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Study on Construction Safety in Building Construction Projects of Bharatpur Metropolitan City

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Abstract
Safety in construction industry is a challenging job. The construction industry in Nepal is mounting in a rapid pace and attaining construction safety becomes difficult. Thus, the objective of this thesis research is to study the construction safety in building construction project, to identify and rank the risk level of safety hazards and also to assess the ways to improve safety practices. A field observation at seven under construction sites in Bharatpur Metropolitan City was carried out to study the safety. A checklist survey was done to collect the data regarding the use of PPE as safety practice which showed that the construction safety practice was poor in the observed sites. The likelihood and consequences of risks were identified from a questionnaire survey and risk level rating was assigned to the risks identified. The highest rated risk was found to be falling from height. To develop the improvement measures a questionnaire survey is again conducted to rank the measures that could improve the construction safety status. The appropriate measures that could improve the construction safety were found to be safety brief before start of work each day on work site, regular training and awareness related to construction safety to workers and compulsory use of PPE on construction site.

Keywords
Construction safety, Safety issues, Safety practices, Safety improvements

1. Introduction

The construction industry is a rapidly growing industry in Nepal. In construction industry, safety is very essential. The construction industry stands as one of the unsafe industries. The primary goal in construction industry is to prevent the injuries and attain the construction safety. Regardless of this, construction site safety is usually ignored. Lack of skillful working atmosphere, effective safety management, and the nature of the construction and stakeholders in working sites leads to safety issues[1]. For a long time, the construction industry has progressively been among those industries where the maximum injury and casualty rates prevail. It is predictable that more than ten million workers get injured as a result of safety issues per year throughout the world. In comparison to another industrial sector, which averages 60-80 accidents per 1000 workers, the construction sector averages 160-250 accidents per 1000 workers which shows that the construction industry is susceptible [2].

In Nepal, the concept of safety in construction is still a new topic. In number, 28,386 people dies and lots of people face construction injury yearly in the Nepalese construction industry [1]. Thus, in comparison to other nation the construction accidents are more severe in Nepal [3]. The Nepalese construction industry rarely practices machinery construction and are more labour-oriented. Also, the concerned contractors lack proper safety plan and they do not care the constitutional provisions regarding safety rules. Knowing that, most of the national economy is contributed by the construction industries and is the pillar of national prosperity, but the government and concerned bodies has no strict rules to attain the safety in construction and reduce the unpredictable hazards [4].

2. Research Objective

The objective of the study was to assess the safety practices in the building construction project and to identify and rank the risk level of existing safety hazards in the building construction projects. Also, the study was aimed to develop the improvement measures to the consequences due to lack of safety practices in the building construction project.

3. Research Methodology

The descriptive research study was carried out which used both quantitative and qualitative method to identify the criteria and evaluate those criteria in decision making. Direct field investigation of seven under construction building permitted by Bharatpur Metropolitan City was done. In order to know the perception of the different stakeholders of the project regarding the likelihood of occurrence of various construction risk, a questionnaire survey was conducted and after that, their risk level was identified. This stage is important to find out how key participants perceive various construction safety risks. The aim of questionnaire was to know the profile of respondents in terms of their age, level of participation in construction, their gender, employment status, level of education, construction-related qualifications and experience, exposure to injury and illness, exposure to construction safety training and information. Questions were prepared in Likert scale to answer the research objectives. The questionnaire will have a 5-point Likert scale, namely Never = 1; Seldom = 2; Sometimes = 3, Often = 4; and Always = 5. The data obtained was analyzed using MS Excel. This data helped to analyze the safety practices in the selected building construction sites in Bharatpur Metropolitan City. The risk level rating of various risk identified was carried out

comparing their relative importance index. Risk is the likelihood

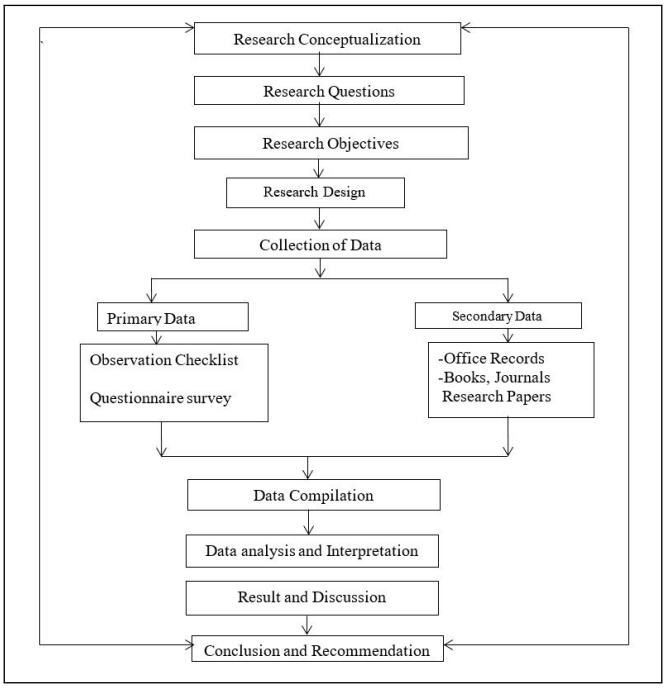


Figure 1: Flowchart of the methodology

of harm occurring and the severity of that harm. Risk scoring for different types of the existing risk associated with each of the hazards identified in selected building projects was calculated by multiplying consequences (C) and likelihood (L) as shown in risk rating matrix. The rating of consequences (1-5) for different hazards was provided based on the responses of respondents, responses from questionnaire survey. Similarly, the rating of likelihood (1-5) for different hazards was also provided based on the responses from questionnaire survey. After calculating the risk scores of different occupational hazards prevailing, they will be placed in reverse chronological order to provide the risk level rating. As per foundation-stone-of-OHSAS-18001:2007, risk level of 20-25 is used for extreme risk/critical risk, risk level of 12-18 for high risk, 6-10 for moderate risk and risk score 1-5 is used for low risk.

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 (OHSAS 18001:2007)

4. Literature Reviews

4.1 Nature of Construction Industry

The construction industry is unique industry. The output differs to one other in terms of form, size, requirement, material, locations, construction technique, quality, durability, appearance etc. Buildings vary from each other, even when they are built to identical plans and specifications. The working environment in construction varies with location and the environment varies even at the same location in response to the ongoing activity and weather as well. Site conditions clearly vary between excavation works, erection works, and demolition works and so on. In addition, it is different working on rainy day, windy day and sunny day. This changing working environment exposes the construction sites to various possible hazards. Safety personnel hence need to be well aware about all this situations and train workers to familiarize themselves with these continuously changing scenarios.

4.2 Safety Issues in Construction Projects

Safety is the state of being safe from any undesired impacts. It is the right of workers in any occupation. In safety management, it encompasses the productivity, the cost of managing each, and coordinating policies and operations with industry standards and practices as well as with national and international regulations. Safety addresses the safety of workers, damage of property and delay.

4.3 Construction Safety in Developing Countries like Nepal

The construction in developing countries like Nepal are more leaned towards labour intensive in comparison to the developed countries. Thus there is more likelihood of construction risks to occur. Some of the common injuries faced in the construction sites are as follows [5]:

i. Fall injuries
ii. Struck by wastage and raw materials
iii. Heat stroke
iv. Head injuries
v. Eye injuries
vi. Burning cases

5. Study Area

Chitwan District is one of 77 districts of Nepal, and is located in the southwestern part of Province No. 3. Bharatpur is the district headquarter of the Chitwan District, as well as a separate Metropolitan authority, and is the fifth largest city of Nepal with the population of 199,867 [6]. Bharatpur is one of the fast-growing cities of Nepal. Bharatpur is the city of migrants where lots of infrastructure projects are ongoing. This makes the city a potential study area to observe the construction activities at the present. In Bharatpur metropolitan city, there are many construction sites. Uncompleted projects will create a good opportunity to observe safety practices before they transfer the project and leave the site. Also, the construction rate is progressively increasing in Bharatpur Metropolitan city with the

average rate of 1172 houses annually (Bharatpur Metropolitan City). This makes the study more essential in Bharatpur to assess the safety practices with the scope of future trend of increasing construction.

6. Relative Importance Index

Questionnaire are designed in the Likert scale. The Relative Importance Index (RII) is very important tool for the determination of the significance of factors by ranking the variables.

(Adnam et al., 2007) defines the way to compute RII as

$$RII = \frac{\sum W}{AN} \quad (1)$$

Where, W is the weightage given to each factor ranging from 1 to 5,

A is the highest weightage and,

N is the total number of respondents.

$$RII = \frac{5\times n_5+4\times n_4+3\times n_3+2\times n_2+1\times n_1}{5(n_5+n_4+n_3+n_2+n_1)} \quad (2)$$

where,

Symbol	Importance
n_1	very low important
n_2	low important
n_3	meduim
n_4	high important
n_5	very high important

7. Study Population

Workers are the main respondent for this study. The study focused on the risks faced by workers during construction and was considered for the study. Regarding other administrative parts, the related clients/consultants/contractors were considered for the study. Data collected from the observation and questionnaires was quantitative data. To provide the information, the data were processed, analyzed and interpreted using statistical tools.

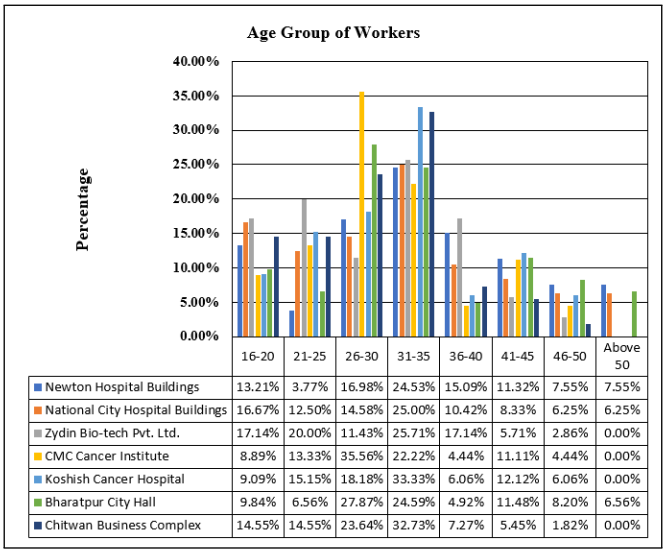
Table 1: Study Population

Name of Site	Population			
	Client representatives	Consultant representatives	Contractor representatives	Workers
Newton Hospital Buildings	2	2	3	53
National City Hospital Buildings	3	2	2	48
Zydin Bio-tech Pvt. Ltd.	3	2	2	35
CMC Cancer Institute	3	2	2	45
Koshish Cancer Hospital	3	2	2	33
Bharatpur City Hall	3	2	2	61
Chitwan Business Complex	3	2	2	55

8. Finding and Discussion

8.1 Demographic Characteristics

The age distribution of workers as obtained from questionnaire survey is as shown in the figure-2: It is seen that the age group of

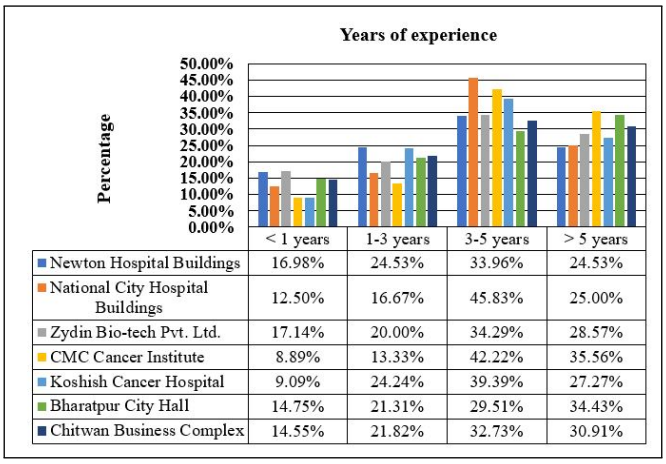


	16-20	21-25	26-30	31-35	36-40	41-45	46-50	Above 50
Newton Hospital Buildings	13.21%	3.77%	16.98%	24.53%	15.09%	11.32%	7.55%	7.55%
National City Hospital Buildings	16.67%	12.50%	14.58%	25.00%	10.42%	8.33%	6.25%	6.25%
Zydin Bio-tech Pvt. Ltd.	17.14%	20.00%	11.43%	25.71%	17.14%	5.71%	2.86%	0.00%
CMC Cancer Institute	8.89%	13.33%	35.56%	22.22%	4.44%	11.11%	4.44%	0.00%
Koshish Cancer Hospital	9.09%	15.15%	18.18%	33.33%	6.06%	12.12%	6.06%	0.00%
Bharatpur City Hall	9.84%	6.56%	27.87%	24.59%	4.92%	11.48%	8.20%	6.56%
Chitwan Business Complex	14.55%	14.55%	23.64%	32.73%	7.27%	5.45%	1.82%	0.00%

Figure 3: Age Distribution of Workers

31-35 years have greater participation in overall sites. Whereas, 26-30 age group from CMC Cancer Institute was the highest among all with percentage of 35.56

The experience of the workers is as shown in figure-3: It was

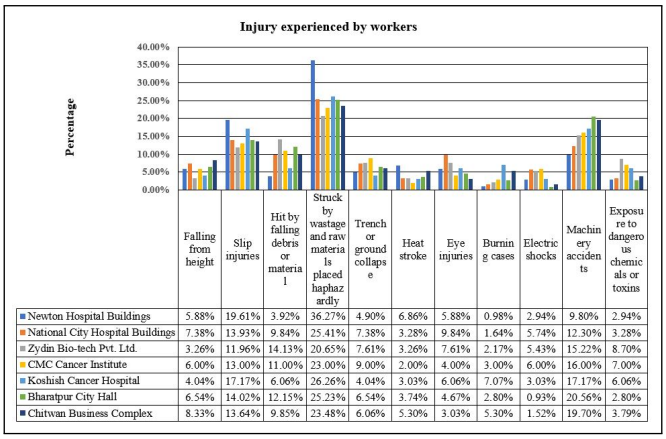


	< 1 years	1-3 years	3-5 years	> 5 years
Newton Hospital Buildings	16.98%	24.53%	33.96%	24.53%
National City Hospital Buildings	12.50%	16.67%	45.83%	25.00%
Zydin Bio-tech Pvt. Ltd.	17.14%	20.00%	34.29%	28.57%
CMC Cancer Institute	8.89%	13.33%	42.22%	35.56%
Koshish Cancer Hospital	9.09%	24.24%	39.39%	27.27%
Bharatpur City Hall	14.75%	21.31%	29.51%	34.43%
Chitwan Business Complex	14.55%	21.82%	32.73%	30.91%

Figure 4: Work experience of workers

found that the work experience of the labours form 3-5 years is maximum in overall sites.

The workers were asked about injuries they have faced. The result showed that “Struck by wastage and raw materials placed haphazardly” was the most faced injury with 36.27% of workers from Newton hospital, 25.41% from National City hospital, 20.65% from Zydin Bio-tech Pvt. Ltd., 23.00% from CMC cancer institute, 26.26% from Koshish cancer hospital, 25.23% from Bharatpur city hall and 23.48% from Chitwan business complex facing the particular hazard. Other details have been presented in Figure-4: Regarding if, the workers had ever received any kind of training related to construction safety, it



	Falling from height	Slip injuries	Hit by falling debris or material	Struck by wastage and raw materials placed haphazardly	Trench or ground collapse	Heat stroke	Eye injuries	Burning cases	Electric shocks	Machinery accidents	Exposure to dangerous chemicals or toxins
Newton Hospital Buildings	5.88%	19.61%	3.92%	36.27%	4.90%	6.86%	5.88%	0.98%	2.94%	9.80%	2.94%
National City Hospital Buildings	7.38%	13.93%	9.84%	25.41%	7.38%	3.28%	9.84%	1.64%	5.74%	12.30%	3.28%
Zydin Bio-tech Pvt. Ltd.	3.26%	11.96%	14.13%	20.65%	7.61%	3.26%	7.61%	2.17%	5.43%	15.22%	8.70%
CMC Cancer Institute	6.00%	13.00%	11.00%	23.00%	9.00%	2.00%	4.00%	3.00%	6.00%	16.00%	7.00%
Koshish Cancer Hospital	4.04%	17.17%	6.06%	26.26%	4.04%	3.03%	6.06%	7.07%	3.03%	17.17%	6.06%
Bharatpur City Hall	6.54%	14.02%	12.15%	25.23%	6.54%	3.74%	4.67%	2.80%	0.93%	20.56%	2.80%
Chitwan Business Complex	8.33%	13.64%	9.85%	23.48%	6.06%	5.30%	3.03%	5.30%	1.52%	19.70%	3.79%

Figure 5: Injury experienced by workers

was observed that only 16.15% in overall have received any form of training with 83.85% workers not receiving any form of safety related training as shown in Figure-5. To study about the

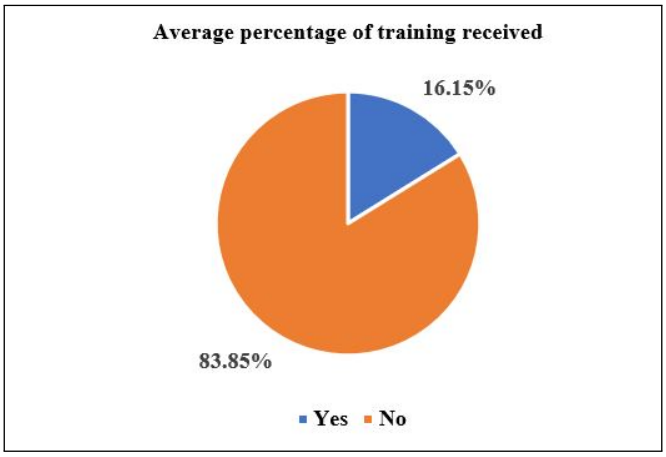
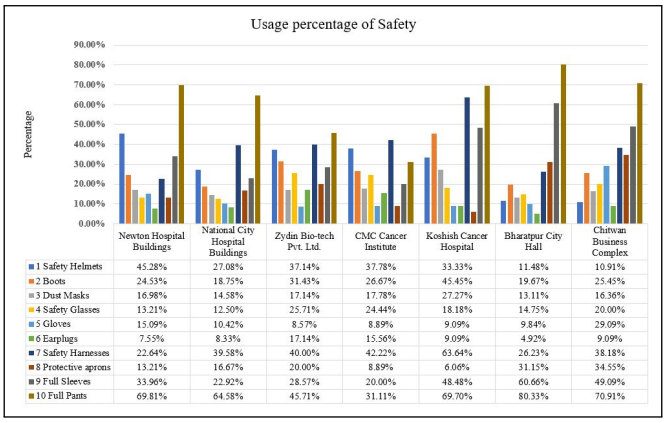


Figure 6: Training received by workers

use of safety tools, a checklist was prepared based on existing literatures and then following the same checklist, a checklist survey was carried out at the individual selected sites. Data was entered in the checklist by direct observation [7]. The observation was carried out on workers only. The observation was made on several dates by direct site visit on individual sites and the observation was put together and converted to numerical frequency as tabulated below in Figure-6. The Figure 6 shows the percentage of use of safety tools in individual sites which indicates that 43.64% by workers in Newton hospital building site, 27.08% in National City hospital building site, 37.14% in Zydin Bio-tech Pvt. Ltd. building site, 37.78% in CMC Cancer Institute building site, 33.33% in Koshish Cancer Hospital, 11.48% in Bharatpur City Hall, 10.91% in Chitwan Business Complex were seen wearing safety helmets. Similarly, the use of boots with 23.64% in Newton hospital building site, 18.75% in National City hospital building site, 31.43% in Zydin Bio-tech Pvt. Ltd. building site, 26.67% in CMC Cancer Institute building site, 45.45% in Koshish Cancer Hospital, 19.67% in Bharatpur City Hall, 25.45% in Chitwan Business Complex and so on as shown in Figure 6.



	Newton Hospital Buildings	National City Hospital Buildings	Zydin Bio-tech Pvt. Ltd.	CMC Cancer Institute	Koshish Cancer Hospital	Bharatpur City Hall	Chitwan Business Complex
1 Safety Helmets	45.28%	27.08%	37.14%	37.78%	33.33%	11.48%	10.91%
2 Boots	24.53%	18.75%	31.43%	26.67%	45.45%	19.67%	25.45%
3 Dust Masks	16.98%	14.58%	17.14%	17.78%	27.27%	13.11%	16.36%
4 Safety Glasses	13.21%	12.50%	25.71%	24.44%	18.18%	14.75%	20.00%
5 Gloves	15.09%	10.42%	8.57%	8.89%	9.09%	9.84%	29.09%
6 Earplugs	7.55%	8.33%	17.14%	15.56%	9.09%	4.92%	9.09%
7 Safety Harnesses	22.64%	39.58%	40.00%	42.22%	63.64%	26.23%	38.18%
8 Protective aprons	13.21%	16.67%	20.00%	8.89%	6.06%	31.15%	34.55%
9 Full Sleeves	33.96%	22.92%	28.57%	20.00%	48.48%	60.66%	49.09%
10 Full Pants	69.81%	64.58%	45.71%	31.11%	69.70%	80.33%	70.91%

Figure 7: Usage percentage of safety

8.2 Injuries- Likelihood of Occurrence and consequences

Eleven different injuries in building construction were identified from literature review. The workers were asked to respond to each injury regarding their possibility of occurrence and the consequences that those injuries bring upon. The ranking is as below in Table 2:

Table 2: Ranking of Injuries based on Likelihood and Consequences

Injuries	Likelihood RII	Consequences RII
Falling from height	0.807	0.923
Slip injuries	0.779	0.388
Hit by falling debris or material	0.699	0.856
Struck by wastage and raw materials placed haphazardly	0.864	0.421
Trench or ground collapse	0.695	0.348
Heat stroke	0.599	0.367
Eye injuries	0.688	0.718
Burning cases	0.332	0.722
Electric shocks	0.534	0.912
Machinery accidents	0.825	0.586
Exposure to dangerous chemicals or toxins	0.449	0.594

8.3 Risk Score and Risk Level Rating

For all the injuries identified, the risk score of 1-5 was assigned based on number of respondents. For example: “Falling from height” was assigned 5 risk score in terms of likelihood as 155 respondents considered so which is the biggest number in that particular risk rating. And, the same risk for consequences was assigned as 5 as 240 respondents were considered which is the biggest number in that particular risk rating. The detailed risk score calculated is shown in Table 3 below: After computing the risk scores of the risks that are faced in construction sites, the risk level rating was given to them as per foundation stone of OHSAS-18001:2007 as shown below in Figure 7. The above risk level rating table indicates likelihood of occurrence of risk to its level of consequences. Table 4.5 shows that the “slip injuries” occurs almost certain causing its consequence to be minor. Likewise, “Struck by wastage and raw materials placed haphazardly”, “Machinery accidents” and “Falling from height”

Table 3: Risk Score

Injuries	Likelihood of Occurrence	Consequences	Risk Score
Falling from height	5	5	25
Slip injuries	5	1	5
Hit by falling debris or material	4	5	20
Struck by wastage and raw materials placed haphazardly	5	2	10
Trench or ground collapse	3	2	6
Heat stroke	2	1	2
Eye injuries	3	4	12
Burning cases	1	3	3
Electric shocks	4	5	20
Machinery accidents	5	3	15
Exposure to dangerous chemicals or toxins	2	3	6

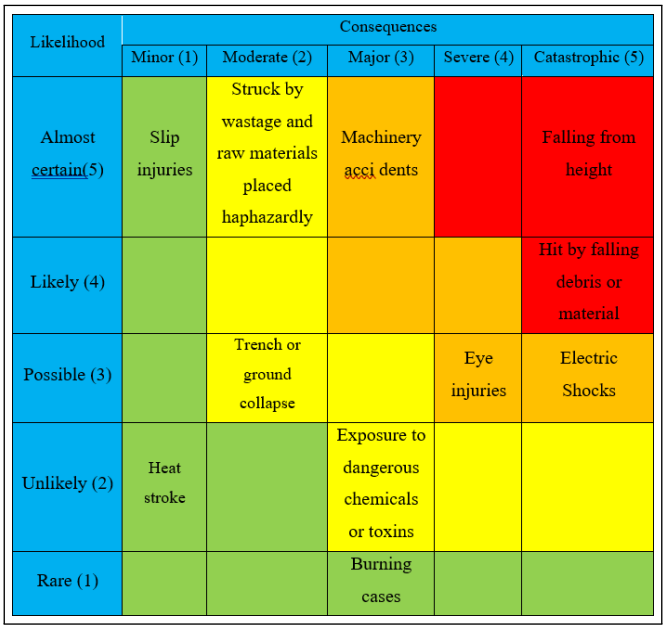


Figure 8: Risk level rating

also occurs almost certain causing moderate, major and catastrophic consequences respectively. Another catastrophic risk that occurs liklely is "Hit by falling debris or material". The possible risks to occur are "Trench or ground collapse", "Eye injuries" and "Electric shocks" bearing the level of consequences of moderate, severe and catastrophic respectively. "Heat stroke" and "Exposure to dangerous chemicals or toxins" are unlikely to occur but bears minor and major consequences respectively. However, "Burning cases" are rare but has a major consequences.

8.4 Perception of Related Clients / Consultants / Contractor Representatives

The number of representatives of client, consultant and contractor were small, hence they were directly asked to rank the injury based on the likelihood of occurrence, consequences and the improvement measures regarding prevention risks. Then the ranking was tested for agreement using Kendall's coefficient test.

Table 4: Ranking of injuries based on likelihood as per other stakeholders

Injuries Likelihood	Rank from workers calculation	Rank from Clients' opinion	Rank from Contractors' opinion	Rank from consultants' opinion
Falling from height	3	4	4	2
Slip injuries	4	1	2	3
Hit by falling debris or material	5	2	1	4
Struck by wastage and raw materials placed haphazardly	1	3	4	1
Trench or ground collapse	6	7	8	7
Heat stroke	8	5	5	8
Eye injuries	7	8	9	9
Burning cases	11	11	11	11
Electric shocks	9	10	10	10
Machinery accidents	2	6	3	5
Exposure to dangerous chemicals or toxins	10	9	9	6

Table 5: Ranking of injuries based on consequences as per other stakeholders

Injuries Consequences	Rank from workers calculation	Rank from Clients' opinion	Rank from Contractors' opinion	Rank from consultants' opinion
Falling from height	1	1	1	1
Slip injuries	9	10	6	6
Hit by falling debris or material	3	2	3	2
Struck by wastage and raw materials placed haphazardly	8	7	9	9
Trench or ground collapse	11	11	10	10
Heat stroke	10	9	11	11
Eye injuries	5	4	5	4
Burning cases	4	5	4	5
Electric shocks	2	3	2	3
Machinery accidents	7	6	7	8
Exposure to dangerous chemicals or toxins	6	8	8	7

From above calculation, we could see the variations in perception of different respondent group. However, they are similar in many ways as well. Thus, to test if there is any agreement between the different respondent group regarding each group, Kendall's coefficient of concordance test was carried out.

8.4.1 Group wise Agreement

Null hypothesis, H0: There is no agreement or concordance among the four stakeholders regarding the rank in each group.

Alternative Hypothesis, H1: There is an agreement on concordance among the four stakeholders regarding the rank in each group.

8.4.2 Kendall's Coefficient of Agreement Test

To determine the agreement among the rank from workers, clients, contractors and consultants, Kendall's Coefficient of agreement test is used. The test is performed by MS-Excel and SPSS. The Kendall's coefficient of concordance is obtained.

Table 6: Test statistics of Kendall's Test for the Coefficient of Agreement likelihood of occurrence

N	4
Kendall's Wa	0.871
Chi-Square	34.852
df	10
Asymp. Sig.	0.00

The computed Kendall's coefficient 0.871 shows that there is strong level agreement between all four respondent groups for the likelihood of occurrence of the injuries. Also, the test statistic (Chi- Square) 34.852 is greater than the tabular value in each group at 0.05 level of significance with m = 4 and for given degrees of freedom, as shown in Table 6 which verifies that the agreement is significant. Hence, the alternative hypothesis H1 is accepted, i.e. it is evident that there is an agreement or concordance among the four respondent groups regarding the rank in each group for the likelihood of occurrence of injuries. Similarly, the test is done for the agreement of ranks of the consequences of injuries among all four respondents. The Kendall's coefficient of concordance is obtained as below:

Table 7: Test statistics of Kendall's Test for the Coefficient of Agreement for consequences of injuries

N	4
Kendall's Wa	0.936
Chi-Square	37.455
df	10
Asymp. Sig.	0.00

Similarly, computed Kendall's coefficient 0.936 shows that there is strong level agreement between all four respondent groups for the consequences of the injuries. Also, the test statistic (Chi-Square) 37.455 is greater than the tabular value in each group at 0.05 level of significance with m = 4 and for given degrees of freedom, as shown in Table 7 which verifies that the agreement is significant.

8.5 Perception on Measures regarding Improvement Mechanism to Reduce Accident

Relative importance index was calculated and ranking of the measures were done in each group and as a whole to identify the important measures as per their opinions. From Table 8, it is seen that safety matters should be included in the planning phase. In many construction projects the safety is usually ignored and main focus is oriented in the design and build. But for the smooth and effective construction, safety is equally important and has to be included in the planning phase withe ta budget allocation, safety guidelines and site layout planning. The safety plans should be prepared before the commencement of the work. Also, the booklet of safety should be provided in different languages.

Table 8: Ranking of Measures Related to Planning Part

Measures	RII
Allocation budget for safety management	0.8533
Improved site layout planning	0.82727
Inclusion of safety matters from the planning phasecontract	0.81879
Availability of safety plan before the start of construction project	0.78242
Setting of safety guidelines into condition of contract	0.72424
Provision of safety booklet in various languages	0.70727

Table 9: Ranking of Measures Related to Training and Awareness Part

Measures	RII
Safety brief before start of work each day on work site	0.91818
Regular training & awareness related to health& safety to workers	0.89758
Regular tool box talks led by safety officer or site supervisor to all workers	0.85879
Proper use of warning, signs and symbols	0.83939
Use of safety audio, video and visual displaying gadgets on site	0.82848
Distribution of pocket size copy of safety ethics to workers	0.73394

Table 9 shows the measures included in the training part. It is seen that briefing the safety before work daily on the worksite is very important measure to improve the safety practices in the construction sites. Also, training and awareness in construction safety should be given to the workers regularly. Workers should be trained about the proper use and application of warning sign and symbols in the site. Safety training should be provided in all medium as audio and video. So, the visual displaying devices should be provided in the site. Learning about the safety ethics should be given to the worker.

Table 10: Ranking of Measures Related to First Aid and Health Part

Measures	RII
Availability of at least one emergency vehicle on site all the time	0.85697
Availability of first aid and welfare facilities on site all the time	0.8400
First aid training to workers by a trainer at least once in three months	0.80606
Availability of a Para-medical health worker to examine and advise on workers' health regularly at least once a month	0.79636

The measures listed in the first aid and health part is shown in Table 10. It is seen that there should be at least one emergency vehicle on the site available anytime. The first aid and welfare facilities should also be provided to the workers for the improvement of the safety practices. Also, the first aid training should be given to the workers regularly. Workers have to perform various physical activities the construction sites. So, regular physical check up should be provided to them.

Table 11: Ranking of Measures Related to Material Handling and Site Management Part

Measures	RII
Working environment always cleared and kept free from all objects that have potential to cause harms or injury to workers	0.87939
Provision of safety nets and barriers in risky areas of site	0.85939
Proper waste management on site	0.83758
Availability of fire extinguishers on site all the times	0.82909
Provision of materials storage such that they are safe against falling keeping passage ways clear at all times	0.82667
Provision of dumping the materials from mechanical equipment after the operator/driver ensures the safety of persons & properties	0.82606

Working environment should be clear and free from objects that can cause injuries. Thus, material handling and management of site is also an important part to improve the safety practices. The measures are listed in Table 11. The restricted areas in the construction sites which are prone to the injuries should be provided with nets and barriers. The waste should be properly managed in the site. There should be the provision of fire extinguisher in the site all the time since fire can cause a severe casualties. The materials in the construction site should be stored in a separate place so as to make the site safe against falling or being struck in the passageway. Lastly, the dumping of materials in the site should be safe.

Table 12: Ranking of Measures Related to Implementation Part

Measures	RII
Compulsory use of PPE on construction site	0.89455
Routine check on plant and equipments	0.88182
Providing proper support structures when erecting pre-fabricated structures or components	0.87879
Handling of construction tools & equipment with utmost care	0.87455
Scaffolding properly & adequately fixed and inspected before mounting them	0.85455
Controlled and restricted admittance of persons to the site i.e. no entry without permission for unauthorized persons to the site	0.85152
Provision of designated safety officer for strict monitoring of safety policy & proper tracking of safety records	0.8503
Ladders fixed and adequately secured in positions before ascending them	0.84485
Prompt and adequate communication of safety issues to all concerned stakeholders	0.80788

The use of PPE during the construction work should be made mandatory. It improves the safety behavior in the construction site and helps protect the workers form getting injuries. Table 12 shows the measures to be followed under the implementation part. The plants and equipment used on the site should be checked in a routine wise. Extra support, scaffolding, safety harnesses should be provided to erect the pre fabricated structures. Machinery tools and equipment are frequently used in the sites and should be handled with high care. The area where the injuries are more likely to occur in the sire should be restricted. Also, there should be the provision of safety officer to monitor the construction safety. The safety issued should be communicated to the related stake holder.

Labour welfare and motivation towards the construction safety is important for its proper implementation. The measures of this part is listed in Table 13. It is seen that there should be the availability of PPE to all the workers in the site. The workers should be motivated towards the use of safety practices by awarding the prize and gifts. Extreme weather condition and rain makes the site condition vulnerable. Thus, there should not be ongoing work on the site during rain. Also, safe accommodation should be given to the labour near the construction site. Water break, mini break should be provided to the workers during the work.

Table 13: Ranking of Measures Related to Labor Welfare and Motivation Part

Measures	RII
Access of PPE to all workers at site	0.87152
Institute safety awards to motivate the workers	0.85455
No work when it is raining that causes the difficult site conditions & difficult access road conditions	0.84485
Provision of adequate and safe shelter plus toilet facilities for employed labor near construction sites, outside the danger zone	0.78121
Provision of having regular water breaks while working on site	0.77333
Deduction wages of workers who failed to use PPE	0.35455

Thus, overall ranking of all the measures shows that construction safety practices can be improved by following the above measures with their respective priorities. Construction process is a step-wise process and various activities have to be run daily. Thus, it is very essential to give the safety brief before the work starts daily on the worksite. Similarly, regular training and awareness related to safety to workers holds the second rank on the table which is also equally important and need to be conducted on the site regularly. On the third rank of improvement to safety the use of PPE in the construction site should be made compulsory.

9. Conclusion

This thesis study was carried out to assess the safety practice status and different safety hazards in building construction sites in Bharatpur Metropolitan City, to identify the risk level rating of those hazards and to assess the measures for prevention and control. The use of safety related tools in selected building construction sites is not satisfactory as the usage percentage is around 61.37% for Full pants and all other have usage below 40%. From the computed risk scores of the different injuries on the basis of their likelihood and consequences, it is seen that the slip injuries occur almost certain causing the consequences to be minor. In the construction site being struck by materials placed randomly, machinery accidents, falling from height occurs almost certain causing the casualties of moderate, major and catastrophic level. Another catastrophic risk that occurs probably is being hit by the falling objects. The possible risks to occur are Trench or ground collapse, Eye injuries and Electric shocks bearing the level of consequences of moderate, severe and catastrophic respectively. Heat stroke and Exposure to dangerous chemicals or toxins are unlikely to occur but bears minor and major consequences respectively. Lastly, Burning cases are rare but has a major consequences. The appropriate measures that could improve the construction safety were found to be safety brief before start of work each day on work site, regular training and awareness related to construction safety to workers and compulsory use of PPE on construction site.

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