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Barriers to Implementing Safety Measures During COVID-19 Pandemic on Building Construction Projects in Nepal

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Abstract

The COVID-19 pandemic caused disruptions in building construction projects, with safety measures being a major concern for workers and the public. This study aims to assess the barriers to safety measures during the COVID-19 pandemic on building construction projects in Nepal. A total of 330 responses were collected from construction professionals in Nepal using a Likert scale. To ensure the data's suitability for factor analysis using Principal Component Analysis, Kaiser-Meyer-Olkin, Bartlett's Sphericity test, inter-component correlations, and Cronbach alpha scores for internal consistency were checked, and principal components were extracted. A 25-item safety barrier to safety measures in building construction projects during the COVID-19 pandemic was identified through an extensive review of the literature; six components were retained using Principal Component Analysis which represented the model of choice and explained 62.86 % of the data variance. The components were; inappropriate safety guidelines, psychological working pressure, inadequate hygiene monitoring and control, lack of safety awareness, improper working culture, and insufficient planning and scheduling. The internal consistency for the retained components was high; Cronbach α scores ranged from 0.72 to 0.796. “Inappropriate Safety Guidelines” was the most critical barrier to implementing safety measures during the COVID-19 pandemic in building construction projects, according to the rankings of the six identified components. It is recommended that construction professionals and regulatory bodies prioritize the development and adherence to robust safety protocols tailored to pandemic conditions. Regularly updating and reinforcing these guidelines will be crucial in safeguarding the health and well-being of workers while ensuring project continuity. Additionally, investing in thorough training and awareness programs can significantly mitigate this barrier's impact.

Keywords: Building construction projects; COVID-19 pandemic; Principal component analysis; Safety barriers; Safety measures

Introduction

The COVID-19 pandemic has had a remarkable impact on the safety sectors worldwide, and the construction industry has been greatly affected. Barriers to safety measures, in building construction projects due to COVID-19 have been considered important topics that plague stakeholders in building construction projects.

Neither the government nor the construction professionals in Nepal explored barriers to safety measures and barriers toward a possible pandemic unmanageable against which construction professionals must first identify the fundamental cause and its effect, after which they could prioritize prevention. However, many researchers have focused on the study of the effects or impact of COVID-19 on the construction industry but, limited insights have been provided for the major critical factors affected due to COVID-19, and barriers to safety measures, in building construction projects.

(Amoah and Simpeh, 2021) highlights challenges of COVID-19 safety measures on building construction projects. These challenges encompass a wide array of issues, including a pervasive ignorance regarding the pandemic's implications, the subpar quality of Personal Protective Equipment (PPE) provided by contractors, a concerning lack of adherence to health protocols, obstacles in sharing tools and equipment among workers, challenges related to public transportation due to restrictions, deeply ingrained superstitions, and noteworthy offsite behaviors. To overcome the situation created by the pandemic first the barriers are essential to be identified. This research aims to highlight the major barriers to implementing safety measures to reduce COVID-19 or similar pandemic situations in building construction projects in Nepal.

Literature Review

As the COVID-19 epidemic spread over the world, it caused enormous fear, tension, and stress, affecting practically everyone. It has an impact not just on people's physical health, but also on their mental health and sense of well-being even though employees were worried about job security, and were forced to work despite heightened health risks (Grensing-Pophal, 2020). The lack of control was another hazard, as much of the control that an employee has traditionally had over how they perform their job was been withheld by COVID-19 restrictions (Letitia, 2020).

(Pamidimukkala et al., 2021) highlighted major safety and health concerns that the construction workforce may face during the COVID-19 pandemic, mainly concerns about the risk of being exposed to the virus at work, family pressure, managing workloads, isolation, lack of access to equipment, low self-esteem, uncertainty about the future of the workforce, adapting to different workplaces and new schedules, and learning new communication tools and dealing with technical difficulties.

Major challenges to implementing safety measures in building construction projects from COVID-19 pandemic

Table 1: Barriers to implementing safety measures in building construction project due to COVID-19 pandemic

S. N	Major Safety Barriers Challenges	Sources
1	Ignorance of COVID-19	(Amoah and Simpeh, 2021)
2	Supply of poor PPEs by contractors	(Amoah and Simpeh, 2021)
3	Difficulty in sharing tools and equipment	(Amoah and Simpeh, 2021)
4	Lack of funds to implement COVID-19 measures	(Amoah and Simpeh, 2021)
5	Poor safety culture	(Maqbool and Khan, 2020)
6	Lack of strict enforcement of WHO regulations	(Maqbool and Khan, 2020)
7	Supply of wrong information by the workers	(Amoah and Simpeh, 2021)
8	Site access and egress (one-way systems; minimize congestion; hygiene; site inductions)	(Stiles et al., 2021)
9	Lack of resources for implementing public health and social measures	(Maqbool and Khan, 2020)
10	Sanitizing all materials	(Maqbool and Khan, 2020)
11	Lack of government policies	(Maqbool and Khan, 2020)
12	Personal protective equipment (PPE) shortages	(Alsharef et al., 2021)
13	New procedures to provide health and safety on-site	(Sierra, 2022)
14	Lack of safety leadership across the sector	(Stiles et al., 2021)
15	Lack of safety measures compliance	(Amoah and Simpeh, 2021)
16	Incorrect use of face mask	(Amoah and Simpeh, 2021)
17	Inadequate work planning to avoid close contact	(Stiles et al., 2021)

18	Inappropriate hygiene at the workplace (Hand washing, promoting hygiene, guidance for cleaning of hygiene areas)	(Stiles et al., 2021)
19	Learning new communication tools and dealing with technical difficulties.	(Bou Hatoum et al., 2021)
20	Thinking of personal and family while working	(Bou Hatoum et al., 2021)
21	Major concerns about the risk of being exposed to the virus at work	(Bou Hatoum et al., 2021)
22	Uncertainty about the future of the workplace	(O'Connor et al., 2021)
23	Taking responsibility for personal and family needs while working	(Bavel et al., 2020)
24	The feeling of not contributing enough to work	(CDC, 2022)
25	Adjusting to a different workplace and work schedule	(CDC, 2022)

Methodology

This study aimed to identify the primary barriers to implementing safety measures in building construction projects during the COVID-19 pandemic period in Nepal, utilizing quantitative research methods and a cross-sectional design. The targeted study population comprised project managers, contractors, consultancies, site engineers, suppliers, and procurement officers who were actively involved in various commercial and government building construction projects in Nepal. A total of 330 individuals were surveyed using a questionnaire that was prepared by reviewing previous research articles and included a Likert scale of five ordinal measures from one (1) to five (5) (1=Strongly Agree; 2=Agree; 3=Neutral; 4=Disagree; 5=Strongly Disagree). The respondents were asked to rank the barriers to implementing safety measures in building construction projects based on frequency of occurrence according to their judgment and experience. After data collection, the data was processed, cleaned, and prepared for analysis. Principal Component Analysis (PCA) was used to extract the major components underlying the dimensions of barriers to implementing safety measures, with the help of SPSS version 25.

Result and Discussion

Demographic and professional information of respondents:

Table 2: Demographic and professional information of respondents

Variable	Frequency	Percent	Variable	Frequency	Percentage
Age (in years)			*Education*		
20-25	159	48.18	Higher Secondary	74	22.42
26-35	135	40.91	Undergraduate	89	26.97
36-45	27	8.18	Graduate	98	29.70
46 or above	9	2.73	Postgraduate	69	20.91
Work experience (in year)			*Professionals*		
1-4	116	35.15	Contractor	122	36.97
5-8	117	35.45	Consultancy	95	28.79
9-12	58	17.58	Suppliers	46	13.94
13 or more	39	11.82	Site Engineers	67	20.30

Table 3 provides a comprehensive overview of the demographic and professional information of the respondents. In terms of age distribution, the majority fall within the 20-25 and 26-35, accounting for 48.18% and 40.91% respectively. The older age groups, 36-45 and 46 or more represent smaller segments, making up 8.18% and 2.73% respectively. Regarding educational attainment, the largest group has completed their graduate studies, comprising 29.70% of the respondents. This is closely followed by undergraduates at 26.97%, while those with higher secondary education make up 22.42%. Post-graduate education is the least common, constituting 20.91% of the sample.

A majority of respondents have accumulated 1-8 years of professional experience. Specifically, those with 1-4 years and 5-8 years of experience represent 35.15% and 35.45% respectively. Participants with 9-12 years of experience make up 17.58% of the group, while those with 13 or more years of experience constitute 11.82%.

In terms of professions, the largest group is comprised of Contractors at 36.97%, followed by Consultancy professionals at 28.79%. Site Engineers make up a substantial portion at 20.30%, while Suppliers represent the smallest category, accounting for 13.94%. This data paints a vivid picture of a diverse and dynamic respondent population, showcasing a broad range of ages, educational backgrounds, work experiences, and professional roles within the sample group.

Reliability Analysis:

Cronbach's alpha (α) was employed to assess the internal consistency of the factors related to barriers to implementing safety measures. The obtained alpha values indicated a high level of reliability 0.802, which exceeded the recommended threshold of 0.70 proposed by (Nunnally, 1978).

Kaiser–Meyer–Olkin (KMO) and Bartlett's tests:

Kaiser–Meyer–Olkin (KMO) and Bartlett's tests were performed to examine the suitability of these data for PCA. The KMO measure of sampling adequacy of items was performed and found 0.829, in the meritorious range according to Kaiser (1974). Additionally, Bartlett's test was significant ($\chi 2$ = 1449.595, df = 300, Sig. = 0.000), indicating a significant correlation among the variables and thus making it suitable for factor analysis (Shrestha et al., 2021).

Factor extraction for safety measures barriers:

The Scree test and eigenvalue were used to identify six components through Varimax rotation. Based on the results shown in Figure 1, it was found that there are six factors with eigenvalues greater than one that contribute significantly to the total variability observed in the data. On the other hand, the remaining factors only account for a minor proportion of the variability and are therefore considered less important (Shrestha et al., 2021).

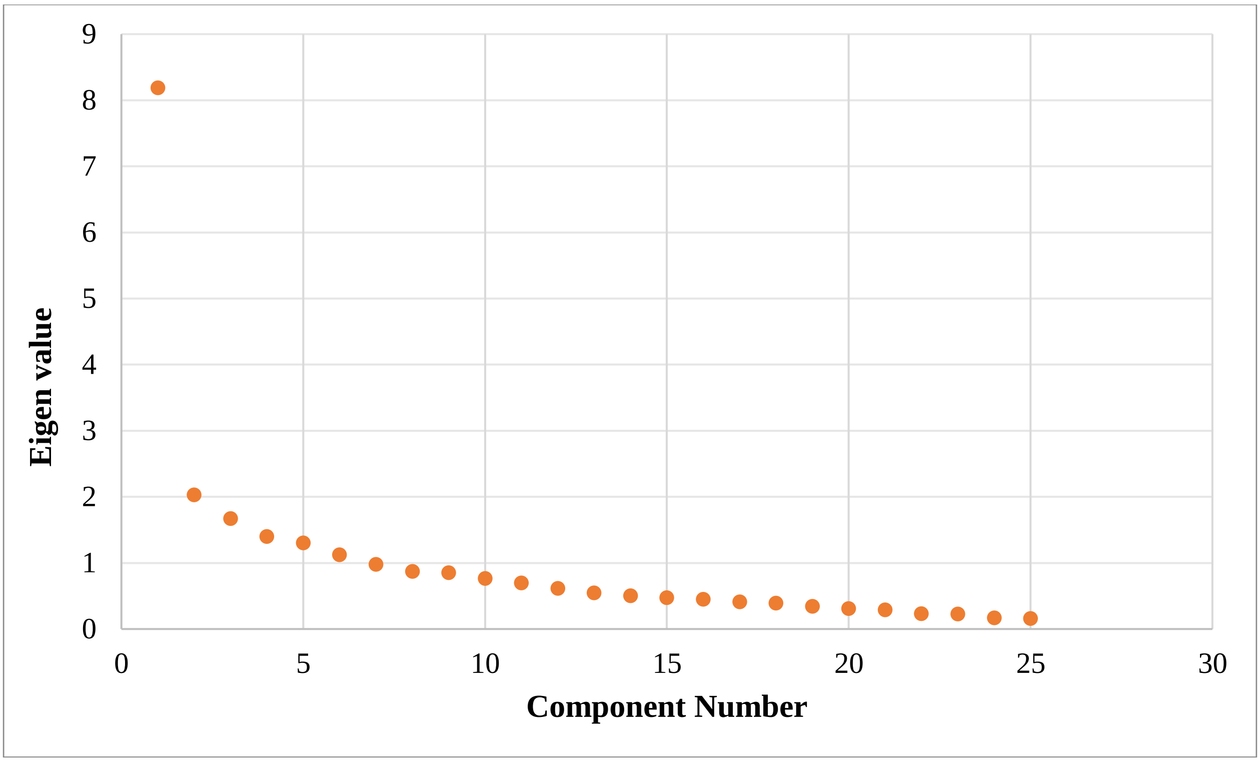

Figure 1: Scree Plot

In Table 3, each factor is presented with its corresponding eigenvalue and percentage of variance explained by each component.

Table 3. Eigenvalue and total variance explained by the components

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.189	32.756	32.756	8.189	32.756	32.756	4.323	17.293	17.293
2	2.031	8.125	40.882	2.031	8.125	40.882	3.616	14.465	31.758
3	1.673	6.690	47.572	1.673	6.690	47.572	2.814	11.258	43.016
4	1.399	5.595	53.167	1.399	5.595	53.167	1.964	7.857	50.873
5	1.301	5.205	58.372	1.301	5.205	58.372	1.548	6.192	57.065
6	1.122	4.487	62.859	1.122	4.487	62.859	1.449	5.794	62.859
7	0.976	3.906	66.765						

8	0.874	3.494	70.259						
9	0.851	3.402	73.662						
10	0.763	3.052	76.713						
11	0.699	2.798	79.511						
12	0.617	2.468	81.980						
13	0.546	2.184	84.164						
14	0.504	2.016	86.179						
15	0.474	1.896	88.075						
16	0.448	1.793	89.868						
17	0.411	1.645	91.513						
18	0.391	1.563	93.077						
19	0.344	1.376	94.453						
20	0.311	1.245	95.697						
21	0.288	1.152	96.850						
22	0.234	0.935	97.784						
23	0.226	0.906	98.690						
24	0.167	0.668	99.358						
25	0.161	0.642	100.00						

Component 1 has the highest eigenvalue of 8.19 and accounts for 32.76% of the variance, followed by Component 2 with an eigenvalue of 2.03 and explaining 8.13% of the variance, Component 3 with an eigenvalue of 1.67 and explaining 6.69% of the variance, Component 4 with an eigenvalue of 1.40 and explaining 5.60% of the variance, Component 5 with an eigenvalue of 1.30 and explaining 5.21% of the variance, and Component 6 with an eigenvalue of 1.12 and explaining 4.49% of the variance. Overall, these six factors account for a combined 62.82% of the total variance in the barriers to implementing safety measures.

Factor Rotation and Interpretation for Barriers to Implementing Safety Measures

Table 4: Principal component analysis of barriers to implementing safety measures

Barriers to implementing safety measures	Components					
	Inappropriate safety guidelines	Psychological working pressure	Inadequate hygiene monitoring and control	Lack of safety awareness	Improper working culture	Insufficient planning and scheduling
Ignorance of COVID-19					0.855	
Poor safety culture	0.817					
Lack of strict enforcement of WHO regulations	0.701					
Lack of resources for implementing public health and social measures	0.709					
Sanitizing all materials				0.720		
New procedures to provide health and safety on-site				0.712		
Incorrect use of face mask			0.764			
Inadequate work planning to avoid close contact			0.781			
Inappropriate hygiene at work place (Hand washing, promoting hygiene, guidance for cleaning of hygiene areas)			0.747			
Thinking of personal and family while working		0.790				
Major concerns about the risk of being exposed to the virus at work		0.700				
Taking responsibility for personal and family needs while working		0.782				
Adjusting to a different workplace and work schedule						0.825

Rotation method: Varimax with Kaiser normalization.

Table 4 shows that out of the 25 barriers to implementing safety measures, only 13 were identified as major critical barriers, and all of these were further divided into six components. The remaining 12 barriers to implementing safety measures with factor loading less than 0.5 were omitted.

Component 1: Inappropriate Safety Guidelines

'Inappropriate Safety Guidelines' is the first critical barrier in building construction projects to implementing safety measures which contain three factors that strive for poor safety culture, lack of strict enforcement of WHO regulations, lack of resources for implementing public health and social measures. These factors have a correlation of 0.817, 0.701, and 0.709 with component 1, respectively, and account for 32.756% of the total variance with an eigenvalue of 8.189. Previous studies (Maqbool and Khan, 2020) have also shown that poor safety culture, inadequate enforcement of WHO regulations, and insufficient resources hinder the implementation of public health and safety measures to prevent COVID-19 in construction projects.

Component 2: Psychological Working Pressure

'Psychological Working Pressure' is considered the as second major critical safety barrier to implementing safety measures in building construction projects, which is explained with 8.125% variance with an eigenvalue of 2.031. This component contained three items such as thinking of personal and family while working, major concerns about the risk of being exposed to the virus at work, and taking responsibility for personal and family needs while working, and have correlation of 0.790, 0.700, and 0.782 with Component 2 respectively. Several past research studies have identified that considering personal and family needs while working, worrying about the risk of being exposed to the virus at work, and being responsible for personal and family needs while working are significant safety barriers to implement in the construction industry (Pamidimukkala et al., 2021, Bou Hatoum et al., 2021, Pamidimukkala and Kermanshachi, 2021).

Component 3: Inadequate Hygiene Monitoring and Control

'Inadequate Hygiene Monitoring and Control', is identified as the third critical barrier to implementing safety measures in building construction projects. It contains three factors namely "incorrect use of face mask", "inadequate work planning to avoid close contact with different lifestyles", and "inappropriate hygiene at workplace" and which have a correlation of 0.764, 0.781, and 0.747 with Component 3 respectively. This component contributes to 6.690% of the total variance and holds an eigenvalue of 1.673, underscoring its significance in the overall analysis. Previous research (Amoah and Simpeh, 2021, Stiles et al., 2021) also proves that inadequate use of a face mask for stress reduction, insufficient work planning to avoid close contact with people who have different lifestyles, and poor cleanliness at work are all major impediments to implementing safety measures in the construction business.

Component 4: Lack of Safety Awareness

'Lack of Safety Awareness', is identified as the fourth critical barrier to implementing safety measures in building construction projects. It contains two factors namely "incorrect sanitizing of all materials", and "new procedures to provide health and safety on-site" and which have a correlation of 0.720, and 0.712 with Component 4 respectively. This component accounts for 5.595% of the total variance and has an eigenvalue of 1.399, indicating its importance in the overall analysis. (Sierra, 2022, Maqbool and Khan, 2020) also found that sanitizing all materials, and new procedures to provide health and safety on-site should be considered as they are all major safety measures barriers to implement in the construction industry.

Component 5: Improper Working Culture

The 'Improper Working Culture,' is the fifth critical safety barrier in building construction projects, posing challenges to the effective implementation of safety measures. This component specifically pertains to one key factor: the incorrect handling of COVID-19 precautions, which shows a strong correlation of 0.855 with Component 5. This component accounts for 5.205% of the total variance and has an eigenvalue of 1.301. (Amoah and Simpeh, 2021) also shows that an ignorance of knowledge of COVID-19 is one of the most significant safety barriers to address in the construction industry.

Component 6: Inadequate Planning and Scheduling

'Inadequate Planning and Scheduling,' represents the sixth critical barrier to implementing safety measures in building construction projects. It contains one factor namely adjusting to a different workplace and work schedule which has a correlation of 0.825 with Component 6. This component accounts for 4.487% of the total variance and possesses an eigenvalue of 1.122. (CDC, 2022) additionally, shows that adjusting to a different workplace and work schedule makes it difficult to maintain safety measures owing to its varied job nature and work schedule.

Reliability and Validity of Retained Components

The Cronbach alpha (α) score was calculated to assess the internal consistency and reliability of each component. The obtained results demonstrated that the α coefficients of the dimensions ranged from 0.727 to 0.796, which indicated a high level of reliability, as the values exceeded the acceptable threshold of 0.70 suggested (Baggio and Klobas, 2017). The Component Transformation Matrix (Table 5), derived from Principal Component Analysis (PCA) with Varimax rotation, reveals the intricate relationships between six original variables and the resulting extracted components. Employing Varimax rotation aims to maximize component independence, enhancing interpretability. Within the matrix, the loadings clearly illustrate the magnitude and direction of each variable's influence on the components. It is noteworthy that each component prominently loads on specific variables, while others exhibit comparably lower loadings. This distinctive pattern suggests a substantial degree of independence between the components, reflecting distinct dimensions. Consequently, this Varimax-rotated PCA method effectively elucidates distinct and meaningful facets of the underlying data structure.

Table 5: Component transformation matrix

Component Transformation Matrix						
Component	1	2	3	4	5	6
1	0.600	0.393	0.310	0.382	0.216	0.027
2	-0.320	0.858	-0.310	0.196	0.153	0.056
3	0.255	-0.221	0.590	-0.452	-0.330	0.453
4	0.317	-0.397	-0.035	0.637	-0.141	-0.238
5	-0.304	-0.101	-0.388	0.237	0.568	-0.135
6	-0.009	-0.092	-0.121	0.386	-0.335	0.846
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.						

Research Implication

Policymakers should prioritize developing and implementing clear and appropriate safety guidelines against a pandemic like COVID-19 in the coming future in building construction projects, with the collaboration of construction professionals, government organizations, and other related stakeholder organizations. The policy intervention could include strict enforcement of WHO regulations and the promotion of a strong safety culture in the construction industry.

Policymakers should address various components identified in the study, including providing workers with necessary support for reducing psychological pressure and promoting proper hygiene monitoring. They can do this by implementing guidelines for proper hygiene practices, providing adequate sanitation facilities, and supporting workers to reduce misunderstandings related to pandemics. These policy interventions can promote a safer and healthier work environment, minimizing the impact of pandemics, and enhance safety of construction workers.

Conclusion

The barriers to implementing safety measures in building construction projects during the COVID-19 pandemic were identified and categorized into six principal components, that are inappropriate safety guidelines, psychological working pressure, inadequate hygiene monitoring and control, lack of safety awareness, improper working culture, and insufficient planning and scheduling. These six components explained the 62.859% of the variation in barriers to implementing safety measures in building construction projects indicating inappropriate safety guidelines as the most critical barrier to implementing safety measures. Construction professionals, government organizations, and other related stakeholder organizations should work together to establish clear and appropriate safety guidelines to overcome the barriers to implementing safety measures during pandemic situations in building construction projects.

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