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Impact of COVID-19 Pandemic on Road and Bridge Projects under Road Division Pokhara

Kiran Subedi [1] *, Nirmal Prasad Baral [2]

[1]Pokhara Engineering College, Pokhara University, Kaski, Nepal

[2]Institute of Engineering, Paschimanchal Campus, Tribhuvan University, Kaski, Nepal

* Author to whom correspondence should be addressed; E-Mail: kiransubedi545@gmail.com

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Abstract

COVID-19 is a global pandemic that has caused social disruption and altered the global economic perspective. The construction sector plays an essential role in the worldwide economy, drawing upon a diverse array of resources within regional economies. Since the COVID-19 outburst in Nepal, it has been a really difficult task for the construction sector to initiate a project or to continue running at a normal pace. The objective of this research was to determine the impact of COVID-19 on the road and bridge project under the road division Pokhara. About 52 respondents comprised contractors and client/consulting agencies at different structure questionnaires compatible with the requirement of the study were recorded. As a result, the eight most important factors were ranked based on the severity of the effect and prioritization of multiple factors on the project due to the pandemic. Obtained responses from consultant and contractor representatives, it was found that the factors beyond the control of projects, transportation shutdown were ranked first followed by the shortage of labor under manpower factor and others. This paper observes the actual severity of the various factors regarding construction projects due to the corona virus and will also lead to better management in upcoming pandemics. The results of this study establish the groundwork for future researchers and practitioners by offering suggestions for how to prioritize and re-organize work plans, workplace management, and strategies for unforeseen circumstances.

Keywords: Construction industry, Covid impact, Global Pandemic, Prioritization

1. INTRODUCTION

The COVID-19 pandemic continues to impact the global economy, supply chain disruption and workforces, and straining contractual relationships in every sector. These issues are especially important for construction projects, which usually depend on precise schedules of resources with respect to workers, procedures and materials [1]. Supply chain interruptions, strict health and safety protocols mandatory social distancing, use of Personal Protective Equipment (PPE), sick or quarantined workers and quarantine periods for workers while crossing from district to district and one place to another, including changing government executive orders are the issues frequently encountered. Due to the complete shutdown of the transportation system, workers were not able to reach their workplaces. Furthermore, the ailment stemmed from a viral infection, thereby increasing the likelihood of transmission among workers upon interacting and instilling apprehension about potentially transmitting the infection to their households. Furthermore, there existed a notable lack of willingness among the workforce to engage in their employment obligations. Additionally, without any protection, it is not possible to make the workers on construction sites. [2] As the impacts of this novel corona virus (COVID-19) pandemic expanded day by day, industries were struggling both to adjust to the new ways of life and to grasp what this will probably mean for their executions and operations, especially in their construction projects due to their multi-faceted mechanisms. More businesses and government entities were obligated to run with minimum staff or shut down altogether. There would be time overruns, loss of efficiencies, and cost overruns because of COVID-19 and related regulatory responses, and there was petite to no outline to help businesses understand what the potential future impacts might be or when restrictions might end [3]. Some suppliers, contractors, subcontractors and sources of labor were greatly impacted, whereas some were less due to their well-managed resource allocation. However, it was very possible that at some point, work might have needed to pause due to health and safety concerns. Even if it did not stop altogether, work was likely to have become costlier and take more time [4],[5].

The given text discusses the impact of the COVID-19 pandemic on the global economy, supply chains, and workforces, particularly in the construction industry. The disruptions caused by the pandemic, such as supply chain interruptions, strict health and safety protocols, mandatory social distancing and quarantine periods have led to time overruns, loss of efficiencies and cost overruns in construction projects. The study aims to assess the precise impact and severity of COVID-19 on road and bridge construction projects within the Road Division of Pokhara and develop strategies to mitigate their effects. The objectives of the study include enhancing positive experiences, leveraging technological tools, optimizing their utilization, and developing skills in schedule planning, collaborative teamwork, risk assessment, workspace management and innovative problem-solving. The study emphasizes the integration of precautionary measures to anticipate and effectively address unexpected challenges. This research aims to determine the impact of COVID and its severity of effect in construction project of Road and Bridge under Road Division, Pokhara.

2. LITERATURE REVIEW

Extensive research has been dedicated to exploring the impacts of the COVID-19 pandemic on the construction industry. Three levels of effects on Nepal's construction sectors financial, operational and institutional have been forecast by Timilsina for 2021. Due to COVID-19, fewer construction projects were undertaken and it was discovered that contractors' financial situations were getting worse as a result of the industry's unsatisfactory financial performance. Additionally, contractors encountered issues with late payments and project cost overruns. These issues had an impact at the operational level by delaying project completion, disrupting the supply chain, making it difficult to manage the workforce, failing to maintain the health and safety of the workforce[5]. According to Larasati, 2021 more than 50% of construction contracts have undergone changes as a result of the COVID 19 pandemic, with the implementation time clause and contract value being the two most significant changes. In Indonesia, 16% of respondents reported changes to payment terms of up to 8% each. Due to pandemic conditions, several stakeholders are reducing their field staff, which will inevitably lengthen the completion time.

Pandemics caused adjustments to 10% of the respondent's scope of work in several projects[6]. In a study conducted by Suiko, a division of Turner & Townsend, encompassing 45 projects executed during the pandemic, findings revealed a reduction in productivity of around 7% due to both labor shortages and the implementation of social distancing measures. Additionally, a deficiency in effective transmission of design information while working remotely contributed to a marginal 1% decrement in overall productivity, and Ogunnusi, 2020 mentions that material unavailability and delivery contributed to a 7% loss in productivity[7]. Early pandemic effects on the U.S. construction sector have been summarized into a few key general detrimental effects, including issues with safety, supply chain disruptions, project suspension and lengthening, increased costs, payment delays and workforce-related difficulties [7]**.**

According to the International Labor Organization's assessment, COVID-19 would have an impact on about 2.7 billion workers, or 81%of the world's workforce, and it is safe to assume that this number includes those employed in the construction industry[8], [9]. Within a study conducted in Oman, scholars observed a significant decline in workforce engagement stemming from the repercussions of COVID-19. They associated this reduction with elevated mortality rates and the implementation of social distancing measures [10]. China heavily relies on approximately 54 million rural migrant labourers. The imposition of lockdown measures following the Lunar New Year holiday in 2020 resulted in a substantial portion of this workforce being unable to resume their duties at work locations [11]. The labour force has additionally borne significant emotional strains due to concerns about their prospects and potential financial hardships. This is particularly pronounced since a majority of them are responsible for familial and financial commitments. Consequently, a considerable number of informal construction sector workers persisted in their employment endeavours during the epidemic, thereby subjecting themselves and their families to potential risks [12].

Construction activities abruptly ceased in major cities and neighbouring regions due to the imposed lockdown. Similarly, in remote locations, construction operations ceased within a few days of the lockdown's initiation due to shortages of materials and strict government enforcement. The COVID-19 pandemic, an unforeseen event, was deemed a force majeure situation [13]. Under the terms of force majeure, several of the larger contracts were terminated. Some construction sites equipped with accommodation facilities managed to sustain operations for a brief period, yet owing to the absence of clear directives and resource provisioning, their activities eventually dwindled. On April 21, 2020, the government attempted to alleviate the situation by announcing that enterprises and construction sites capable of providing housing and sustenance to their workforce within self-contained premises could recommence operations while adhering to essential social distancing measures [14]. Even well-managed locations are not functioning at full capacity due to disturbances in the labor supply and other factors. The whole supply of raw materials for wire, pipes, paint, rolling and forging steel used in Nepal is imported[15] .

Based on reviewing the numbers of the literature through different means the guidelines of FIDIC, contractual documents incorporating impact of COVID-19 and group discussion, the following factors can be considered to study the impact of COVID at prevailing road and bridge construction and is shown in figure 1.

Equipment factors	Execution and construction factors	Payment factors	Health and safety factors	Leadership and supervisor factors	Manpower factors	Materials factors	External Factors
Lack of equipment	Change in schedule	Delay payments of bill	Lack of personnel proctective equipment	Absence of authority to maintain quality and standards	Shortage of labor	Mack of raw materials	Transportation shutdown
Lack of impotable cables and tools(bearing,stretching wires,etc)	Work interruption (social cause)	Operating system work (daily pay, lump sum etc.)	Lack of epidemic knowledge	Lack of proper administrative and administrative support	Migrant workers	Lack of storage materials	High inflation
maintenance of equipment	communication between workers		Health and safety protocol	Slow decisions	Laid-off workers	Lack of supplying materials	
			Lack of observers for health and safety			Increase in materials price	
			Infection in unskilled manpower				
			Worker not familiar with health protocol				
			Medical insurance				

Figure 1: Impact Factors in the construction of road and bridge projects

3. METHODOLOGY

3.1 Research Design

The research method used in this study was descriptive research, and the population included clients/consultants and contractors selected through a combination of purposive and convenience sampling methods. Data was collected from primary and secondary sources and a questionnaire was used to assess primary data from stakeholders involved in various road and bridge construction projects of Road Division Pokhara. The data was analyzed using simple graphs, spreadsheets and the Likert-Scale for ranking qualitative information.

3.2 Population of the study

During the fiscal year FY-077/078, the Pokhara Road Division encountered substantial disruptions due to the COVID-19 pandemic, impacting a comprehensive scope of 42 Road projects and 13 Bridge Projects. Respondents were meticulously chosen from each project, with the exclusion of contractors involved in 12 recurrent projects within the division. Notably, the entire population of 43 contractors and 15 consultants was encompassed in our study, resulting in a sample size equivalent to the total population. This methodological approach underscores the thoroughness nature of our investigation, enhancing the validity and reliability of our study's findings.

3.3 Population Inclusion and Exclusion Criteria:

Inclusion Criteria:

Client/Consultants:

- A full-time technical employee from Government of Nepal working in Road Division Pokhara.

- Technical employee: Division chief, Engineer/ Site Engineer, Sub-Engineer

Contractors:

- Contractor having single contract regarding road and bridge projects in FY 077/78 in Road Division, Pokhara.
- Contractors with multiple contracts are considered single.

Exclusion Criteria:

Client/ Consultants:

- Full-time technical staff member under contract in the Road Division, Pokhara
- Non-technical Staff

Contractors:

- Contractors with multiple contracts already included in the questionnaire

3.4 Sample and sampling procedure of the study

The study utilized a combination of convenience and purposive sampling methods to select 58 eligible participants, including 43 contractors and 15 consultants, who were directly involved in various road and bridge projects in Kaski and Syangja districts.

The sample size, “SS” for the infinite population was calculated as [16]

$$SS = \frac{Z^2 * (p) * (1 - P)}{C^2} \qquad (1)$$

where,

Z = Z-score (e.g. 1.96 for a 95% confidence level),

P = Probability of the questionnaire accurately representing impact causes, presented as a decimal (0.5 used for required sample size),

C = Confidence interval, represented as a decimal (e.g. 0.05 = ±5)

$$SS = \frac{1.96^2 * (0.5) * (1 - 0.5)}{0.05^2}$$

$$SS = 384.16$$

Sample size for finite population was calculated using correlation as follows, [16]

$$New\ SS = \frac{SS}{[1 + \frac{(SS - 1)}{Population}]} \qquad (2)$$

$$New\ SS = \frac{384.16}{[1 + \frac{(384.16 - 1)}{58}]}$$

$$New\ SS = 50.50$$

The sample size was calculated using the Z-score, probability, and confidence interval, and the minimum sample size required was 50.50. However, the study received 52 responses from the questionnaire, which were more than sufficient. The data was collected through a thoughtfully designed questionnaire administered via Google forms, and the analysis involved descriptive and inferential statistical techniques. The data was analyzed using Microsoft Excel to determine frequency distribution, calculate the mean value, and establish rankings for different factors.

The study used both primary and secondary data sources, with primary data collected through semi-structured questionnaires and secondary data collected through various literature, discussions, and articles. The following analysis formulae used:

a) Relative Mean score:

The formulae used for calculating Relative Mean score is[16]:

$$RM = \frac{\sum_{1}^{5}(W.X)}{N.} \tag{3}$$

Likert scale (1-5)- Strongly disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly agree (5).

where,
RM = Relative mean; W = Weighting given to each factor by respondents and its ranges from 1-5 ; X = Frequency of it response given for each factor, N = Total no. of participants.

From RM results, the ranking for different factors was determined.

b) Severity Index analysis

The “importance index” was derived for each factor using the following formula [17]:

$$Important\ Index = \frac{5n5 + 4n4 + 3n3 + 2n2 + 1n1}{5[n5 + n4 + n3 + n2 + n1]} \tag{4}$$

In this context, where n1 represents the count of participants who responded as "strongly important," n2 stands for the count of participants who responded as "important," n3 indicates the count of participants who responded as "neutral," n4 represents the count of participants who responded as "not important" and n5 signifies the count of participants who responded as "strongly not important."

Subsequently, the survey participants were requested to assess the frequency of occurrence for each factor using three ordinal scales: high (3), medium (2), or low (1). The "frequency index" for each factor was computed using the following formula [17]:

$$Frequency\ Index = \frac{3n3 + 2n2 + 1n1}{3[n3 + n2 + n1]} \tag{5}$$

In this context, n1 signifies the count of participants who selected "high," n2 represents the count of participants who chose "medium" and n3 indicates the count of participants who opted for "low." Ultimately, a comprehensive index, named the "severity index," was established by multiplying the importance index" with the "frequency index." This severity index was employed to prioritize the overall impact of each factor on road and bridge projects resulting from the influence of COVID[17].

"Severity index" = "Importance index" * "Frequency index"

c) Reliability Analysis using Cronbach's Alpha

Cronbach's (alpha) is used as a lower bound estimate of the reliability of a psychometric test. Through the analysis of reliability, it becomes possible to ascertain the degree to which the items within questionnaires are interrelated, thereby deriving a comprehensive indicator of the scale's collective capacity for both repeatability and internal consistency [16].

Cronbach's Alpha	Internal Consistency
$\alpha \geq 0.90$	Excellent
$0.90 < \alpha \geq 0.80$	Good
$0.80 < \alpha \geq 0.70$	Acceptable
$0.70 < \alpha \geq 0.60$	Questionable
$0.60 < \alpha \geq 0.50$	Poor
$0.50 > \alpha$	Unacceptable

$$\text{Cronbach's Alpha } (\alpha) = \frac{K}{K-1} * \left[1 - \frac{\Sigma i=1\ \sigma yi2}{\sigma x2}\right]$$

$$\text{Cronbach's Alpha } (\alpha) = \frac{28}{28-1} * \left[1 - \frac{25.3782}{263.587}\right]$$

$$= 0.93$$

K= Items or Questions

$\Sigma i=1\ \sigma yi2$ = Sum of item variances

$\sigma x2$ = Variances of total scores

The alpha (Cronbach's) model was used to check the reliability of the questionnaire. An acceptable threshold is set at 0.7. Utilizing MS Excel, the calculation of Cronbach's alpha yielded an outstanding value of 0.93, indicating a high level of reliability.

4. RESULTS AND DISCUSSION

Respondents filled in and returned the questionnaires giving a response 52 out of 58 at the rate of 90%.

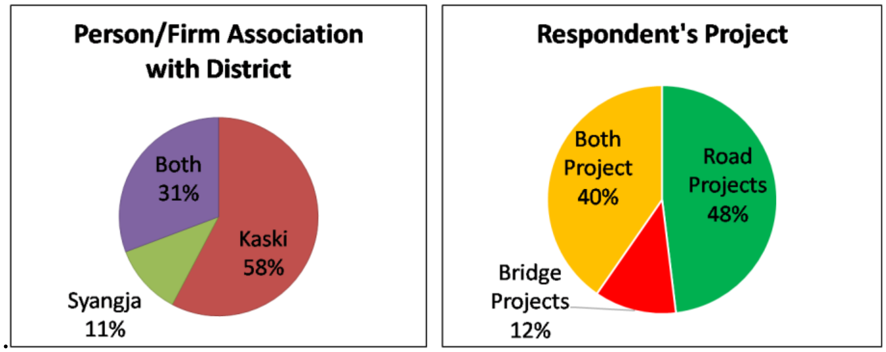

Figure 2: Respondent's (Person/Firm) project and their association

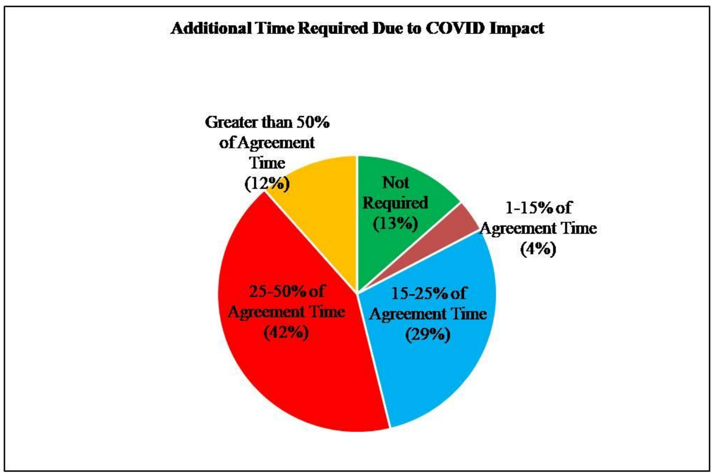

Figure 3: Additional time requirement with respect to agreement time

Figure 2 illustrates a comprehensive breakdown of project timelines. Remarkably, 13% of the projects seamlessly adhered to their initial schedules without necessitating any time extensions. In contrast, figure 3 shows a notable 12% of the projects faced substantial delays, requiring extensions exceeding 50% of the originally stipulated time. Significantly, the majority of respondents, constituting 42%, found themselves in a scenario where an additional time span ranging between 25% and 50% from the agreed-upon timeframe was imperative to accomplish project goals. This analysis helps us understand how different timeframes affect the progress of the project. The government of Nepal had granted a six-month extension for the completion of ongoing construction projects throughout the nation. That measure, taken in response to COVID-19 related disruptions, applies to projects initially scheduled during the lockdown period [18].

Table 1: Rank of Various Impact Factors and their group in Road and Bridge projects with importance and severity index

	Impact Factors	Importance Index	Frequency Index	Severity Index	Rank based on RII	Rank Based on SI	Average Severity of Group	Rank of severity of Groups
	Lack of equipment	0.754	0.712	0.536	19	20		
	Lack of importable cables and tools (bearing, stretching wire)	0.712	0.679	0.483	22	21		
Equipment Factors	Lack of maintenance of equipment	0.735	0.647	0.476	21	22	0.498	6
	Change in schedule	0.885	0.801	0.709	3	5		
Execution and	Work interruption (Social cause)	0.669	0.814	0.545	24	19		
construction Factors	Lack of communication between workers and engineer	0.665	0.635	0.422	25	25	0.559	5
	Delay payments of bill	0.65	0.59	0.383	27	28		
Payment Factors	Operating system work (daily pay, lump sum etc.)	0.742	0.609	0.452	20	24	0.418	8
	Lack of personnel protective equipment	0.777	0.718	0.558	16	17		
	Lack of epidemic knowledge	0.762	0.763	0.581	18	16		
	Health and safety protocol	0.831	0.75	0.623	10	10		
	Lack of observers for health and safety	0.819	0.756	0.62	12	11		
	Infection in skilled manpower	0.827	0.744	0.615	11	13		
	Infection in unskilled labor	0.796	0.731	0.582	13	14		
	Worker not familiar with health protocol	0.858	0.763	0.654	5	9		
Health and safety Factors	Medical insurance	0.777	0.718	0.558	16	17	0.599	4
	Absence of authority to maintain quality and standards	0.65	0.647	0.421	27	26		
Leadership and	Lack of proper administration and administrative support	0.665	0.628	0.418	25	27		
Supervision Factors	Slow decisions	0.681	0.673	0.458	23	23	0.432	7
	Shortage of Labor	0.888	0.846	0.752	2	2		
	Migrant Workers	0.854	0.769	0.657	6	8		
Manpower Factors	Laid-off Workers	0.796	0.731	0.582	13	14	0.663	3
	Lack of raw materials	0.846	0.833	0.705	8	6		
	Lack of storage materials	0.785	0.788	0.619	15	12		
	Lack of supplying materials	0.85	0.846	0.719	7	4		
Materials Factors	Increase in materials Price	0.885	0.84	0.743	3	3	0.696	2
	Transportation shutdown	0.904	0.878	0.794	1	1		
External Factors	High Inflation	0.842	0.814	0.686	9	7	0.74	1

Table 1 presents the major challenges faced by road and bridge projects during the COVID-19 pandemic. The lack of transportation was the most significant problem, followed by a shortage of workers due to COVID-related issues. The projects also faced pressure due to higher material costs and other factors, leading to changes in their schedules. The shortage of supplies, production problems, and storage issues seriously affected the projects need for building materials. The lack of understanding and knowledge about health guidelines during the pandemic, combined with the difficulty of implementing COVID-19 rules in construction, added to the challenges. The most serious impacts were caused by external factors, followed by problems with materials and the availability of workers. The analysis revealed that workers faced a significant impediment in reaching their workplaces due to a complete shutdown of the transportation system. To mitigate the adverse effects on road and bridge construction projects during a pandemic, it is advisable to explore alternate options to address transportation disruptions, provide enhanced facilities for the workforce, and maintain vigilant oversight of market trends to preempt artificial price escalations. A proactive approach to anticipate and effectively manage such scenarios is imperative to ensure timely project completion [19].

This study showed that COVID had adverse effect in road and bridge construction. The Eight most important factors based on the priority were: External factor, material factor, manpower factor, health and safety factor, execution and construction factor, equipment factors, leadership and supervision factors and payment factor.

From the analysis of responses from consultant and contractor representatives, it was found that under external factor, transportation shutdown is ranked as first (RII=0.904, SI=0.794).

The shortage of labor under manpower factor falls under 2nd rank (RII=0.888, SI=0.752) and increase in materials price under material factor falls in 3rd rank (RII=0.885, SI=0.743) and change in schedule under execution and construction factors falls in 3rd rank for relative importance index with (RII=0.885) and 5th in severity index (SI=0.709).

From this study it could help to contribute best towards site management, monitoring and supervision activities, manpower and material management, in a manner that will less impact in the construction industry due to such unexpected catastrophic pandemic. The survey participants and project team members have comprehended the impact of this unforeseeable situation on a conducive work environment. They have recognized the significance of prioritizing the implementation and utilization of technological tools, acquiring the ability to swiftly readjust and restructure work plans, appreciating the benefits of having substantial on-site resources, adopting proactive planning strategies, fostering collaboration and risk evaluation, managing workspace effectively and considering design aspects, acknowledging the merits of incorporating additional personal protective equipment (PPE) and adhering to social distancing norms. Moreover, they have embraced the importance of preparing for unexpected circumstances by including contingency plans to address such occurrences, as well as endorsing the expansion of off-site operations, such as off-site construction and the utilization of precast elements.

5. CONCLUSIONS

The road and bridge construction industry must take proactive measures to mitigate the adverse effects of pandemics such as COVID-19. The industry should prioritize the implementation of contingency plans, explore alternate options to address transportation disruptions, provide enhanced facilities for the workforce and maintain vigilant oversight of market trends to preempt artificial price escalations. The industry should also embrace the importance of preparing for unexpected circumstances by including contingency plans to address such occurrences, as well as endorsing the expansion of off-site operations, such as off-site construction and the utilization of precast elements. By doing so, the industry can ensure timely project completion and minimize the impact of pandemics on the construction industry.

CONFLICTS OF INTEREST STATEMENT

The authors declare no conflicts of interest for this study.

DATA AVAILABILITY STATEMENT

The data can be available by author upon request.

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