropriate safe working offices ought to be guaranteed in voids and conduits where plumbing works are to be done to guarantee safe workplace.

Risk Rating Matrix for Painting Works in Reverse Chronological order

Table 8; Risk rating matrix in reverse chronological order

Risk Score = Consequences(C) X Likelihood (L)					
S.N	**Job Hazards**	**Consequences (1-5)**	**Likelihood (1-5)**	**Risk Score**	**Risk level Rating**
1	Painting on scaffolding	4.5	4.0	18.0	High
2	Lifting up of painting material	3.5	3.5	12.25	High
3	Storing paint on platform/ scaffolding	3.5	3.25	11.8	Moderate
4	Painting in required pattern	3.5	3.0	10.5	Moderate
5	Using faulty tools	3	3.0	9.0	Moderate
6	Sanding/ scrubbing wall surface for painting	2	4	8.0	Moderate
7	Blending of paints	2	3	6	Moderate

Table 8 presents the risk rating matrix for painting works in reverse chronological order. Risk score has been calculated by multiplying the consequences by likelihood. Priority of preventive and control measures should be given according to the hierarchy of risk level i.e. as per the rating of risk level.

Painting on scaffolding seems to have the highest level of risk among the different steps involved in painting in high-rise building, so the preventive and control measure should be applied within 1-2 days. The task should not proceed unless the risk is accessed and control options selected based on the hierarchy of controls. In case of painting work hazard, proper rigid scaffolding, proper encourage points for flexible scaffolding, supplying proper fall arrestors/harness, proper safety ladders with paint holding platforms and barricades must be applied to make painting at high level safe. Lifting of paint materials is high risk activities in high rise building painting works so preventive and control measures must be applied within 1-2 days. The task must be started after applying proper control options selected based on hierarchy of control.

Storing of paint on platform /scaffolding, painting in required pattern, using faulty tools, sanding/scrubbing wall surface for painting, blending of paints seems to have moderate risk level in descending orders from risk score of 11.375 to 6 respectively. So the action's required for these steps of painting works is required within a week to eliminate or minimize the risk using hierarchy of controls. Proper anchorage for storing paint on platform/scaffolding should be provided so that it cannot slip off or fall down. Painting in required pattern should be made safe by providing proper scaffolding and support points at required level where painter can stand in comfortable postures to carry on their painting works. Tools to be used for painting should be properly checked for its fault regularly and to be operated in proper and safe manner. Sanding/scrubbing of wall paint surface should be done using proper mask, globes and PPE required. Blending of paints should be done over level rigid surface in proper manner.

Risk Rating Matrix for Brick Works in Reverse Chronological order

Table 9; Risk rating matrix in reverse chronological order

Risk Score = Consequences(C) X Likelihood (L)					
S.N	**Job Hazards**	**Consequences (1-5)**	**Likelihood (1-5)**	**Risk Score**	**Risk level Rating**
1	Working on scaffolding	4.0	4.0	16.0	High
2	Lifting up of construction material	3.5	4.0	14.0	High
3	Storing materials over platform of scaffolding	3.5	3.75	13.13	High
4	Cutting/ breaking/ drilling	3.0	3.75	11.25	Moderate
5	Using faulty tools	4	2.25	9	Moderate
6	Brick laying in line	2.3	3	6.9	Moderate

Table 9 presents the risk rating matrix for brick works in reverse chronological order. Risk score has been calculated by multiplying the consequences by likelihood. Priority of preventive and control measures should be given according to the hierarchy of risk level i.e. as per the rating of risk level.

Among the different activities involved in brick works, working on scaffolding seems to have the highest level of risk so the preventive and control measure should be applied within 1-2 days. The task should not proceed unless the risk is accessed and control options selected based on the Hierarchy of Controls. In case of brick work hazard, proper rigid scaffolding having styles and verticals rigidly connected by proper clamps in proper spacing/intervals should be provide, platform over the scaffoldings should be confirmed for their rigidness and capacity to withstand the materials and workers load, proper guard rails and barricades should be applied on working areas of scaffoldings to ensure no fall hazards to workers. Lifting up of brick work materials, storing materials over platforms of scaffolding also seems to have high risk in high rise building brick works so preventive and control measures must be applied within 1-2 days. The task must be started after applying proper control options selected based on Hierarchy of Control.

Cutting/ Breaking/ Drilling jobs, using faulty tools, brick laying in line seems to have moderate risk level in descending orders from risk score of 11.25 to 6.9 respectively. So the action required for these activities of brick works is required within a week to eliminate or minimize the risk using Hierarchy of Controls. Cutting/breaking/drilling works required for brick work should be made safe by providing proper tools, mask, gloves and other PPE required. Also the scaffolding and platforms should be provided at proper areas and height to avoid fall hazard and other hazard risks involved. Tools to be used for brick works should be properly checked for its fault regularly and to be operated in proper and safe manner.

Risk Rating Matrix for Plaster works in Reverse Chronological order

Table 10; Risk rating matrix in reverse chronological order

Risk Score = Consequences(C) X Likelihood (L)					
S.N	**Job Hazards**	**Consequences (1-5)**	**Likelihood (1-5)**	**Risk Score**	**Risk level Rating**
1	Plastering on scaffolding	3.75	3.5	13.125	High
2	Lifting up of construction material	3.5	3.5	12.25	High
3	Plastering in required line and level	3.5	3.0	10.5	Moderate
4	Storing mortar over platform	3.25	3.0	9.75	Moderate
5	Cutting/ breaking/ drilling	3.0	3.0	9.0	Moderate
6	Using faulty tools	4.0	2.0	8.0	Moderate

Table 10; presents the risk rating matrix for different jobs under study in reverse chronological order. Risk score has been calculated by multiplying the consequences by likelihood. Priority of preventive and control measures should be given according to the hierarchy of risk level i.e. as per the rating of risk level.

Among the different activities involved in plastering works plastering on scaffolding seems to have the highest level of risk so the preventive and control measure should be applied within 1-2 days. The task should not proceed unless the risk is accessed and control options selected based on the Hierarchy of Controls. In case of plastering work hazard, proper rigid scaffolding having styles and verticals rigidly connected by proper clamps in proper spacing's/intervals should be provided, platform over the scaffoldings should be confirmed for their rigidness and capacity to withstand the materials and workers load, proper guard rails and barricades should be applied on working areas of scaffoldings to ensure no fall hazards to workers. Lifting up of plastering materials also seems to have high risk in high rise building plastering works so preventive and control measures must be applied within 1-2 days. The task must be started after applying proper control options selected based on Hierarchy of Control.

Plastering in required line and label, storing mortar over platform, cutting/ breaking/ drilling jobs, using faulty tools, seems to have moderate risk level in descending orders from risk score of 10.5 to 8.0 respectively. So the action's required for these steps of plastering works is required within a week to eliminate or minimize the risk using hierarchy of controls. Plastering in required line and label should be made comfortable by providing proper scaffolding and support platforms at required level where plaster masons can stand in comfortable postures to carry on their plastering works. Cutting/breaking/drilling works required for plastering work should be made safe by providing proper tools, mask, gloves and other PPE required. Also the scaffolding and platforms should be provided at proper areas and height to avoid fall hazard and other hazard risks involved. Tools to be used for plastering works should be properly checked for its fault regularly and to be operated in proper and safe manner.

Risk Rating Matrix for Plumbing Works in Reverse Chronological order

Table 11; Risk rating matrix in reverse chronological order

Risk Score = Consequences(C) X Likelihood (L)					
S.N	**Job Hazards**	**Consequences (1-5)**	**Likelihood (1-5)**	**Risk Score**	**Risk level Rating**

1	Narrow working space/ voids	3.0	3.25	9.75	Moderate
2	Working on scaffolding	2.75	3	8.25	Moderate
3	Cutting/ breaking/ drilling walls for pipe laying	3	2.5	7.5	Moderate
4	Cutting/Welding/ jointing of pipes and fittings	3	2.25	6.75	Moderate
5	Using faulty tools	2.5	2.5	6.25	Moderate
6	Lifting up of plumbing materials	2	2.5	5	Low

Table 11 presents the risk rating matrix for plumbing works in reverse chronological order. Risk score has been calculated by multiplying the consequences by likelihood. Priority of preventive and control measures should be given according to the hierarchy of risk level i.e. as per the rating of risk level.

Working in narrow working space/voids among the different activities involved in plumbing works, seems to have higher degree of moderate risk level so preventive and control measures must be applied within a week to eliminate or minimize the risk using Hierarchy of Controls. Providing wider ducts/voids in building design, providing proper lighting facilities in duct/voids, proper barricading and safety netting, adequate scaffoldings and platform required for working in voids etc. should be provided to ensure safe working environment for ducts. Working on scaffolding, cutting/breaking/drilling walls for pipe laying, cutting/wielding/jointing of pipes and fittings, using faulty tools also seems to have moderate level of risk in descending orders from risk score of 8.25 to 6.25 respectively among the steps involved in plumbing works. So the action's required for these steps of plumbing works is also required within a week to eliminate or minimize the risk using hierarchy of controls. Working on scaffolding for plumbing should be carried on proper rigid scaffolding, mobile scaffolding with lockable wheels and platform over the scaffoldings should be confirmed for their rigidness and capacity to withstand the materials and workers load. Cutting/breaking/drilling works required for plumbing work should be made safe by providing proper tools, mask, gloves and other PPE required. Also the scaffolding and level platforms should be provided at proper areas and height to avoid fall hazard and other hazard risks involved. Tools to be used for plumbing works should be properly checked for its fault regularly and to be operated in proper and safe manner. Lifting up of plumbing materials seems to have low risk level having risk score of 5 but it should also be taken in care for its control.

Only 33% of the site management team marked that they have practice of risk assessment at construction site. This indicates that the practice of assessing working condition and associated risk before allowing worker to work for any job is in poor status of implementation which is must in high-rise building for ensuring proper safe work environment.

The response on preventative measures used by site management team of different high-rise building projects under study. As per their response, 67% considers using proper sign and signals as most effective prevention measures whereas 58% of manager considers training, 42% considers safety meeting, 33% considers proper housekeeping, 25% considers Job rotation practice, and only 25% of the site management team considers job safety plan/policy as effective prevention measure for accident prevention tools. Works as most risky job whereas brick work marked by 42% is second most risky job. This clearly shows that most of the site management team for high-rise building projects are not well familiar with the significance of proper job safety policy/plan for prevention of accident and its contribution in job safety. This should must be considered for improvement.

Regarding installation of safety net around the building 73% of the average worker and 75% of the site management team responded that they have provided it at site.

Control Measures Used for Accident Control

The response on accident control measures used by site management team of different high-rise building projects under study. As per their response, 100% considers using proper PPE as most effective control measures whereas 83% of manager considers Engineering control as effective control tool. Likewise, 42% considers Administrative control, 8% considers Elimination, and only 8% considers Substitution as effective accident control tool. Practice and only 25% of the site management team considers job safety plan/policy as effective prevention measure for accident prevention tools. Works as most risky job whereas brick work marked by 42% is second most risky job. This trend of adopting accident control measure in reverse to the principal of hazard control shows that the trend of adopting control measures by site management team of high-rise building need to be re-thought.

The response on Act/Regulation which could best address the safety of the worker at high-rise building construction site. 14% of workers on average and 8% of site management team marked that new Labor Act 2074 should be followed. Likewise,

6% of workers on average and 17% of site management team marked that new NBC 114:1994 should be followed. Beside these major proportion i.e. 81% of workers on average and 75% of site management team marked that Safety Provision in Contract should be sufficient enough and must followed for best addressing safety issue of worker at site. For better and effective implementation of proper safety and health condition, safety provision in contract document should be strongly highlighted and facilitated with separate safety budget.

The response on arrangement for proper First Aid facilities at high-rise building construction site. 44% of workers on average and 83% of site management team marked that they do have proper first aid facilities at site whereas 56% of workers on average and 17% of site management team responded that they have certain basic first aid facilities at site but they are not proper and enough. Accident can never be forecasted nor completely avoided, in such risky jobs of high-rise building construction, thus proper and enough first aid facilities much be made available at site.

Activities Currently to be Undertaken for Job Safety at Site

The figure 4 reveals about activities currently to be undertaken for job safety at high-rise building construction site. 33% of the brick workers, 33% of the plaster worker, 33% of the plumbing worker, 44% of the painting workers, and 42% of the site management team mentioned that providing sufficient safety equipment's is essential. Beside that 44% of the brick workers, 44% of the plaster worker, 67% of the plumbing worker, 44% of the painting workers, and 25% of the site management team mentioned that appointing separate safety supervisor would be more significant. In addition, 33% of the brick workers, 56% of the plaster worker, 56% of the plumbing worker, 56% of the painting workers, and 50% of the site management team mentioned that providing more safety trainings would be effective. Similarly, 22% of the brick workers, 33% of the plaster worker, 22% of the plumbing worker, 44% of the painting workers and 42% of the site management team mentioned that adopting proper job safety plan could be effective. Replacement of faulty equipment were marked by 33% of the brick workers, 22% of the plaster worker, 11% of the plumbing worker, 33% of the painting workers, and 33% of the site management team.

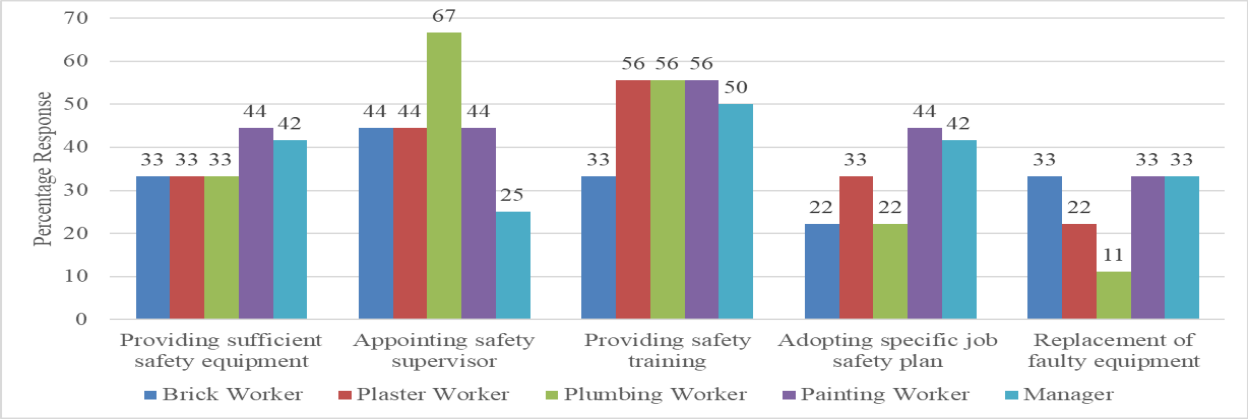

Figure 4: Activities currently to be undertaken for job safety at site

7. CONCLUSION

The study concluded that noise and vibration were the major physical hazards for all the jobs. Dust from cement, sand, admixtures, sanding of painted surface, cutting/drilling of walls/RCC structures, etc. were major chemical hazards for all the jobs but chemical from paints/thinner for painter and PVC/CPVC solvent cement (pipe joint bonding agent) were additional major chemical hazards at site. Material falling from height, falling from in-adequate scaffolding, and narrow working space/voids we identified as major mechanical hazards at site. Wrong working position and lifting of materials were found as major physiological hazards for brickwork, plaster, and painting works whereas for plumbing it was identified as repetition of wall surface cutting for pipe laying.

Regarding safety practice prevailing at construction site, 31% of workers on average and 58% of site management team responded that there was presence of safety officer to supervise the safe working practice and condition. The practice to must comply the safety rules before and during progress of different job were marked "yes" by 31% of average workers and 50% of site management team. Regarding different types of safety training being provided to workers at site, Induction and safety briefing marked by 83% and 31% of average workers whereas 100% and 67% of manager respectively was found common. Practice to provide proper safety sign, signal and safety notice at site was accepted only by 31% of average workers only although 67% of site management team responded for its availability. 75% of the site management team responded that they

have documented job safety plan in the project site. Regarding provision of providing required numbers of adequate PPE, 67% of brick workers, 56% of plaster worker, 67% of plumbing workers, 56% of painting workers and 83% of site management team only responded as yes. Rest responded that although there was practice of providing PPE, but the so provided PEE were either insufficient or in-appropriate.

Risk level of Painting works was revealed as the highest among all four types of job under study and fall under "High" risk level rating. Brick works and plaster works was found to have the score of 16 and 13.125 respectively as highest risk and both having risk rating level of "High". Plumbing works have been found to have the risk score of 9.75 and having risk rating level of "Moderate". Risk level of activity, working on scaffolding has been revealed as the highest for painting works, brick works, and plaster works with activity risk score of 18.0, 16.0, and 13.125 respectively having risk rating level of "High" but for plumbing works it was "moderate risk level with risk score of 8.25. The riskiest activity for plumbing work has been revealed as Working in narrow space/ voids with risk score of 9.75 having risk rating level of "Moderate". Lifting up of construction materials to working platform has been revealed as another common activity for painting works, brick works, and plaster works with respective risk score of 12.25, 14.0, 12.25 having risk level rating of "High". Storing materials over platform of scaffolding has been revealed as the another common activity with respective risk score and risk level 11.375 "Moderate" for painting works, 13.125 "High" for brick work, and 9.75 "Moderate" for plaster works. Painting in required pattern, use of faulty tools, sanding/ scrubbing wall surface for painting, blending of paints were another activities in painting works with "Moderate" risk level rating and respective risk score of 10.5, 9.0, 8.0, and 6.0. For brick work in high-rise building, cutting/ breaking/ drilling, using faulty tools, and brick laying in line were the another activity in with "Moderate" risk level rating and respective risk score of 11.25, 9.0, and 6.9. For plaster work in high-rise building, plastering in required line and level, cutting/ breaking/ drilling, using faulty tools, were the another activity with "Moderate" risk level rating and respective risk score of 10.50, 9.0, and 8.0. For plumbing work in high-rise building, cutting/ breaking/ drilling walls for pipe laying, using faulty tools, were the another activity with "Moderate" risk level rating and respective risk score of 6.75, and 6.25. For plumbing works lifting up of plumbing materials has been revealed as the activity with "Low" risk level rating having risk score of 5.0.

Sign and signal along with proper safety training being responded 67% and 58 % respectively were major preventive measures used for accident control at construction site. Site management team responding 100% for use of PPE as major control measure adopted for controlling risk of accident also responded 83% for engineering control as another major control mechanism. 44% of workers on average and 83% of site management team responded that there was proper arrangement of first aid facilities at construction site. Presence of Emergency plan/ Rescue plan for emergency condition was responded by 42% of workers on average and 83% of site management. Until June 2019 only few minor accidents with minor injuries and no major or fatal injuries were recorded at all the high-rise construction site under study. Regarding the activities need to be undertaken currently for better job safety at high-rise building construction site, 56% of plaster worker, 56% of painting worker, and 50% of site management team responded for providing safety training as major activities where as 44% of brick worker and 67% of plumbing worker responded for appointing separate safety supervisor as major activities needed.

Regarding safety regulation, 81% of workers on average and 75% of the site management team at high-rise building construction site believes that providing safety provision in contract document could be best choice.

8. RECOMMENDATIONS:

Commitments of a sincere and coordinated effort among all the stakeholders of development sector are needed to maintain a safe and healthy work environment at site. Workers should be empowered to demand for improvement of working conditions and they must be provided education and training on OHS.

- Job safety analysis and identification of activity with high risk level involved should be determined so that proper prevention and control mechanism could be determined and implemented.
- Management should review job safety plan in the interval of fixed time for improvement and conduct safety training to workers frequently to reduce rate of near miss and mishap accidents at construction site
- Dust exposure at construction site should be reduced and wearing of mask should be enforced to reduce health problem due to dust hazard.
- Management should provide suitable, proper and sufficient PPEs to the workers and maintain safe workplace by developing effective safety inspection mechanisms at site.

- Management should develop the system of formulating and implement the practice to comply safety rules for every works having potential hazards with higher risk.

- First aid facilities like first aid box, stretchers, required types of medicines, and well trained first aid expert should be available at construction site.

- Safety Engineer/Officer should be appointed at site and empowered to monitor all temporary structures such as scaffolding, ladder, use of PPE, mobile scaffolding, cradle, hoist, etc.

- Management should establish a site safety system providing adequate safety sign and signal, safety nets, guardrails and barriers in hazardous area.

- Management should develop emergency plan and rescue plan and must display the emergency contact number for emergency condition.

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