

Research Article

Occurrence of Accident and Safety Culture in the Construction Industry of Bhutan

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A B S T R A C T

Background: The global construction industry is highly dangerous, accounting for one in five fatalities, particularly prevalent in developing countries. As construction activities surge in Bhutan, safety standards and the occurrence of accidents have become concerning. This article aims to examine fatal and non-fatal accidents and safety culture in Bhutan's construction industry.

Methods: A desk review was conducted to examine reports and documents related to construction accidents in Bhutan. Additionally, a cross-sectional study was carried out at various construction sites, including roads, bridges, buildings, and hydropower projects. The sample size consisted of 208 participants, selected with consideration of a 6.76% margin of error (e) at a 95% confidence level, assuming a standard deviation of 50% (d = 0.5).

Results: The construction industry has the highest frequency of workplace accidents, particularly fatal ones, compared to other sectors. Despite a decrease in the accident rate over time, it remains significantly elevated. This study found that 26.4% of construction workers experience annual accidents. Workers who didn't use personal protective equipment (39.1%) or used it sporadically (23.7%) had higher accident rates. The safety culture in construction workplaces generally showed an acceptable level, with a mean score of three or higher. However, workers with low safety behavior and moderate scores in safety leadership, communication, training, and awareness exhibited higher rates of non-fatal accidents.

Conclusion: Construction workers in Bhutan face a higher risk of workplace accidents and injuries. Contributing factors include insufficient safety training and awareness, ineffective safety leadership and communication, and the prevalence of unsafe behaviors among workers.

Keywords: Non-fatal Accident, Construction Industry in Bhutan, Construction Safety and Health, Construction Accident, Safety Leader, Unsafe Behaviour

Introduction

The construction industry is one of the most hazardous workplaces as compared to other sectors with a higher prevalence of accidents and illness.^{1,2} According to International Labour Organization (ILO), almost 108,000 fatal accidents occur on a construction site annually. Workers in developing countries are three to six times more likely to encounter accidents compared to developed nations. Furthermore, it is proven that construction workers are exposed to hazardous substances such as asbestos, silicosis, and excessive noise which negatively impact their livelihood.^{1,3}

Construction accidents in Delhi, India constituted 29% of fatal accidents and 71% of non-fatal accidents, estimating an annual injury rate of 49.5 per 100,000 workers.⁴ In Malaysia, the prevalence of construction accident injuries was 22.6% among foreign construction workers.⁵ Similarly, in Bangladesh, about 63.80% of the construction workers suffered from workplace injuries, out of which, 24.7% were attributed mainly to falls from heights and poor safety facilities.⁶ Hong Kong recorded 76% of fatal accidents in the construction industry in 2017.⁷ Limited compliance with the safety culture at the workplace was the possible cause aside from various causes of non-fatal accidents.

The most common cause of non-fatal accidents in the United Kingdom construction industry was found to be slips, trips, or falls on the same level (26%) followed by falls from height (19%), injured while handling lifting or carrying (18%), and struck by moving objects (12%).⁸ Similarly, slips and trips or falls on the same level were found to be the leading cause of construction accidents in Hong Kong.⁷ Falls from height (51%) were found to be the leading cause of fatalities in the United Kingdom, China, South Korea, and the United States.^{8,9} Workplace stress, use of unsafe machinery and tools, unsafe activities and conditions, and also latent factors such as inadequate training and lack of awareness among the workers were found to be the common causes of workplace accidents in Malaysia.¹⁰

Similarly, the construction workers in Bhutan are also prone to health and safety hazards. In 2022, the Department of Labour reported that among the accident cases reported, non-fatal accidents comprised 25% and fatal accidents contributed 62.5%.¹¹

A good safety culture ensures high safety performance as well as increases productivity, boosts the morale of workers, and empowers them. Safety culture is all about individual and group values, attitudes, beliefs, behaviours, and the promotion of these values in an organisation.¹² According to Reason, safety culture comprises an informed culture, reporting, just culture, and learning culture.¹³ Studies have shown that lack of safety behaviour accounts for 80% of construction accidents and is the leading cause of them.¹⁴

Thus, safety culture is influenced by the safety behaviour of an individual. In contradiction, it was found that there is a significant influence of safety culture on safety behaviour.¹⁵

Safety leadership has always been a vital catalyst for safety culture and a determining factor for the realisation of safety goals. The study on construction safety leadership highlighted that transformational, rule-oriented, and participative leadership predicts positive safety performance and reduces accidents.¹⁶⁻¹⁸ Similarly, effective safety communication expands the knowledge and understanding of workplace safety and enhances safety culture.¹⁹ Safety communication can be articulated in the form of risk assessment and accident reports, training, workplace safety and health statistics, policy, procedures, and regulations. Immediate supervisors have more influence on safety culture than top management. Safety and health in the workplace are not only influenced by policy decisions but also by the actions and attitudes of the managers and supervisors. The workers emulate their managers and supervisors, thus safety behaviours of the managers and supervisors influence the safe conduct of the worker.¹⁹

In order to improve the safety culture, it is not only essential to oversee the safety performance of workers but it is also equally important to evaluate the worker's psychological health and conduct training to improve it.²⁰ Safety awareness, competence, and safety communication are key to enhancing and promoting the safety culture.²¹

Materials And Methods

Study Design and Sample Size

The study was carried out over a period of one year, starting from December 2021. A mixed-methods research design was exploited in this study, involving the collection and analysis of both quantitative and qualitative data. The desk review involved an examination of reports and other relevant documents related to construction accidents in Bhutan.

In order to collect quantitative data, a cross-sectional study was conducted at various construction sites, including roads and bridges, buildings, and hydropower construction. A sample size of 208 was chosen from an infinite population, considering a margin of error (e) of 6.76% at a 95% confidence level and a standard deviation of 50% (d = 0.5) using the following formula for infinite population:

$$n = (Z^2 * p * q) / e^2$$

where:

n = the required sample size

Z = Z-score (i.e. 95% confidence level)

p = the estimated proportion (since it is unknown, 0.5, which represents maximum variability and results in the largest possible sample size)

$q = 1 - p$ (i.e., the proportion of the population without the characteristic of interest)

e = the desired margin of error (0.05 for 5%)

Data Collection and Statistical Analysis

A structured questionnaire was used to collect data through face-to-face interviews and recordings. The data were analysed using descriptive statistics and simple binary logistic regression for inferential statistics to determine the association between independent and dependent variables.

The participants were informed, and consent was obtained prior to the interview and data collection.

Results

Annual Fatal Accident Rate

Compared to other sectors, the construction sector has a higher recorded rate of fatal accidents, as reported by the Department of Labour. However, this data only represents a portion of the total number of accidents, as many go unreported. Although there has been a decline in the fatal accident rate over the years, from 93.8% in 2018-2019 to 85.7% in 2020-2021, the construction sector still experiences a significant number of fatal accidents, as shown in Table 1.²²

Table 1. Reported Fatal Accidents in Construction Industry

Year	Fatal (%)	Injury (%)	Overall (%)
2018-2019	93.8	26.9	52.4
2019-2020	82.4	14.3	62.5
2020-2021	85.7	21.7	36.7

Non-fatal Accident Rate

A total of 208 participants, out of which 152 were male,

Table 2. Non-fatal Accidents and their Association with Different Variables

Characteristics	Sample Size	Experienced Accidents		p Value	Odd Ratio	95% CI	
		n	%			Lower	Upper
N	208	55	26.4				
Gender							
Female	56	10	17.9		Ref		
Male	152	45	29.6	0.09	0.52	0.24	1.114
Age group (years)							
18-25	87	18	20.7	0.69	1.57	0.18	13.84
26-30	46	15	32.6	0.34	2.90	0.32	26.33
31-35	29	7	24.1	0.58	1.91	0.20	18.69
36-40	18	6	33.3	0.36	3.00	0.29	30.92
51-50	21	8	38.1	0.26	3.69	0.37	36.57
≥ 51	7	1	14.3		Ref		

consented to the participation and completed the interview. The age range of the participants was from 18 to 55 years. The prevalence of non-fatal accidents in the construction industry was found to be 26.4%. Although insignificant, males were found to be more prone to accidents in workplaces. Studying the marital status and workplace accidents, participants who were divorced (57.1%) were found to be more vulnerable to accidents compared to the ones who were married (28.3%) or single (22.5%). Furthermore, the study found that the accidents increased with an increasing number of hours worked.

The study also found that workers who did not use personal protective equipment (PPE) were more vulnerable to accidents (p value = 0.03 at 95% CI: 1.08-4.36) in comparison to those using PPE. Workers who used PPE occasionally were found to experience accidents 2.32% times more as compared to those who always used PPE with a p value of 0.02 at 95% CI: 1.12-4.79.

Comparing the work sites' data, workers at hydropower construction (28.1%) and building construction (26.8%) were found to experience more incidence of non-fatal accidents than those working at road construction and maintenance sites as detailed in Table 2.

Common Non-fatal Accidents

The study found that most of the non-fatal accidents in the construction industry were slips, trips, and falls to a lower level or at the same level, which accounted for 20.6% as indicated in Table 3. Injuries while lifting and carrying seemed no different as they constituted nearly 20% of the accidents. Direct involvement with materials and equipment was reported at 19.26% and there is always a possibility of dangerous near-miss incidences which accounted for 20%. Overall, no accidents were negligible and occurrence rates were indifferent.

Characteristics	Sample Size	Experienced Accidents		p Value	Odd Ratio	95% CI	
		n	%			Lower	Upper
Marital status							
Single	102	23	22.5	Ref			
Married	99	28	28.3	0.06	4.58	0.96	21.95
Divorced/ separated	7	4	57.1	0.35	1.36	0.72	2.56
Working hours in a day							
≤ 8	99	23	23.2	Ref			
9-10	86	25	29.1	0.37	1.35	0.70	2.62
11-13	23	7	30.4	0.47	1.45	0.53	3.94
Awareness on PPE							
Aware of types of PPE	194	51	26.3	Ref			
Lack of knowledge of PPE	14	4	28.6	0.85	1.12	0.34	3.73
Usage of PPE							
Using PPE	162	37	22.8	Ref			
Not using PPE	46	18	39.1	0.03	2.17	1.08	4.36
Use of PPE							
Always	129	28	21.7	Ref			
Sometimes	33	9	27.3	0.02	2.32	1.12	4.79
Types of construction sites							
Road, RCC wall and maintenance	24	5	20.8	Ref			
Building construction	127	34	26.8	0.86	1.07	0.53	2.15
Hydropower	57	16	28.1	0.54	0.72	0.25	2.08

Table 3. Types of workplace accidents in the construction sector

Types of Accidents	Frequency	Percentage
Total incidences	296	100.00
Slips, trips and falls	61	20.61
Injured while handling/ lifting/ carrying	58	19.59
Struck by a moving/ flying/ falling object	53	17.91
Injuries directly involving materials/ tools/ equipment	57	19.26
Strike against something fixed/ stationary	49	16.55
Contact with/ by moving machinery	50	16.89
Trapped by something collapsing/ overturning	48	16.22
Contact with electricity/ electrical discharge	48	16.22
Dangerous occurrence (near-miss)	59	19.93
Others	35	11.82

Perception of the Safety Culture

The study considered eight parameters such as safety leadership, safety communication, safety training, manager’s and supervisor’s influences, work stress, tools and machinery, awareness and competency, and perception and behaviour of the workers that influence safety culture in the construction industry.

The descriptive analysis shows an acceptable level of safety culture in all parameters with a mean score of three or more. However, the mean score was found to be less than three in the case of two elements under work stress and tools and machinery parameters each, indicating negligence of safety culture. The workers reported that they often feel stressed working in the company and furthermore,

have too much work to do as a result, they compromise safety procedures. Similarly, under the tools and machinery parameter, poor maintenance and lack of safety features of tools and equipment were reasons for the low mean score.

A high level of the mean score (4.02) was found where the workers believed that their safety is more important than productivity under perception and behaviour parameter as detailed in Table 4.

Table 4. Worker’s Perception of Safety Culture

Perception Statement	Minimum	Maximum	Sum	Mean	SD
Safety leadership					
Safety is a primary concern for the top management of our company	1	5	792	3.81	1.22
Management puts safety ahead of productivity	1	5	771	3.71	1.17
A penalty is imposed on employees who fail to follow safety measures	1	5	694	3.34	1.25
Safety communication					
Safety is a regular part of company communications	1	5	783	3.76	1.17
I am encouraged to discuss safety issues with my supervisor often	1	5	796	3.83	1.04
I am informed of any safety issues at my workplace by my supervisor	1	5	792	3.81	1.10
Safety training statement					
Safety training is taken seriously in our company	1	5	743	3.57	1.23
Safety training is received at regular intervals to refresh and update knowledge	1	5	704	3.39	1.18
Safety induction is conducted for new employees	1	5	736	3.54	1.23
Manager’s and supervisor’s influence					
Managers and supervisors take prompt action when safety issues are raised	1	5	724	3.60	1.14
Managers and supervisors regularly discuss the hazards and precautions pertaining to my job	1	5	719	3.58	1.19
Managers and supervisors have good knowledge of hazards and safety	1	5	747	3.75	1.24
Work stress					
I often feel stressed working in the company	1	5	614	2.95	1.14
Sometimes there is too much work to do without following the safety procedures	1	5	589	2.83	1.10

My job demands long working hours (more than 8 hours per day)	1	5	660	3.17	1.08
Tools and machinery					
The tools and equipment are poorly maintained	1	5	613	2.95	1.13
Employees are provided with induction on the operation of the tools and machinery	1	5	704	3.39	1.07
Provided tools and machines do not have safety features	1	5	590	2.84	1.15
Awareness and competency					
I am clear about what my responsibilities are for health and safety	1	5	823	3.96	0.97
I can deal with safety problems at my workplace	1	5	799	3.84	1.00
I know how to report work-related injuries and hazards	1	5	815	3.92	0.98
I pay attention to safety while doing my job	1	5	647	3.11	1.47
Perception and behaviour					
I feel that my safety is more important than my productivity	1	5	837	4.02	1.05
I would report a workplace safety hazard if I am aware of one	1	5	825	3.97	0.91
I would report other workers who are not following safety procedures	1	5	786	3.78	0.96
I would refrain from working if workplace hazards are not removed	1	5	801	3.85	1.05

Point of score from 1 (low) to 3 (high).

Non-fatal Accidents and Perception of Safety Culture

Table 4 presents a comparison of safety levels based on workers' perceptions and experiences of workplace accidents. Using a score of one to three to represent low to high safety levels, the overall mean score was found to be at an acceptable or moderate level. However, the study revealed a low mean score for work stress (1.9%) as compared to other safety culture parameters.

The findings showed that a higher percentage of workers rated their perception and behaviour towards safety (73.1%) as high, followed by safety communication (66.3%), safety leadership (59.1%), and manager's and supervisor's influence (57.7%). The lowest safety scores were observed for safety leadership (13.9%), followed

tools and machinery (14.4%), safety training (15.4%), and Manager's and supervisor's influence (17.3%)

Regarding the relationship between safety level and workplace accidents or incidents, a low percentage of accidents was observed in the high safety level category for tools and machinery (23.9%) and perception and behaviour parameters (25%). Additionally, workers with high safety levels in perception and behaviour encountered 5.8% fewer accidents than those with low safety levels in these parameters. On the other hand, a higher percentage of accidents were observed in the moderate safety level category for safety leadership (30.4%), safety communication (36.2%), safety training (29.7%), and awareness and competency (28%) parameters. Similarly, workers with low safety levels in tools and machinery

(36.7%) and perception and behaviours (30.8%) parameters had higher accident rates compared to other parameters.

Discussion

After analysing the data on construction accidents, it was observed that the incidence of workplace accidents among construction workers was higher compared to other sectors, especially in cases of fatal accidents. Despite a decrease in the accident rate among construction workers over time, it remains significantly high. The implementation of safety awareness programmes and safety standards by the Department of Labour may have contributed to this decline.

In quantitative terms, the analysis revealed that the rate of non-fatal accidents in the construction industry is 26.4%, which is higher than the prevalence recorded in the ferroalloy industry of Bhutan (20.0%).²³ Further, it is slightly higher than the foreign workers in the construction industry of Malaysia (22.6%) but lower than the Bangladesh construction sector (63.8%). The possible cause of this difference can be the safety cultures and practices existing in different countries. A higher percentage of workplace accidents was recorded due to slips, trips, and falls from height and same level (20.6%) which resembles the situation in countries like the United Kingdom, United States, South Korea, Bangladesh, and China.^{9,8,6,7}

The safety culture in the construction industry concerning eight parameters was found to be at an acceptable level of safety culture in all the parameters with a mean score of three or more. This is in contrast to the record of higher non-fatal accident rate in the construction industry but resembles the study conducted by Wangchuk et al., where it indicated that 84.5% of workers are aware of the importance of wearing protective devices but only 1.4% of them use them always.²⁴ Although putting safety knowledge into practice yields good safety outcomes, this does not seem the case among the workers in the Bhutanese construction industry.

A lower percentage of accidents was observed in the group with higher safety level scores in the tools and machinery, and perception and behaviour parameters. Advancements in tools and machinery with good safety features in the workplace could be a possible factor behind the record of a lower prevalence of non-fatal accidents in the construction industry.

Results also show that those having high levels of safety perception and behaviours encountered 5.8% less frequency of accidents compared to those with low perception and behaviour. The lower percentage of non-fatal accidents among the workers with higher safety level scores on perception and behaviour is in line with the study conducted by Meng et al.,¹⁴ and Al-Bayati¹⁵ where safety behaviour influences the safety performance of the workers. This

finding is also inclined with the fact that the attitude and practices of the workers regarding the use of personal protective devices are associated with a less adverse effect on health.²⁴

Conclusion

Like many developing countries, the construction industry in Bhutan is prone to more hazardous conditions with a higher incidence of workplace accidents. Slips, trips, and falls from heights or same level, as well as manual handling, were identified as the main causes of accidents. The study also revealed that accidents were more prevalent among male workers and those with divorced marital status. Interestingly, the use of Personal Protective Equipment was highly associated with accident prevention, highlighting the importance of positive safety behaviour and perception in the workplace.

The safety culture was evaluated using eight parameters, and the means and standard deviation were analysed. The results indicated an acceptable level of safety culture across most parameters, with an average mean score of three or higher. However, poor safety behaviours among construction workers, a lack of safety training and awareness, and inadequate safety leadership and communication were identified as factors contributing to a higher rate of workplace accidents.

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