Research Article *Volume 18* *Issue 1*

ISSN NO. 2091-1742

SCITECH NEPAL

Journal of Scientific and Technical Studies

Nepal Engineering College, Pokhara University

Received: June 10, 2025

Accepted: January 30, 2026

DOI: https://doi.org/10.3126/scitech.v18i1.90813

Assessing the Impacts of COVID-19 on Nepal's Construction Industry: Insights from Principal Component Analysis

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Abstract:

This study assesses the impacts of COVID-19 in Nepal's construction industry. A total of 387 responses were examined by Principal Component Analysis (PCA) technique with the help of SPSS software. PCA analysis identified five major components, which together accounted for 62.022% of the variation. The most important impact component observed was time and cost overruns, which accounted for 27.342% of the variation and had an eigenvalue of 5.742 with delay in completion of projects as the major indicator with coefficient 0.794. Likewise, the second major impact component was financial restrictions, accounted for 14.267% of the variation and had an eigenvalue of 2.996 with deterioration of financial condition of contractor due to loss in projects as the major indicator with coefficient 0.731. Based on these findings, it is advised deployment of cutting-edge technology, early purchasing of materials and following strict cost control measures would assist to prevent the impacts of COVID-19 on the construction industry.

Keywords: COVID-19, Impacts, Principal Component Analysis, Construction Industry.

1. Introduction

The construction industry contributes about 5.5% to the GDP of Nepal (MOF, 2023). Moreover, the construction industry employs 1 million people i.e., 14% of total employment generation in the country. However, COVID-19 posed an unprecedented threat to the construction industry of Nepal. In order to fight with COVID-19, the government imposed a nationwide lockdown which resulted in the shutdown of construction activities (Shrestha, 2022). COVID-19 severely impacted the construction industry due to which the growth rate of the construction industry of Nepal fell by negative 0.31% in Fiscal Year 2019/20 (Prasain, 2020).COVID-19 caused delay in completion of the project, supply chain problems, workforce shortage and hardship in maintaining health and safety of the workforce (Timilsina et al., 2021). It's been nearly six years of COVID-19 breakout but there have been few researches on impacts posed by COVID-19 in the construction industry of Nepal and this research will try to fill this gap.

2. Literature Review

COVID-19 halted or slowed most of the construction projects and caused low budget spending of the projects. Department of Road is the highest spender of capital budget of Nepal government. But due to COVID-19, it spent only 65% of the allocated budget in F/Y 2019/20 compared to 85% in F/Y

2018/19 (Shrestha, 2022). Construction projects faced delay in completion of projects. Delay of projects doubled in comparison to pre-pandemic level in large construction projects (Brown, 2022). This delay was caused because of the late payment to the contractors, no timely decision making by the consultants, delay in material delivery due to travel restrictions and taking too much time for revision and approval of the document (Nasir, 2022).

Lockdown imposed by the government forced the transportation and aviation industry to shut down. Borders with India and China were closed and all import-export activity stopped except essential goods. Due to this supply chain of construction materials broken down and import of construction materials, for which Nepal is dependent on India, like steel, wires, pipes and paints became difficult (Thapa, 2020). In addition to this, the construction industry faced contractual disputes in the name of compensation for time and cost (Leo and Singh, 2020). Moreover, projects faced hurdles in declaring COVID-19 as the force measure condition of the contract (Hansen, 2020).

COVID-19 caused a hike in the price of materials required for the construction sector. Due to interruption of supply chain and spike in fuel cost due to COVID-19, cost of materials like steel, cement, sand, plywood, bricks etc. escalated up to 40% as per Prakash (2021), which caused the average construction cost of houses to surge by 12%. This led to degradation of financial condition of contractors involved in the construction industry as per Timilsina et al. (2021) and faced losses in their projects (Lagat et al., 2023). To add this, the increase in construction cost was also fueled by change in foreign exchange rate, additional cost for pandemic management works like vaccination, test and more demand than supply of construction materials (Zamani et al., 2021).

Impacts of COVID-19 in the construction sector are restriction in movement of labor, decline in profit, increase in delay of project, cash flow problems, skilled manpower shortages, reduction in labor productivity, extra expenses in site management, site closure and low quality of construction work (Bist et al., 2021). Travel restriction and strict quarantine rules made skilled labor unable to reach worksites which caused labor shortage which poised difficulties in site supervision due to which errors in sites surged (Shrestha, 2022). About 60% of construction companies reported project delay occurred due to workforce shortages (McMurray, 2022). Also, wages of laborers increased dramatically after COVID-19 (NRB, 2023). Furthermore, foreign direct investment reduced sharply in construction projects of Nepal (Khatiwada, 2021).

3. Methodology

Initially, Cronbach's alpha assesses the internal consistency of the components, and a high level of dependability was shown with value of 0.813 (Taber, 2018). Similarly, I-CVI for each individual indicator was found to be >=0.872 and S-CVI for the whole indicator under impact of COVID-19 was 0.902 respectively (Polit et al., 2006).

In order to investigate the impacts of COVID-19 in the construction industry of Nepal, cross sectional design and quantitative research methods were used. Clients, contractors and consultants were targeted populations. A total of 450 professionals were surveyed by preparing questionnaires with adequate review of literature and 387 valid responses were received i.e., 86%. Questionnaires contained a Likert scale and respondents ranked the impacts of COVID-19 in the construction industry of Nepal with their perception, knowledge and experience. The obtained data were processed for analysis. With the assistance of SPSS software, Principal Component Analysis (PCA) was utilized to explore the major components of impacts of COVID-19 in the construction industry of Nepal. All respondents were more

trustworthy since they were highly qualified, experienced, and had an appropriate designation in the construction sector as mentioned in Table 1.

4. Result and discussions

Table 1: Demography

Variable	Frequency	Percent	Variable	Frequency	Percent
Types of respondent organization			Position of respondent in organization		
Client	130	33.59%	Office/site engineer	185	47.80%
Contractor	165	42.63%	Site supervisor	150	38.75%
Consultant	92	23.77%	Others	52	13.43%
Education Level			Work Experience (in years)		
Diploma	97	25.06%	1-4	190	49.09%
Bachelors	170	43.92%	4-8	110	28.42%
Masters	70	18.08%	8-12	57	14.72%
Others	50	12.91%	>12	30	7.75%

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

Suitability of data was tested by KMO and Bartlett's tests. KMO sampling adequacy value was obtained as 0.775 which exists in the high range. Moreover, Bartlett's tests obtained a significant value of ($\chi 2$ = 915.451, df = 210, Sig. = 0.000) which showed significant correlation existed between variables and suitable for factor analysis (Shrestha, 2021a) as shown in Table 2.

Table 2: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.775
Bartlett's sphericity test	Approx. X^2	915.451
	Df	210
	Sig.	0.000

4.2 Factor extraction for impacts of COVID-19:

Scree test and eigenvalue were applied to find the components by varimax rotation. According to the results of the Scree test, 5 components were obtained with eigenvalue more than one which have significantly impacted the total variability observed in data as shown in Fig 1. Other factors, which registered minor proportionality of variables were discarded as they were less important (Shrestha, 2021a).

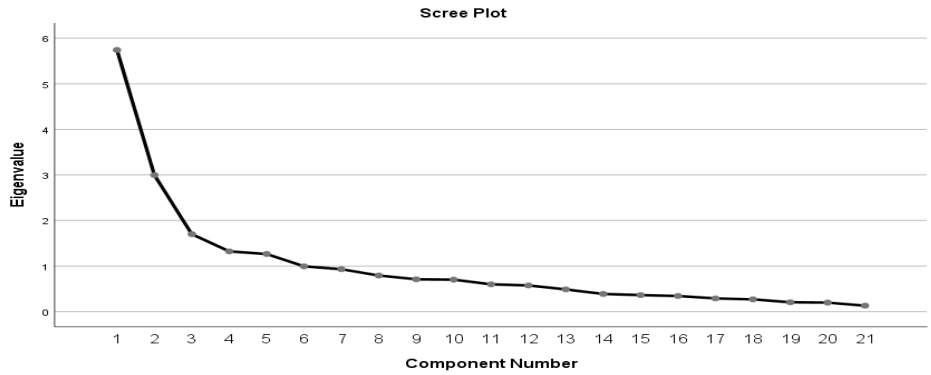

Fig 1: Scree Plot

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	5.742	27.342	27.342	5.742	27.342	27.342	3.587	17.079	17.079
2	2.996	14.267	41.609	2.996	14.267	41.609	2.713	12.921	30.000
3	1.700	8.096	49.705	1.700	8.096	49.705	2.465	11.736	41.736
4	1.322	6.297	56.003	1.322	6.297	56.003	2.167	10.317	52.053
5	1.264	6.019	62.022	1.264	6.019	62.022	2.093	9.969	62.022
6	0.994	4.732	66.754						
7	0.930	4.429	71.183						
8	0.792	3.772	74.955						
9	0.709	3.378	78.333						
10	0.702	3.341	81.675						
11	0.599	2.853	84.528						
12	0.574	2.735	87.263						
13	0.488	2.322	89.585						
14	0.388	1.847	91.432						
15	0.363	1.727	93.159						
16	0.343	1.633	94.792						
17	0.290	1.381	96.173						
18	0.270	1.284	97.457						
19	0.206	0.979	98.436						
20	0.198	0.941	99.377						
21	0.131	0.623	100						

As per above Table 3, the variance described by first, second, third, fourth and fifth factors are 27.342%, 14.267%, 8.096%, 6.297% and 6.019% respectively with their respective eigenvalues 5.742, 2.996, 1.7, 1.322 and 1.264. Total variance was found to be 62.02 % which accounted for more than 50% as suggested by (Sarstedt and Mooi, 2014).

4.3 Factor rotation and interpretation for impacts created by COVID-19

Table 4: Principal component analysis of impacts of COVID-19 on construction industry

Impacts of COVID-19 on construction industry	Components				
	Time and cost overrun	Financial constraints	Contractual disputes	Construction quality deterioration	Supply chain breakdown
Delay in completion of projects.	0.794				
Low spending of capital budget.	0.759				
Rise in wages of workers.	0.703				
Increase in cost of construction materials.	0.697				
Deterioration of financial condition of contractor due to loss in projects.		0.731			
Additional payments of bank interest and insurance premium by the contractor due to the project being delayed due to COVID-19 lockdown.		0.708			
Reduction in profit of contractors.		0.680			
Difficult to apply force majeure condition of contract.			0.772		
Increase in litigation and contractual disputes.			0.714		
Reduction in quality of construction work.				0.712	
Mistakes and errors in sites due to poor site supervision.				0.695	
Interruption in the supply chain of construction materials inside the country.					0.807
Difficult to import construction materials, equipment and goods unavailable in Nepal.					0.698

As per Table 4, out of 21 impacts only 13 were found to be critical and divided into five components such that remaining 8 impacts were discarded as outliers due to correlation value is taken as greater than 0.60 and according to Kline (2014) factor loading could be regarded as high if it is greater than 0.60.

Component 1: Time and Cost Overrun

The first major impact of COVID-19 in the construction industry of Nepal is "Time and Cost Overrun". It consists of 4 sub-factors i.e., delay in completion of projects, low spending of capital budget, rise in wages of workers and increase in cost of projects which have correlations of 0.794, 0.759, 0.703 and 0.697 respectively as shown in Table 4. Component 1 has 27.342% and 5.742 variance and eigenvalue respectively. This finding aligns previous study which states that COVID-19 caused rise in the construction project duration and costs (Khanal et al., 2020). Also, previous study showed that 91% construction projects were delayed due to COVID-19 as mentioned by Shrestha (2021b) and overall construction project cost surged by 4-5% (Kisi and Sulbaran, 2022).

Component 2: Financial Constraints

"Financial Constraints" is the second major impact of COVID-19. It consists of 3 sub-factors i.e., deterioration of financial condition of contractor due to loss in projects, additional payments of bank interest and insurance premium by the contractor due to the project being delayed due to COVID-19 lockdown, and reduction in profit of contractor having correlations of 0.731, 0.708 and 0.680 respectively as demonstrated in Table 4. Component 2 registers 14.267% of the total variance and has an eigenvalue 2.996. Past study showed that COVID-19 caused a transport ban, rise in operating costs and a significant decline in demand which reduced turnover by nearly 70% and decreased in profit which caused financial difficulties (Minett, 2020).

Component 3: Contractual Disputes

The third major impact of COVID-19 in the construction industry of Nepal is "Contractual Disputes". It consists of 2 sub-factors i.e., difficult to apply force majeure condition of contract, and increase in litigation and contractual disputes which have correlations of 0.772 and 0.714 respectively as displayed in Table 4. Component 3 has variance of 8.096% with an eigenvalue 1.7. Previous research also states that claims and disputes have hiked by 80% due to COVID-19 as per Olanrewaju et al. (2023) which occurred due to issue of time extension and cost compensation.

Component 4: Construction Quality Deterioration

"Construction Quality Deterioration" is the fourth most major impact of COVID-19 in the construction industry of Nepal. It contains 2 sub-factors i.e., reduction in quality of construction work, and mistakes and errors in sites due to poor site supervision having correlations of 0.712 and 0.695 respectively as represented in Table 4. Component 4 comprises 1.322 as eigenvalue and 6.297% as total variance. Past study also stated that travel restrictions forced technical and skilled workforce to reduce their frequency of site visit as stated by Mishra et al. (2023) which resulted in mistakes and error in sites thus reducing quality of works (Bist et al., 2021).

Component 5: Supply Chain Breakdown

The fifth major impact of COVID-19 in the construction industry of Nepal is "Supply Chain Breakdown". It consists of 2 sub-factors i.e., interruption in supply chain of construction materials inside the country, and difficult to import construction materials, equipment and goods unavailable in

Nepal which have correlations of 0.807 and 0.698 respectively as presented in Table 4. With an eigenvalue 1.264 and Component 5 has variance of 6.019% respectively. Earlier study by Moosavi et al. (2022) also resembles that COVID-19 had made severe impacts and interruptions on the supply chain system through production halt, distribution disbalance and cost escalation of raw materials (Emmett, 2024). Due to the closure of the border, imports-export activity of the country disturbed which and supply of construction materials and manpower got broken down (Khan et al., 2022).

4.4 Reliability of retained components:

To examine reliability of 5 components, Cronbach's alpha test was carried out. The α obtained values were ranging from 0.701 to 0.839 which indicated greater reliability as values are > 0.7 suggested by Taber (2018) as mentioned in Table 5.

Table 5: Cronbach's Alpha value.

Components	**Cronbach's Alpha**
Time and cost overrun	0.839
Financial constraints	0.796
Contractual disputes	0.701
Construction quality deterioration	0.730
Supply chain breakdown	0.798

5. Conclusion and Recommendation

COVID-19 had a severe impact on the construction industry of Nepal. This study explored impacts of COVID-19 in the construction industry of Nepal and categorized it into five principal components; time and cost overrun, financial constraints, contractual disputes, construction quality deterioration and supply chain breakdown with variation of 27.342%, 14.267%, 8.096%, 6.297% and 6.019% respectively. It is recommended that policymakers should proactively act in such a pandemic by formulating pragmatic plans and policy so that less harm will occur. Likewise, proper communication and collaboration should be ensured between stakeholders. In addition to this, application of modern machines and equipment should be increased with adaptation of the latest technology. Furthermore, the government should support the construction projects and facilitate them by waving taxes, prolonging loan paying time, providing special monetary packages and not stopping construction works of projects where chances of transmission is low. Moreover, stakeholders should prepare scientific strict cost control measures, contingency plans, inventory and inspection plans so that the construction industry will be less impacted. Additionally, Building Information Modeling (BIM) should be implemented in construction projects of Nepal.

6. Practical Implications

This research helps the construction management body of knowledge by investing impacts of COVID-19 to the construction industry of Nepal. The exact depth of impact posed by COVID-19 to the construction industry of Nepal shown by this paper will assist strategist and policy formulators of government and relevant authority to act, plan and reduce impact for similar situations in future.

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