

EVALUATING THE SITE SAFETY SCENARIO OF THE CONSTRUCTION INDUSTRY IN KHULNA CITY

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ABSTRACT

Any nation's economic growth depends heavily on its construction industry. Construction workers are the backbone of this industry because of its less mechanized and heavily labor-intensive nature. Therefore, a guarantee of safety for construction workers is of utmost importance. This study evaluates the underlying dangers and their root causes that pose a threat to the workers' safety in the construction sites of Khulna city in Bangladesh. Firstly, a thorough literature evaluation was done to determine the possible causes of construction accidents. This study identified 16 variables that impact job site construction safety performance. After that, a Likert scale questionnaire was created using the data acquired, and a survey was carried out at several construction sites in Khulna City, Bangladesh. The questionnaire survey was analyzed using relative importance index (RII) criteria and validated using the Cronbach alpha test. The survey data revealed significant factors related to the construction site safety absence system. The tendency to make more profit (RII=.812, SD=3.666, Mean=4.06), Inadequate safety training culture in the construction industry (RII=.805, SD=3.627, Mean=4.022), Lack of proper planning to handle emergencies (RII= .804, SD =3.613, Mean= 4.022) are the top 3 crucial factors in the field of construction safety as their RII factor is above 0.80. The government and stakeholders of the construction industry could use the survey results to promote safety and enforce construction safety regulations in the planning stages of future projects.

Keywords: Construction safety, construction management, site management, risk management, safety awareness.

1. INTRODUCTION

A construction site is a location or plot of land where all construction work on a proposed structure is conducted. Construction safety involves necessary steps related to the construction industry or construction sites for people's safety. The construction sector earned 6% of the world GDP in 2018 and is still expanding (Ahmed, Sobuz, & Haque, 2018). Bangladesh is a developing nation; hence, the building sector is vital to the national economy. Infrastructure developments, encompassing both local and large-scale projects, and urbanization are the primary drivers of the construction industry. Both sectors maintain GDP growth rates of almost 8% and 4%. However, one of the most hazardous industries to work in is the construction sector. The ILO states that there are about 60,000 fatal accidents happen in the construction sites of the world each year (Patel & Jha, 2016). Every day, about 950 deaths and over 720,000 workers get hurt because of occupational accidents. The most common causes of these unnatural fatalities include electrocution, falling from a height, and being struck by things, which are due to lack of personal care of employees, less prioritization of safety measures from upper management, defective equipment, less safety awareness and training, etc. The work rate is slowed down by these mishaps and injuries, which often put the workers' families in danger. To ensure the safety of the employees who work in the construction sector, the government passed the following Act/Code at the national level: BLA 2006 (Bangladesh Labor Act 2006) and BNBC 2006 (Bangladesh National Building Code 2006).

The Bangladesh Labor Act 2006 (BLA 2006) covers all labor involved in any job relevant to the nation's GDP. Contrarily, the Bangladesh National Building Code 2006 (BNBC 2006) focuses primarily on the construction industry's labor safety. According to a survey, workers in the construction industry are three times more likely than those in other industries to die or get injuries (Ikediashi & Ogwueleka, 2016). According to statistics, work-related accidents cause thousands of workers' injuries and deaths in Bangladesh each year, with the construction sector accounting for more than 40% of these incidents. Therefore, to accomplish the intended outcome, it is critical to pinpoint the precise elements required for the effective execution of safety initiatives. Lack of education and training, ignorance of safety precautions, resistance to implementing safety measures, and careless behavior are the components of inadequate construction safety management. The fact that falls during building construction account for 55% of fatal accidents should receive attention (Shao, Hu, Liu, Chen, & He, 2019). The bulk of construction accident victims are workers 45 and older, indicating serious challenges with labor shortages and aging labor, two global concerns (Chiang, Wong, & Liang, 2018). The construction business in Bangladesh is characterized by a higher-than-average number of fatal accidents and severe injuries, as well as physical property damage, dangers, and complexity compared to other countries worldwide (Islam, Razwanul, & Mahmud, 2017). Approximately 179 persons lost their lives in construction accidents in Bangladesh in 2017, compared to 145 and 172 in 2016 and 2015, respectively (Ahmed et al., 2018). Construction accidents are the main cause of project delays, which also affect the quality of the work (Aziz & Abdel-Hakam, 2016)

Consequently, the authors have identified the factors from the existing literature and identified the top 16 factors obstructing construction safety, as presented in Table 1. Recently, a few construction site workers met gruesome deaths due to a lack of safety standards at the construction sites, resulting in both human and material losses. Therefore, this study identifies the factors necessary for construction safety. The main objective of this study is to explore the safety aspect of building sites and examine the safety element that affects construction site safety performance. For this, questionnaire survey research was done following three stages: i) Literature review, ii) forming questionnaire, iii) field survey, and data analysis. A field survey was conducted using an open questionnaire, during which experts gave their opinion. This study is expected to contribute to the construction field by allowing contractors and project managers to improve their awareness and focus on the most important factors of construction safety.

2. METHODOLOGY

A thorough literature review and an investigation of the current laws and regulations governing construction safety in Bangladesh were used to determine the risk to construction workers' safety in the real world. The survey was then carried out at several construction sites, and the questionnaires were developed based on the literature research.

Table 1: Factors affecting site safety in the construction industry

Category	Sym.	Factor	Reference
Organization related Factors (ORF)	ORF1	Less prioritization on Safety Measures From top management.	(Aliyu, Bello, Muhammad, Singhry, & Bukar, 2016)
	ORF2	Inadequate Safety Training culture in the construction industry.	(Hauashdh, Jailani, & Rahman, 2021)
	ORF3	Lack of Fall protection.	(Jandali & Sweis, 2018)
	ORF4	Improper inspection in different stages of construction.	(Hassanain, Assaf, Al-Ofi, & Al-Abdullah, 2013; Jandali & Sweis, 2018)
Human Resource-related Factors (HRF)	HRF1	Lack of Safety Awareness.	(Ahmed, Hossain, & Haq, 2021)
	HRF2	Lack of personal care.	(Ahmed et al., 2018)
	HRF3	Less use of safety signs.	(Hauashdh et al., 2021)
	HRF4	Failure to communicate effectively in emergency situations.	(Vitharana, De Silva, & De Silva, 2015)
Technical related Factors (TRF)	TRF1	Defective equipment and errors during Operating it.	(Ahmed et al., 2018)
	TRF2	Lack of Expertise Knowledge.	(Hauashdh et al., 2021)
	TRF3	Improperly maintained stairways & lift hollows lead to severe accidents.	(Hassanain et al., 2013)
	TRF4	Less Head protection.	(Hassanain et al., 2013)
Contractor related (CR)	CR1	Errors in Decision making.	(Suraji, Sulaiman, Mahyuddin, & Mohamed, 2006)
	CR2	Lack of proper planning to handle the emergency situations.	(Aliyu et al., 2016)
	CR3	Tendency of making more profit, which leads to cost cutting in safety measures.	(Ahmed et al., 2018)
	CR4	Lack of governance in imposing safety rules & regulations.	(Ahmed et al., 2021)

2.1. Data Collection

At the construction site in Khulna City, a thorough survey was conducted to examine the factors affecting construction safety. The survey's diverse target respondents included engineers, project managers, students, workers, and contractors, and they all provided a wealth of theoretical knowledge and real-world experience. The data was collected using a combination of in-person interviews and online surveys, allowing participants freedom and accessibility. The construction site provided the ideal setting for obtaining individual information and viewpoints, enabling a thorough analysis of the variables affecting construction safety.



Figure 1: Survey at different construction sites

2.2. Questionnaire Design

The survey's questions were designed to determine respondents' opinions on several Bangladesh's construction safety risk variables. The amenities available on construction sites may be impacted by sixteen chosen factors (based on articles published on the Asian subcontinent) among 30 factors after reviewing the literature. There was no bias involved in the process of creating these inquiries. Most of the participants comprised contractors, engineers, project managers, employees, and students. The questions were developed using the conventional five-point scale because that is how we often grade our responses: strongly agree (5 points), agree (4 points), neutral (3 points), disagree (2 points), and strongly disagree (1 point).

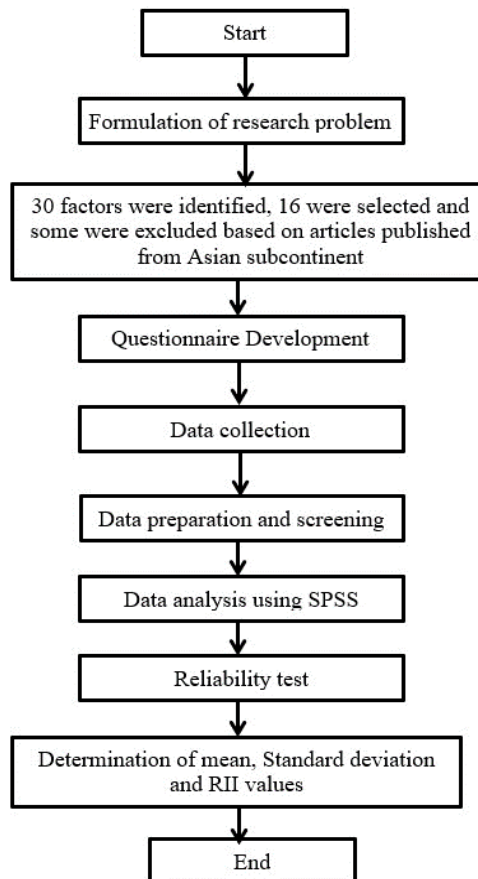


Figure 2 - Research flow chart

2.3 Data Analysis

A descriptive analysis was performed using the survey's raw data. Descriptive analysis is a helpful tool. The respondents' assessed relative importance of several elements was illustrated using descriptive statistics, namely the relative importance index (RII). The gathered data was analyzed using Microsoft Excel and the statistical package for social sciences (SPSS) software to determine the mean, standard deviation, and RII. SPSS is used to confirm that the information gathered is reliable. The RII was used to examine the respondent's evaluations. A validation test was run using Cronbach's alpha test for the collected data.

2.3.1 Relative important index (RII): Numerous studies indicate that because they do not show any relationship between the elements, each factor's mean and standard deviation are inadequate metrics for evaluating overall rankings. The RII is capable of successfully resolving the difficulties listed above. This study attempted to rank the discovered delay-causing causes and effects in order of significance using the RII approach. This equation was used to calculate the RII:

$$RII = \frac{\sum w}{A \times N} \quad (1)$$

“Where W= weighting of each factor given by respondents, A= maximum weight, which is 5 for this study, N= total number of respondents, which is 133. The calculated RIIs range from 0 to 1. The factors are ranked from highest to lowest, factors with the highest RII or rank 1 having the greatest effect on the safety, and those with the lowest rank having the smallest impact on the accident causes.”

2.4 Data Validation Test

Numerous sources, including respondents with different designations and projects, provided data for this investigation. Ensuring the correctness and dependability of the independently gathered data also requires a data reliability analysis. With several Likert questions in a questionnaire, one of the most used reliability tests is Cronbach's alpha. Cronbach's alpha measures the factors' internal consistency. The Cronbach's alpha reliability test in this analysis used SPSS software. Table 2 displays the range of the internal consistency of the Cronbach's alpha coefficient. Its value ranges from 0 to 1. Increased reliability across the items is indicated by a higher value.

Table 2: Internal consistency of Cronbach's alpha coefficient

Cronbach's alpha (α)	Internal-consistency
$\alpha \geq 0.9$	Excellent
$0.7 \leq \alpha < 0.9$	Good
$0.6 \leq \alpha < 0.7$	Acceptable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

3. RESULT AND DISCUSSION

3.1 Survey Outcome

After conducting the survey (133 Responses), here by using total survey responses, the study shows and indicates which factors rank top and most impactful based on mean method calculation, standard deviation, and relative index of inequality method. After analyzing data from the questionnaire survey, the reliability of the survey data was checked by using Cronbach's alpha test. The alpha value was 0.917 for the obtained data, which stated excellent internal consistency. Moreover, Table 3 presents the complete responses of data with the RII value.

Table – 3: Survey responses

Sym.	Factors	Mean	Standard Deviation	RII	Rank
ORF1	Less prioritization on Safety Measures From top management.	3.849	3.477	0.770	07
ORF2	Inadequate Safety Training culture in construction industry	4.022	3.627	0.805	02
ORF3	Lack of Fall protection	3.662	3.279	0.732	15
ORF4	Improper inspection in different stages of construction	3.782	3.376	0.756	10
HRF1	Lack of Safety Awareness	3.872	3.511	0.774	06
HRF2	Lack of personal care	3.692	3.327	0.738	14
HRF3	Less use of safety sign	3.736	3.356	0.747	11
HRF4	Failure to communicate effectively in emergency situations	3.834	3.448	0.767	08
TRF1	Defective Equipment's & Errors during Operating it	3.887	3.501	0.777	05
TRF2	Lack of Expertise Knowledge	3.706	3.331	0.741	13
TRF3	Improperly maintained stairways & lift	3.789	3.392	0.758	09
TRF4	Less Head protection	2.323	2.022	0.465	16
CR1	Errors in Decision making	3.721	3.317	0.744	12
CR2	Lack of proper planning to handle the emergency situations.	4.022	3.613	0.804	03
CR3	Tendency of making more profit, which leads to cost cutting in safety measures	4.060	3.666	0.812	01
CR4	Lack of governance in imposing of safety rules & regulation.	3.924	3.520	0.785	04

Along with the RII value, mean and standard deviation are used to analyze the survey questionnaire and their answers. As per Figure 2, “Tendency of making more profit, which leads to cost-cutting in safety measures (RII=.812, SD=3.666, Mean=4.06)”, “Inadequate safety training culture in the construction industry (RII=.805, SD=3.627, Mean=4.022)” and “Lack of proper planning to handle the emergencies (RII= .804, SD =3.613, Mean= 4.022)” are the top 3 crucial factors in the field of construction safety as their RII factor is above 0.80. So, these factors need immediate mitigation in a proper and effective way. The greedy owner’s existence in Bangladesh's construction field makes this sector creepy. They are indifferent to the workers' safety and make more profit by investing less in safety sectors. It is the duty of every safety officer to ensure proper guidelines in every emergency, but hardly the officers do so, and accidents happen frequently. The construction safety sector in Bangladesh will improve only when the owners and other officials refrain from greediness, corruption, and impersonality.

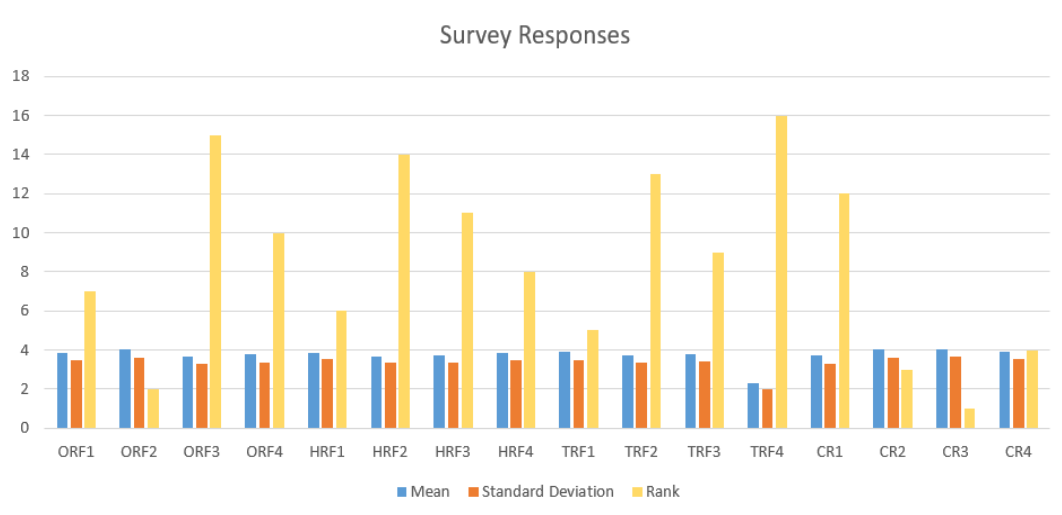


Figure 3: The mean, sd, and rank of factors

The “Lack of governance in imposing of safety rules & regulation (RII=.785, SD=3.520, Mean= 3.924)”, “Defective Equipment’s & Errors during operating it (RII=.777, SD=3.501, Mean= 3.887)” and “Lack of safety awareness (RII=.774, SD=3.511, Mean=3.872)” are the mediocre factors as their RII values are above 0.77. By resolving these barriers, the construction safety era of Bangladesh could go far. Workers' personal irresponsibility, disobedience to rules and regulations, and contractor’s defective supplies should be minimized for sorting out the factors.

According to analysis of Figure 3, it is observed that the bottom three barriers are “Lack of fall protection (RII=.732, SD=3.279, Mean=3.662)”, “Lack of personal care (RII=.738, SD=3.327, Mean=3.692)” and “Lack of expertise knowledge (RII=.741, SD=3.331, Mean=3.706)” as their RII values are less than 0.742. After resolving the top crucial factors, these bottom barriers have to be looked at.

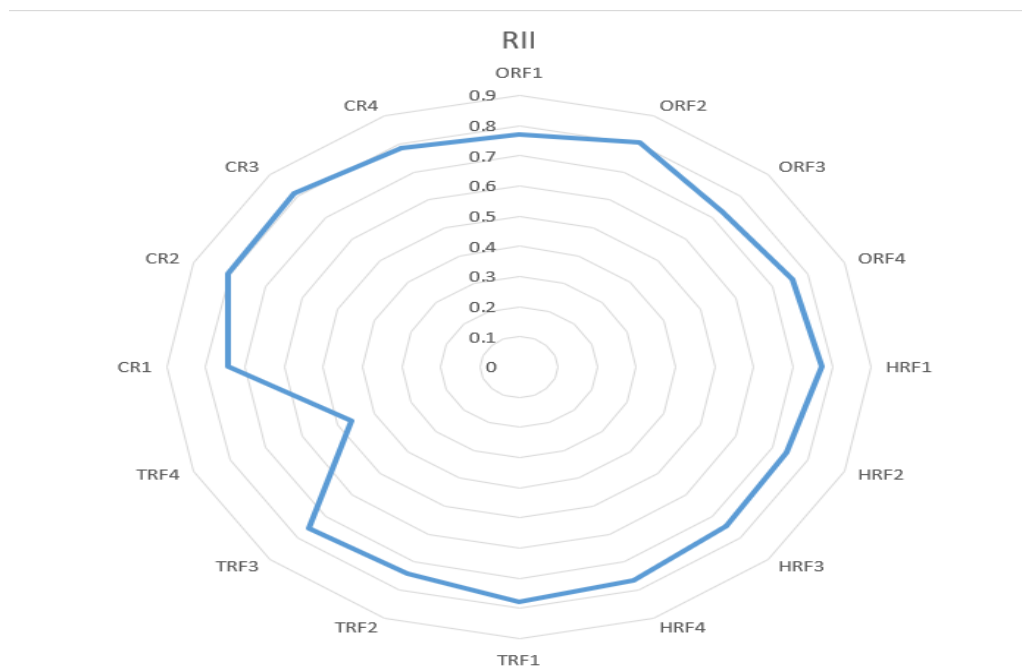


Figure 4: Radial graph of factors

4. DISCUSSION AND FUTURE PROSPECTS

From the era when construction workers had limited safety means, it has been upgraded in the construction site to be fulfilled with all safety equipments. A synopsis of the spectrum of the latest inquiries about the safety sector in construction is compared with recent studies (Ahmed et al., 2018). evaluated the scenario of accidents on construction sites in Bangladesh. Jandali and Sweis (2018) conducted research on the assessment of factors affecting the maintenance management of hospital buildings in Jordan. Othman, Shafiq, and Nuruddin (2017) assessed effective safety management in construction projects. Winge, Albrechtsen, and Arnesen (2019) researched a comparative analysis of safety management and safety performance in twelve construction projects. The recent papers conducted research based on accidents on sites, effective safety management, and comparative safety performance. In the current study, the research was conducted to identify the crucial factors that affect and are the core reason for hampering the construction safety of workers and all related stakeholders regarding the context of the construction industry in Khulna, Bangladesh. The current study provides insights into factors that need to be mitigated and provides a vast research gap opportunity to work with the factors of safety that can be mitigated and improved, which will ensure construction safety. Additionally, our study includes some recommendations that can be implemented in the construction industry for effective safety management.

Safety ensures for workers and all related stakeholders in the construction industry in Bangladesh is being hampered for several reasons. For that, casualties, economic loss, interruptions in project work, and many barriers happen on construction sites. In this study, the major factors identified in the construction industry responsible for hazards and accidents in construction sites. The factors were determined by a literature review and surveyed to find the top factors that need mitigation. Under the circumstances, we are suggesting some recommendations below which create a safer environment in construction sites for stakeholders regarding crucial factors:

1. Training, incentives, regular audits, ethical relationship plays a vital role in mitigating the tendency to make more profit.
2. Comprehensive training process, regular refresher courses, clear signage, supervision and monitoring, and incident analysis are also important to mitigate construction hazards.
3. Regulatory compliance, stakeholder engagement, public awareness campaigns, industry certification, data collection, and analysis litigation play a vital role in mitigating the construction relative problems (Winge et al., 2019).
4. Equipment, inspection and maintenance, supplier and vendor evaluation error prevention, supervision and oversight, and emergency response plan play a significant role in dealing with the dangers of defective equipment and errors.

5. CONCLUSION

In this study the safety-related issues in the construction industry in Khulna city have been outlined. After reviewing existing literature, 16 significant factors were chosen for a Likert scale-based questionnaire survey. The survey was conducted at several construction sites in Khulna city. According to the survey result, the most dominant factor is “Tendency of making more profit, which leads to cost-cutting in safety measures” which ultimately gives rise to other factors such as defective equipment, lack of fall protection, less head protection, an insufficient amount of PPE that affect the safety in the field of construction. Other major factors were “Lack of proper planning to handle the emergency,” “Inadequate safety training culture in the construction industry,” “Lack of governance in imposing of safety rules and regulations,” and “Defective equipment & error while operating it.” As ignorance plays a vital role here, training incentives and comprehensive training processes are suggested to allow everyone in the construction industry to know about the consequences and preventions of these factors and mitigate those factors in the future. Besides raising awareness through safety training and campaigns, regular supervision and monitoring, incident analysis, equipment

inspection, and maintenance are also advised to execute. More construction sites from additional areas can be surveyed to obtain a more precise result related to the topic.

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