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Original Research Article

Opportunities Created by COVID-19 in the Construction Industry of Nepal

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Abstract

COVID-19 not only generated challenges but also brought new chances in the construction industry of Nepal. The goal of this research is to investigate opportunities created by COVID-19 in the construction industry of Nepal. For this, a total of 309 responses from clients, consultants and contractors were obtained. Principal Component Analysis was deployed and major opportunities obtained were technological transformation, and health and safety culture improvisation with variance of 31.46% and 20.14% respectively. It is recommended that policies should be prepared to make technology use and change adopted sustainable and long-lasting. Also, use of advanced technologies and scientific planning should be encouraged by the government and strategies should be prepared so that difficult situations like pandemic could also be utilized in fruitful ways.

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

1. INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a transmissive disease caused by SARS-CoV-2 virus. On the 11th of March 2020, WHO announced COVID -19 as a global pandemic (Cucinotta, 2020). To combat this pandemic, Nepal government imposed a nationwide lockdown firstly from 24 March to 21 July 2020 (Sharma *et al*., 2021) and second lockdown from 29 April to 1st September 2021 in which all sectors including construction sector were heavily affected. Being nearly 6.17% contributor to GDP of Nepal (MOF, 2021), the construction industry experienced significant hurdles such as stoppage of work, supply chain interruption, unsafe working environment, labor shortage, late payment etc. (Dobrucali *et al*., 2022). However, COVID-19 not only caused hardship but also created many opportunities like digitalization, betterment of work site environment, increase in safety of workers and growth in adoption of modern equipment (Ogunnusi *et al*., 2020).

Although there has been much research conducted about challenges and impacts of COVID-19 in the construction industry, neither the Nepal government nor construction professionals conducted extensive research on opportunities of COVID-19 in the construction industry of Nepal so that this research aims to fill this void.

2. LITERATURE REVIEW

COVID-19 posed a threat to life and human activities. However, it also brought significant positive changes in the construction industry. Utilization of health and safety technologies like automatic disinfection machines, self-cleaning vehicles, smart helmets, digitalization of offices, tracking location by mobile apps and inspection cameras increased which helped to maintain work environment and safety of workers (Yang *et al*., 2021). COVID-19 encouraged digitalization of the construction sector with the implementation of drones, robotics, artificial intelligence and 3D printing which helped to enhance productivity, quality and safety (Clark, 2023).

COVID-19 encouraged contractors and suppliers for proper data-based management of the supply chain. Use of latest software and methodologies helped to reduce lead time of construction materials. In addition to this, due to the requirement of maintaining

onsite social distance and controlled building environments during COVID-19 time, use of prefabricated items surged in construction (Burczyk, 2021). COVID-19 forced contractors to make the job environment safe and they implemented various techniques like double shift of work, controlled access to work site and frequent disinfection of jobsite (Frederick, 2022). Also, construction workers are getting safety amenities like helmets, globes etc. onsite which helps to minimize accidents.

In order to tackle COVID-19, remote work was promoted by many companies. Off-site construction activities like designing, planning, procuring etc. which now becomes permanent in the construction industry. Stakeholders of project offices prefer remote work due to its benefit in the form of flexible work time, savings of time, safety of workers and ease. It also reduced operating cost in the form of electricity bills, rent etc. which helps to increase profit of the company (Orzeł and Wolniak, 2022).

Technical transformation of government offices is a positive outcome of COVID-19 (Leontie *et al*., 2022). Government is going for digitalization; an online building permit, procurement and online application system has been implemented after COVID-19. The dream of paperless public office is going to be successful due to this pandemic (Burczyk, 2021).

Table 1: Opportunities created by COVID-19 in the construction industry

S.N.	Opportunities created by COVID-19 in the construction industry	Source
1	Digitalization of the office.	(Yang *et al*., 2021)
2	Introduction and spread of work from home.	(Ogunnusi *et al*., 2020)
3	Increase in use of prefabrication.	(Burczyk, 2021)
4	Rise in use of advanced and modern equipment machines.	(Yang *et al*., 2021)
5	Increase in demand for houses.	(Alsharef *et al*., 2021)
6	Modernization of site inspection and monitoring by use of drones and AI cameras.	(Yang *et al*., 2021)
7	Reduction in overhead cost.	(Ogunnusi *et al*., 2021)
8	Workers started to get safety amenities in the worksite.	(Ogunnusi *et al*., 2021)
9	Starting separation of contingency for unforeseen circumstances.	(Ogunnusi *et al*., 2020)
10	Getting enough time to rethink, prepare and update strategies and working methods of construction stakeholders.	(Alsharef *et al*., 2021)
11	Start of scientific supply chain management.	(Burczyk, 2021)
12	Reduction of bank interest rate and securing loan at low interest rate.	(Alsharef *et al*., 2021)
13	Increase in awareness about physical and mental health.	(Beyer, 2020, Cleveland, 2021)
14	Increase in construction of health infrastructure.	(Onlinekhabar, 2020)
15	Increase in inventory planning for better stock management of materials.	(Staub, 2021)
16	Realization of cybersecurity importance.	(Weforum, 2020)
17	Creation of decision making and feedback mechanism by use of technology.	(Mckinsey, 2020)
18	Transfer of labor skill from urban to village region.	(Teugh *et al*., 2023)
19	Termination of chronic and underperforming contracts.	(Tamimi, 2020)
20	Increase in buying of insurance policies for workers.	(Kumar, 2022)

3. METHODOLOGY

Firstly, internal consistency of the components were checked by Cronbach's alpha (α) which reflected a high level of dependability with α value 0.793 (Taber, 2018). In addition to this, I-CVI value is greater than 0.872 for each indicator and S-CVI value was 0.902 for overall indicator of opportunities of COVID-19 which is satisfactory as suggested by (Polit, 2006).

A quantitative research method was deployed to explore the opportunities created by COVID-19 in the construction industry of Nepal. The study population consisted of clients, contractors and consultants who were working in construction projects during COVID-19 in Nepal. After proper review of literature and consultation with experts, questionnaires were prepared. Out of total 350 persons served and 309 responses were collected which is 88.28% of total. Questionnaire included a Likert scale of 5 ordinal measures. Based on their experience and knowledge respondents ranked the opportunities created by COVID-19 in the construction industry. In the next step, data were collected and processed for detailed analysis with the use of SPSS v.25 software. Principal Component Analysis (PCA) was utilized to explore the major components of opportunities created by COVID-19 in the construction industry of Nepal. The respondents were reliable as they are qualified and involved in construction projects during COVID-19 with appropriate designation as mentioned in Table 2.

4. RESULT AND DISCUSSIONS

Table 2: Respondents Information

Variable	Frequency	Percent	Variable	Frequency	Percent
Respondents' organization type			Respondent's position		
Client	120	38.83%	Site supervisor	123	39.81%
Consultant	60	19.42%	Office/site engineer	95	30.74%
Contractor	129	41.75%	Others	91	29.45%
Education Level			Work experience		
Masters	70	22.65%	1-3 years	134	43.37%
Bachelors	95	30.74%	3-7 years	89	28.80%
Diploma	115	37.22%	7-10 years	63	20.39%
Others	29	9.39%	>10 years	23	7.44%

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

Kaiser Meyer Olkin (KMO) and Bartlett's test were used to test suitability of data for PCA. The KMO measure of sampling adequacy was obtained 0.824 which was adequate (Statisticshow, 2016). Likewise, Bartlett's test of Sphericity was significant with a value of 1069.814 with associated degree of significance < 0.0001 as shown in Table 3 which resembles that significant correlation existed between the variables and is appropriate for factor analysis (Shrestha, 2021).

Table 3: KMO and Bartlett's Test

KMO measure of sampling adequacy		0.824
Bartlett's test of sphericity	approx. X^2	1069.814
	df	190
	sig.	0.000

4.2 Factor Extraction for COVID-19 Opportunities:

To find out components through Varimax rotation, scree test and eigenvalue were utilized. According to the Scree test, there were 4 factors with eigenvalue greater than one as shown in Fig 1. However, remaining factors were ignored as they contain a low proportion of variability (Shrestha, 2021).

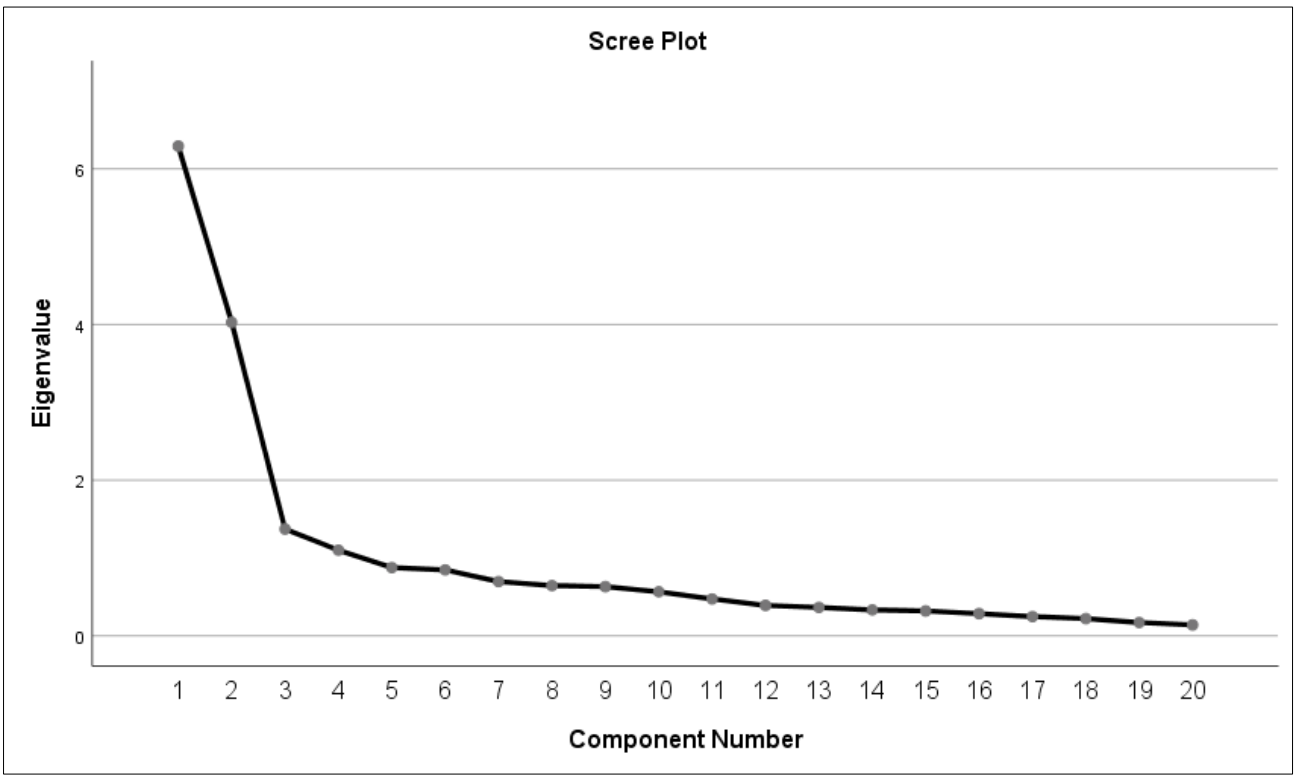

Figure 1: Scree Plot

Table 4: Eigenvalue and total variance explained by the components

Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	Variance %	Cumulative %	Total	Variance %	Cumulative %	Total	Variance %	Cumulative %
1	6.292	31.46	31.46	6.292	31.46	31.46	5.545	27.724	27.724
2	4.028	20.141	51.601	4.028	20.14	51.601	3.867	19.333	47.056
3	1.372	6.86	58.461	1.372	6.86	58.461	1.823	9.117	56.173
4	1.101	5.504	63.964	1.101	5.504	63.964	1.558	7.791	63.964
5	0.877	4.383	68.347						
6	0.847	4.236	72.583						
7	0.697	3.484	76.067						
8	0.646	3.228	79.295						
9	0.632	3.158	82.453						
10	0.566	2.829	85.282						
11	0.474	2.368	87.65						
12	0.39	1.951	89.602						
13	0.365	1.824	91.425						
14	0.333	1.664	93.089						
15	0.319	1.597	94.686						
16	0.285	1.423	96.11						
17	0.247	1.234	97.344						
18	0.221	1.104	98.448						
19	0.171	0.854	99.301						
20	0.14	0.699	100						

Table 4 reflects eigenvalue and variance percentage of each component. The variance explained by first, second, third and fourth components are found to be 31.46%, 20.141%, 6.86% and 5.504% respectively with respective corresponding eigenvalue 6.292, 4.028, 1.372 and 1.101. In general, these 4 factors registered combined 63.964% variance.

4.3 Factor Rotation and Interpretation for Opportunities Created by COVID-19:

Table 5: Principal component analysis of opportunities created by COVID-19

Opportunities of COVID-19	Components			
	Technological transformation	Health and safety culture improvisation	Better planning	Scientific material management
Digitalization of government offices.	0.799			
Increase in work from home culture.	0.798			
Rise in use of modern equipment & machines.	0.786			
Realization of cybersecurity importance.	0.777			
Increase in demand for private and public buildings and roads.	0.756			
Fast deployment and use of new technologies like remote monitoring, drones and AI tools.	0.739			
Increase in use of prefabrication in construction.	0.709			
Transfer of labor knowledge and skill from urban to village region.	0.602			
Workers started to get safety amenities like masks, hand gloves, helmets, etc.		0.799		
Increase in buying of insurance policies for workers.		0.781		
Increase in awareness about physical and mental health.		0.778		
Increase in construction of health infrastructures.		0.760		
Starting separation of contingency for unforeseen circumstances.		0.714		
Getting enough time to rethink, prepare and update strategies and working methods of construction.			0.621	
Creation of an advanced decision making and feedback mechanism by use of technology.			0.601	
Increase in inventory planning for better stock management of materials.				0.833
Start of supply chain management scientifically.				0.719

Table 5 shows that out of 20 opportunities, only 17 opportunities were found to be major and divided into four components and 3 indicators as outliers.

Component 1: Technological Transformation

The first major opportunity created by COVID-19 in the construction industry of Nepal is "Technological Transformation". It consist of 8 sub-factors i.e. digitalization of government office, increase in work from home culture, rise in use of modern equipment & machine, realization of cybersecurity importance, increase in demand of private and public buildings and roads, fast deployment and use of new technologies like remote monitoring, drones and AI tools, increase in use of prefabrication in construction, transfer of labor knowledge and skill from urban to village region which have correlations of 0.799, 0.798, 0.786, 0.777, 0.756, 0.739, 0.709 and 0.602 respectively as represented by Table 5. This component comprises 31.46% of total variance and has 6.292 as eigenvalue. Earlier report also states that COVID-19 pushed construction sector for rapid digital transformation and technology initiatives, with many firms implementing online contracts and record-keeping, virtual trainings, site inspections via drone and AI cameras (Sellers, 2022). Another report by (IMF, 2023) also suggests that the lasting legacy of COVID-19 for various countries has been bigger adoption of digital technologies.

Component 2: Health and Safety Culture Improvisation

"Health and Safety Culture Improvisation" is the second most major opportunity created by COVID-19 in the construction industry of Nepal. This component contains 5 sub-factors i.e., workers started to get safety amenities like masks, hand gloves, helmets, etc., increase in buying of insurance policy for workers, increase in awareness about physical and mental health, increase in construction of health infrastructure, starting separation of contingency for unforeseen circumstances having correlations of 0.799, 0.781, 0.778, 0.760 and 0.714 respectively as shown in Table 5. This component has eigenvalue 4.028 and registered 20.141% of the total variance. Prior investigation also showed that chances for safer working practice were created by COVID-19 through new awareness of safety risk and work redesign (Stiles *et al*., 2021). COVID-19 is successful in making construction stakeholders conscious and dedicated for the fulfillment of health and safety of workers (Raliile, 2021).

Component 3: Better Planning

The third major opportunity created by COVID-19 in the construction industry of Nepal is "Better Planning". It contains 2 sub-factors i.e., getting enough time to rethink, prepare and update strategies and working method of construction, and creation of an advanced decision making and feedback mechanism by use of technology which have correlations of 0.621 and 0.601 respectively as mentioned in Table 5. This component has 6.86% and 1.372 variance and eigenvalue respectively. Former study also suggests that better optimization of existing working procedures and systems occurred due to COVID-19 (Kamiludin and Roy, 2022). Additionally, adequate time is being spent on planning work tasks which surged worker activity, effectiveness and productivity (Jones *et al*., 2020).

Component 4: Scientific Material Management

"Scientific Material Management" is the fourth most major opportunity created by COVID-19 in the construction industry of Nepal. This component contains 2 sub-factors i.e., increase in inventory planning for better stock management of materials, and start of supply chain management scientifically having correlations of 0.833 and 0.719 respectively as demonstrated in Table 5. With an eigenvalue of 1.101, it registers 5.504% of the total variance. This result aligns with previous research which claimed that COVID-19 increased importance of bulky inventory on site which leads to pre-planning of materials (Ogunnusi *et al*., 2020) with the use of methods like multi sourcing, improving collaboration, partnering for manufacturing, early ordering and preparing resilience strategy (Anderson, 2020).

4.4 Reliability of Retained Components:

Cronbach's alpha was determined in order to check reliability of components and α values were found to be ranging from 0.702 to 0.893 which were greater than 0.7 recommended by (Taber, 2018) and suggested a good level of reliability which is shown in Table 6.

Table 6: Cronbach's Alpha value

Components	Cronbach's Alpha
Technological transformation.	0.893
Health and safety culture improvisation.	0.859
Better planning and monitoring.	0.702
Scientific material management.	0.803

5. CONCLUSION AND RECOMMENDATION

COVID-19 not only created difficulties in the construction industry but also brought opportunities and chances. This study identified opportunities created by COVID-19 in the construction industry of Nepal by use of PCA and categorized them into four principal components; technological transformation, health and safety culture improvisation, better planning, and scientific material management registering variation of 31.46%, 20.14%, 6.86% and 5.50% respectively. It is recommended that all parties related to the construction

sector should prioritize use of latest technologies in construction and labor-intensive methods should be replaced by advanced technologies so that it will be easier to fight with pandemics. In addition to this use of software and artificial intelligence should be increased. Similarly, the government should not only focus on tackling the pandemic but also make plans and policy to utilize the pandemic time in fruitful ways. Moreover, policies should be prepared to make technology use sustainable and long-lasting.

6. PRACTICAL IMPLICATIONS

This research will encourage to utilize COVID-19 or similar situations in fruitful and meaningful ways by tackling its negative aspects. It will also motivate government agencies and the private sector to prepare effective plans and policies such that difficult times can also be utilized as opportunities. This will also be insight as to how the pandemic shaped and changed the construction industry of Nepal in its short period of time. Researchers could also utilize the methodologies and ideas of this paper to draw positive opportunities of COVID-19 towards the construction industry of their region and country.

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