JUEM
Research across Technical Disciplines

Journal of UTEC Engineering Management
Volume 01, Issue 01, 2023, Pg. No. 64-76
OPEN ACCESS

Research Article https://doi.org/10.36344/utecem.2023.v01i01.007

Occupational Safety and Health Facilities and Its Impact on Project Success: A Case Study of Narayangarh- Butwal (N-B) Road Project

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Date of Submission:
March 29, 2023

Date of Acceptance:
June 09, 2023

ABSTRACT

The study was conducted in N-B road improvement project funded by Asian Development Bank (ADB) and implemented through International Competitive Bidding (ICB) . The research aims to focus on status of safety and health risk level of workers, assess the safety and health facilities provided to workers in selected road construction project.

The primary data were collected through questionnaire and field observation whereas secondary data were collected through project contract documents and literature study. Basically, percentage- based data were generated and Relative Importance Index (RII), Spearman's Rank Correlation Coefficient was calculated to analyze and interpret the data.

As per the consultant, contractor and labor respondent's response safe drinking water, first-aid/ medical facilities and provision of toilets were the top three ranked health facilities. Similarly, according to respondent safety signs and barriers, safety helmet and safety boots were the top three ranked safety provisions with RII of 98.25%, 96.87% and 96.22% respectively, showing that there is urgent need for upgrading or establishing these requirements at construction site. And, hazard identification, health facilities and safety provisions were ranked as first, second and third high impact factors for project success with RII of 94.07%, 91.85% and 84.44% respectively.

Here it was found and concluded that the client and contractor are lacking to provide adequate safety and health facilities to the construction workers at workplace as per ILO provisions and Labor act 2017.

Keywords: Occupational Safety and Health, Safety Culture, Hazard identification, Impact of OSH management, Project success

How to cite this article: Sanjel G., (2023). Occupational Safety and Health Facilities and Its Impact on Project Success: A Case Study of Narayangarh-Butwal (N-B) Road Project, JUEM 1(1), 64-76. https://doi.org/10.5281/zenodo.8116834

INTRODUCTION

As per International Labor Organization (ILO) estimation, 2.3 million people die every year from work related accidents and diseases globally. More than 160 million people suffer from occupational and work-related diseases, and there are 313 million non-fatal accidents per year. The suffering caused by such accidents and illnesses to workers and their family is incalculable. In economic terms, the ILO has estimated that 4% of the world's annual GDP is lost because of occupational diseases and accidents. Employers face costly early retirements, loss of skilled staff, absenteeism, and high insurance premiums due to work related accidents and diseases. Inadequate or the lack of occupational health and safety not only negatively affects the traditional construction parameters of cost, quality, and schedule, but the sustainability of the environment (Shrestha, 2017). There is evidence that new workers are more vulnerable to injuries at construction site due to lack of knowledge of H&S rules. Therefore, formal orientation by key persons such as project manager, safety manager and others should be given to the new workers regularly which help to reduce the accidents in site. It is found that the chances of accidents are reduced if the top management involves itself in the safety related issues in the site. Record keeping of workplace accidents and incidents is poor in Nepal. Safety and accidents record of the firms should also be included in the evaluation criteria during contracting. Skilled and capable employees should be hired who have the knowledge of unusual risks of their trade and industry. All the workers are required to wear PPE all the times at workplace since PPE is the only effective means of controlling the risks of injury or ill health (Mishra & Shrestha, 2017).

Occupational fatalities, injuries and diseases constitute defects as they are not project requirements. In fact, completing an activity without injury or disease constitutes successful completion. As health and safety also complements the successful completion of a project which includes completion on schedule, within budget, to quality requirements without damaging the environment and without incurring disease, fatalities, or injuries, it is an indispensable project parameter (Smallwood, 2008).

Construction workers are exposed to hazards of occupational diseases and injuries and the adverse effects of excessively long hours of work. Machines, plants, and other sophisticated construction equipment pose danger to the operators, who in most cases do not have prior skills for operating such machines or plants. Several factors having negative impact on health and safety management in developing countries include poor infrastructure, problems of communication due to low literacy level, unregulated practices on construction sites, adherence to traditional working methods, non-availability of suitable working equipment, extreme weather conditions, improper use of equipment and corruption (Muiruri & Mulinge, 2014).

The ongoing research on safety measures (Mishra, A. K., Pokharel, A., & Aithal, P. S., 2023), hazard identification study (Lama, C., Sah, D. P., & Mishra, A. K. ,2019), effectiveness of the same (Mishra A. K., Lama C, Sah D. P. et al. ,2019), Safety Management Practice Impact on Project Performance (Mishra A K. ,2019), job safety (Mishra, A. K. & Aithal, P. S. ,2021), and COVID 19 (Neupane, B.R., Mishra, A.K., 2020) assures the researcher to bring it out though the work was done in 2021. In Nepalese construction industry, health, safety, and welfare of workers are given less importance to budget and time discussions and are rarely managed. Health, safety, and welfare facilities of workers on construction site is considered as waste of money. Top management do not want to invest a little budget and schedule on health and safety of workers as preventive cost since they do not understand the total direct and indirect cost of accidents happened on site. The human life is not considered as valuable in construction due to this no concrete government laws and policies has been established for workers' health, safety, and welfare facilities. The ultimate effect of safety and health in project is neglected. There

are few scientific studies conducted so far in occupational safety and health in Nepal. The overall status of occupational safety and health in Nepal is not satisfactory. Most of the workplaces do not possesses proper safety and preventive measures (Joshi et al., 2011).

Past studies have focused on the causes, casualties, safety policies, humanitarian responses that have been carried out focusing safety issues and ways to minimize them in overall industry. However, the focus on safety and health in construction industry in particular is less and hence there is a need for study on occupational safety and health status, challenges and ways to improve them in road construction in present context of Nepal.

OBJECTIVE

The research was aimed to analyze the status of worker's safety and health risk level in N-B road construction project.

METHODOLOGY

This study examined the impact of occupational safety and health management practices on project success.

Study Area

The study area was limited to the Narayangarh to Butwal as the construction project site areas. The project is sliced into two sections i.e., Package 01 and Package 02 each of length 64.425 km and 48.535 km respectively. The project lies in the Gandaki and Lumbini province of Nepal.

Research Design

The philosophy of this research is pragmatic since it gives solution to the existing problems in safety and health at the construction site. The type of research was field based applied action research since the study was based on field survey. Inductive reasoning was used in this research.

The approach of this research was mixed type since both qualitative and quantitative methods was used to conduct the study. Statistical analysis were carried out in this research so it is quantitative method, and the health and safety related problems was explored from multiple perspectives which is qualitative method.

Research Strategy

The strategy of this research was case study field-based research since only one road construction project was taken for the study and the study was conducted by collecting field-based data.

Time Horizon

The study was carried out in the construction phase of the project in single time frame, so this study is called cross- sectional time horizon research.

Study Population

The scope of this research includes occupational safety and health management practices on Narayangarh- Butwal road project. The population of the study consists of all the key expert employees of the client, consultant and the contractor and the skilled and unskilled labors working at the project, the details of which is shown in Table 3.2. The total population size (N) of the study was 440.

Table 1: Sample size Distribution for Different Strata

SN	Description of strata	Population Size (Nh)	Sample size (nh)	Actual Sample size (nh)
1.	Client	N1 = 04	n1 = 1.91	n1 = 2
2.	Consultant	N2 = 14	n2 = 6.68	n2 = 10
3.	Contractor	N3 = 22	n3 = 10.5	n3 = 15
4.	Labor	N4 = 400	n4 = 190.91	n4 = 190
	Total	N = 440	n = 210	n = 217

The sample size for different strata calculated by using equation (ii) is shown in Table 1. The sample size actually taken for the study was more than as calculated to reduce the sampling error and increase the reliability and validity of the survey data The responses received from client and consultant were merged and presented as consultant's response because of employer's a smaller number of representatives.

Data Collection

A primary and secondary data collection method was used for this research to identify the impact of health and safety management practice on highways construction project in Nepal.

Primary Data

Primary data was collected through questionnaire survey based on long list of references as evidenced from reference list directly or indirectly and field observation with checklist. The checklist consists of questions related to status of site accidents and injuries, measures of health and safety facilities, PPE, safety training, working hour of workers etc. The questionnaire of the study was included the set of questions related to health and safety facilities provided to workers in the site such as safe drinking water, accommodation, rest, toilet, canteen, first aid, safety sign, scaffolding etc.

Secondary Data

Secondary data was collected from the literature study of international and national journals and articles, publications, magazines, reports etc. and contract documents of the project.

To fulfill the first objective of the study i.e., to analyze the status of worker's safety and health at selected road construction project, direct field observation and questionnaire survey of respondents was done to identify the exact health and safety status of workers at site. The questionnaire consisted of several statements that helps to understand the status of worker's health and safety.

Data Preparation and Data Analysis

The data collected from the questionnaire survey was analyzed through MS-Excel software where the results were presented in tabular and graphical ways for easier understanding. The data collected was of both qualitative and quantitative in nature. All the information obtained from the respondents were analyzed by frequency analysis. Basically, percentage-based analysis was generated and used for analysis.

Relative Importance Index (RII)

The aim of the study was to establish the relative importance of safety and health facilities for the successful completion of the project. The RII was used to rank the safety and health facilities in accordance with the respondent's responses in the construction site. The relative importance index was calculated for the respondent's responses by using the equation (iii) as (Fagbenle et al., 2004):

$$RII = \frac{\Sigma W}{(A*N)} \quad \text{.....(iii)}$$

Where,

RII= Relative Importance Index whose value ranges from 0 to 1.

W= Weighting as assigned on Likert scale by each respondent in a range from 1 to 5.

A = Highest weight (Here it is 5)

N= Total number of respondents

$= n_1 + n_2 + n_3 + n_4 + n_5$

$\sum W = 1*n_1 + 2*n_2 + 3*n_3 + 4*n_4 + 5*n_5$

n_1 = Number of respondents for Strongly Disagree

n_2 = Number of respondents for Disagree

n3 = Number of respondents for Neutral

n4 = Number of respondents for Agree

n5 = Number of respondents for Strongly Agree

Likert Scale, invented by Rensis Likert is a psychometric scale commonly involved in research that employs questionnaire. Five-point Likert Scale questionnaire survey was used in this research which ranges from "Strongly Disagree", "Disagree", "Neutral", "Agree" and "Strongly Agree" and will be indicated as 1, 2, 3, 4 and 5 respectively.

Also, the correlation of ranking of safety and health facilities between the consultant, contractor and labor was calculated by using the Spearman's Rank Correlation Coefficient.

By using the formula of Spearman's Rank Correlation Coefficient, ρ (Gang, 2018)

$$\rho = 1 - \frac{6*\Sigma d^2}{(n*(n-1)} \quad \text{.....(iv)}$$

Where,

d = Difference in rank, n = number of factors

The value of Spearman's Rank Correlation Coefficient ρ, ranges from -1 to +1,

Where:

+1 = A perfect positive correlation between ranks

-1 = A perfect negative correlation between ranks

0 = No correlation between ranks.

Reliability and Validity Test

To measure the reliability of collected data, Cronbach's alpha was used. Cronbach's alpha is a function of the number of items in a test, the average covariance between item-pairs and the variance of the total score, which is used to check the internal consistency or reliability of the multiple question Likert Scale questionnaire survey. The theoretical value of alpha varies from 0 to 1. Higher values of alpha are more desirable. Calculated alpha value less than 0.6 will not be acceptable, value between 0.7 to 0.8 will be acceptable, value between 0.8 and 0.9 will be good and alpha value above 0.9 will be excellent (Ritter, 2010).

Cronbach's alpha was calculated by using the following formula:

$$\alpha = \left(\frac{K}{K-1}\right)\left(1 - \frac{\sum_{i=1}^{K} \sigma y i^2}{\sigma x^2}\right) \quad \text{.....(v)}$$

Where,

α = Cronbach's alpha

K= Number of items

σ yi²= Average variance associated with item i.

σ x² = Average variance associated with the observed total scores.

Content validity of the questionnaire set was checked by three expertise and verified that the objective of the study will be fulfilled

To test the reliability and validity of the survey data, additional 5% of labor respondents were resurveyed and the results were compared with the previous survey results. The results were found similar, and it is verified that the data obtained were reliable and valid. The details of resurveyed data are presented in Annex 2.

RESULT AND DISCUSSION

Labor Act Provisions

The employer, consultant, contractor, and labor were asked questions related to the status of labor act implications on the project site. The results of the questionnaire survey in terms of percentage of the total respondents are presented below in Table 2.

Table 2: Responses on status of Labor Act Implications on Project Site

Labor Act Provisions	Consultant		Contractor		Labor	
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
Child Labor Availability	-	100	-	100	-	100
Discrimination among workers	8.33	91.67	-	100	-	100
Equal Remuneration for Equal Work	83.33	16.67	100	-	100	-
Safety and Health Plan at Site	83.33	16.67	100	-	100	-
Safety and Health Committee at Site	16.67	83.33	-	100	-	100
Prevention of Communicable Diseases	66.67	33.33	100	-	100	-
Medical Expenses/ Compensation for Workers	75	25	86.67	13.33	-	100
Working Hours (8 Hours in a day)	91.67	8.33	100	-	100	-
Extra Wages for Overtime work	91.67	8.33	100	-	100	-
Regular Medical Check-up of Workers	-	100	20	80	-	100

Labor Act Provisions	Consultant		Contractor		Labor	
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
Warning Signs in case of Emergency	100	-	100	-	100	-
Routine Inspection of Heavy Machine and Equipment	91.67	8.33	100	-	100	-

(Source: Field Survey, 2021)

According to the responses presented on Table 2, 100% of respondent admitted that child labor was not available at site. Similarly, 91.67% of consultant and 100% of contractor and labor respondent responded that there is no discrimination among the workers at site. Similarly, 83.33% of consultant, 100% of contractor and labor respondent indicated that there is equal remuneration for equal work and there is safety and health plan at site.

Also, 83.33% of consultant and 100% of contractor and labor respondent admitted that there is no provision of safety and health committee at site. Also, 66.67% of consultant and 100% of contractor and labor respondent admitted that there is prevention of communicable diseases at site. Also, about 75% of consultant and 86.67% of contractor's respondents claimed that there is provision of medical expenses/ compensation for injured workers but 100% of labor respondent denied that there is such provision at site. Similarly, about 91.67% of consultant and 100% of contractor and labor respondent admitted that the normal working hour is 8 hours in a day and extra wages were paid for overtime work.

Also, 100% of consultant, 80% of contractor and 100% of labor respondent mentioned that there is no provision of regular medical check-up of workers at site. Also, about 58.33% and 66.67% of consultant, 80% and 86.67% of contractor and 100% of labor respondent agreed that there is designated emergency personnel at site and there is provision of regular risk assessment and risk reduction at site.

Similarly, 100% and 91.67% of consultant and 100% of contractor and labor respondent admitted that there is provision of warning signs in case of emergency and routine inspection of heavy machine and equipment at site respectively.

Enactment and enforcement of labor law is vital for ensuring full and effective protection of labor welfare in construction. The research shows that the reviewed countries have developed mechanism to regulate working conditions within different labor laws, though the ability to implement these laws is still under question. Specifically, although the Palestinian labor law laid down an organic recipe governing working conditions, gaps exist due to limits in its coverage, in particular lack of legal penalties of non-compliances.

The study reflects partial enforcement failure to the Palestinian Labor Law, such as overtime and payment delay. Similarly, results suggest that workers are poorly aware about the occupational safety and health rights, and due to high unemployment rate and difficult economic conditions, many employees accept to work under conditions far below the standards set by the Palestinian Labor Law (Shaaban, 2015).

OSA, (2007) requires every contractor or project to establish health and safety committee at the workplace in accordance with regulations prescribed by the rules of OSA. However, the study established that health and safety committee has not been formed in the study site, which is key aspect in enforcement of health and safety at workplace.

Overall Ranking of Safety Provisions:

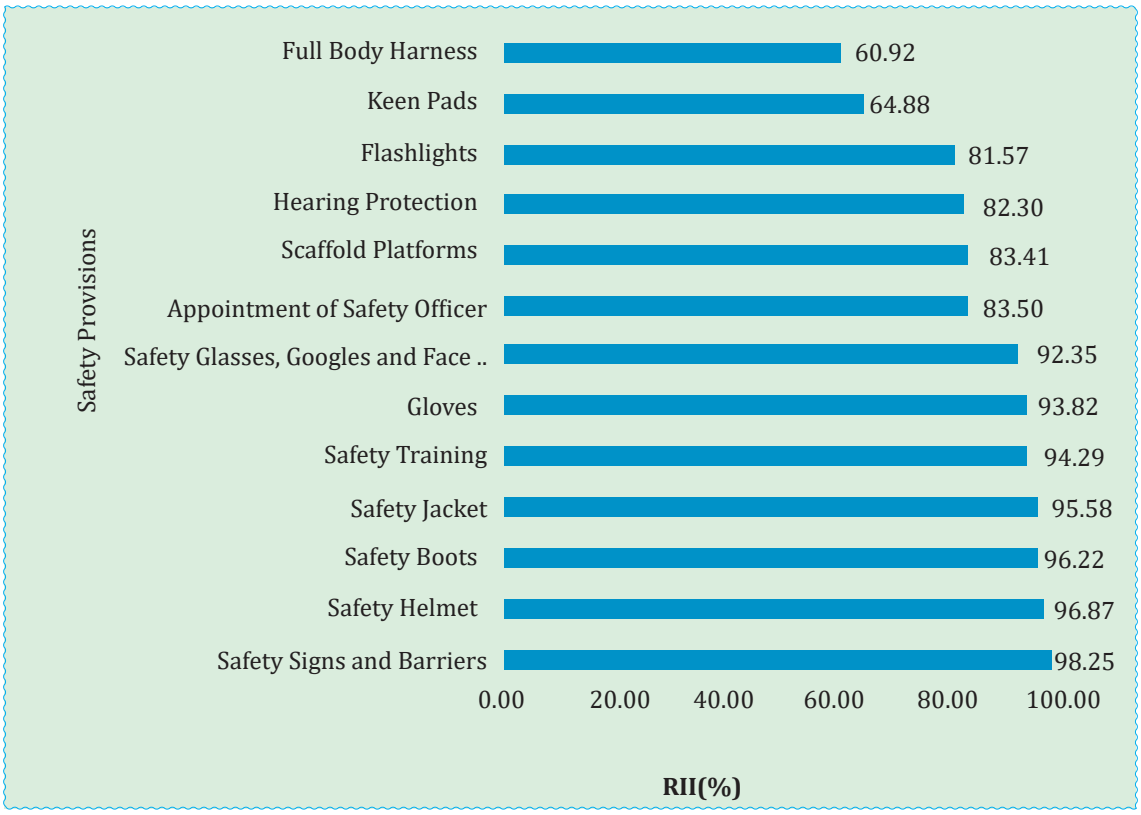

Figure 1: Overall ranking of safety provisions

As per the results presented in Figure 1, safety signs and barriers, safety helmet and safety boots were the first, second and third ranked safety provisions with RII of 98.25%, 96.87% and 96.22% respectively.

As per Smallwood, (2019) Safety and health facilities on construction project complements cost, environment, productivity, quality, schedule, and customer satisfaction. Safety and health help to reduce site accidents and losses and damages due to accidents. It helps to keep project on schedule and desire quality. Safety and health reduce variability and consequently project risk. Safety and health should be both an organizational and project value, as opposed to a priority, as priorities may change.

Safety in construction industry is most important factors that are to be considered. The accident rates in the construction site of Nepal from falling objects to electric shocks are high. No guidelines are present that would help to minimize those incidents. Organization and Government are main responsible for regulating safety and health regulations. Nepal government lags to enforce policies, regulations and legislation that affect the working efficiency. Carelessness of workers together with ignorance of top management is the result of accidents on construction industry in Nepal (Sharma, 2019).

Ranking of Safety and Health Facilities

The correlation between the ranking of health facilities between consultant and labor are presented below in Table 3.

Table 3: Correlation of Rank Between Consultant and Labor's Response on Importance of Health Facilities

Health Facilities	Consult	Labour	D^2
Safe Drinking Water	1	1	0
Provision of Toilets	3	3	0
Washing Facilities	6	6	0
Shelter/ Suitable Accommodation	4	4	0
First-Aid/ Medical Facilities	2	2	0
Resting Areas	9	7	4
Obtaining Food and Drink Facilities	5	5	0
Changing Rooms and Locker	8	9	1
Canteen Facilities	7	8	1
	∑ d2 =		6

(Source: Field Survey, 2021)

Here, ∑ d2 = 6

n = 9

By using the equation (iv) of chapter 3, formula of Spearman's Correlation Coefficient, ρ

$$\rho = 1 \frac{(6*\sum d^2)}{(n*(n-1))}$$

Hence, Spearman's Rank Correlation Coefficient, ρ = 0.95

The Spearman's Rank Correlation Coefficient is 0.95. As the value is near to +1, it showed that there is strong positive correlation between responses of consultant and labor respondents on importance of health facilities to workers on road construction site. Hence, it can be said that the top ranked health facilities of consultant and labor respondents are almost common.

The correlation between the ranking of health facilities between contractor and labor are presented below in Table 4.

Table 4: Correlation of Rank between Contractor and Labor's Response on Importance of Health Facilities

Health Facilities	Contractor	Labour	D^2
Safe Drinking Water	2	1	1
Provision of Toilets	3	3	0
Washing Facilities	5	6	1
Shelter/ Suitable Accommodation	4	4	0
First-Aid/ Medical Facilities	1	2	1
Resting Areas	7	7	0
Obtaining Food and Drink Facilities	6	5	1
Changing Rooms and Locker	9	9	0
Canteen Facilities	8	8	0
	∑ d2 =		4

(Source: Field Survey, 2021)

Here, ∑ d2 = 4

n = 9

By using the equation (iv) of chapter 3, formula of Spearman's Correlation Coefficient, ρ

Hence, Spearman's Rank Correlation Coefficient, ρ = 0.967

The Spearman's Rank Correlation Coefficient ρ is 0.967. As the value is near to +1, it showed that there is strong positive correlation between responses of contractor and labor respondents on importance of health facilities to workers on road construction site. Hence, it can be said that the top ranked health facilities of contractor and labor respondents are almost common.

The correlation between the ranking of safety provisions between consultant and labor are presented below in Table 5.

Table 5: Correlation of Rank between Consultant and Labor's Response on Importance of Safety Provisions

Safety Provisions	Consultant	Labour	d^2
Safety Signs and Barriers	1	1	0
Safety Helmet	2	2	0
Safety Glasses, Goggles and Face Shields	9	7	4
Safety Boots	3	3	0
Safety Jacket	6	4	4
Hearing Protection	11	9	4
Safety Training	4	5	1
Gloves	5	6	1
Knee Pads	13	12	1
Full Body Harness	12	13	1
Flashlights	10	11	1
Appointment of Safety Officer	7	10	9
Scaffold Platforms	8	8	0
	∑ d2 =		40

(Source: Field Survey, 2021)

Here, ∑ d2 = 28

n = 13

By using the equation (iv) of chapter 3, formula of Spearman's Correlation Coefficient, ρ

Hence, Spearman's Rank Correlation Coefficient, ρ = 0.928

The Spearman's Rank Correlation Coefficient is 0.93. As the value is near to +1, it showed that there is strong positive correlation between responses of consultant and labor respondents on importance of safety provisions to workers on road construction site. Hence, it can be said that the top ranked safety provisions of consultant and labor respondents are almost common.

Similarly, the correlation between the ranking of safety provisions between contractor and labor are presented below in Table 6.

Table 6: Correlation of rank between contractor and labor's response on importance of safety provisions

Safety Provisions	Contractor	Labour	d^2
Safety Signs and Barriers	1	1	0
Safety Helmet	3	2	1
Safety Glasses, Goggles and Face Shields	5	7	4
Safety Boots	2	3	1
Safety Jacket	6	4	4
Hearing Protection	11	9	4
Safety Training	4	5	1
Gloves	8	6	4
Knee Pads	12	12	0
Full Body Harness	13	13	0
Flashlights	7	11	16
Appointment of Safety Officer	9	10	1
Scaffold Platforms	10	8	4
	∑ d2 =		40

(Source: Field Survey, 2021)

Here, ∑ d2 = 40

n = 13

By using the equation (iv) of chapter 3, formula of Spearman's Correlation Coefficient, ρ

Hence, Spearman's Rank Correlation Coefficient, ρ = 0.89

The Spearman's Rank Correlation Coefficient is 0.89. As the value is near to +1, it showed that there is strong positive correlation between responses of contractor and labor respondents on importance of safety provisions to workers on road construction site. Hence, it can be said that the top ranked safety provisions of contractor and labor respondents are almost common.

According to Giri, (2020) majority of the construction site accidents can be minimized if appropriate measures are established for the promotion and protection of safety and health of the workers. Safety and health in construction is needed to minimize rate of accidents and cost of construction, to increase quality, efficiency, and morale of workers. To enhance safety practices, an emphasis must be given to enhance interests in active safety management and implementation of awareness programs, which must be developed and implemented among construction workers. An additional safety training for the workers, which could be provided by contractors about plant, tools and equipment they use, before workers engage in their duty, would also help to prevent and minimize the accidents in construction sites.

CONCLUSION

The client and contractor be flexible to provide the adequate safety and health facilities to the construction workers at workplace. Here it was investigated and concluded that the client and contractor have not provided adequate safety and health facilities to the workers at workplace as per ILO provisions and Labor Act, 2017. Among the nine major health facilities studied, five health facilities were found lacking at the site. The lacking facilities at site were safe drinking

water, toilet provisions, resting areas, changing rooms and locker and the canteen facilities. Similarly, among the thirteen major safety provisions, six safety provisions were lacking on site. The lacking facilities were face protection (Safety glasses, goggles and face shields), safety boots, gloves, hearing protection, knee pads and full body harness. Ranking analysis revealed that safe drinking water, provisions of toilets and first-aid/ medical facilities were the top most ranked health facilities. Similarly, safety signs and barrier, safety helmet and safety boots were the top most ranked safety provisions at site.

The ranking analysis revealed that the key factors of OSH management: hazard identification, health facilities and safety provisions were ranked first, second and third high impact factors for project success.

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