

COVID-19 Lockdown's Effect on Building Construction Projects in Kathmandu Valley Nepal

Kreeti Bajracharya¹, Dinesh Sukamani²

Nepal Engineering College

E-mail: bajracharyakreeti@gmail.com, ² dineshs@nec.edu.np

Received: May 15, 2023

Accepted: October 10, 2023

ABSTRACT

This research intends to assess the critical factors as an effect of COVID-19 lockdown on selected building construction projects within the Kathmandu Valley in Nepal. The research identifies “Health and Safety risk management” as the most critical factor compared to the other critical components namely supply chain operation, contractual and construction financial market. This research focuses on utilizing systematic partial least squares structural equation modeling to assess the effect of COVID-19 lockdown. Further, it seeks to demonstrate the direct relationships between COVID-19 effects and the critical factors that have been affected as a result of the pandemic. The study considers these factors as essential components in assessing the overall impact of COVID-19. This study attempts to evaluate and examine the significant pandemic effects on building construction projects. Nepal-based construction firms, government agencies, and non-government organizations were surveyed to identify critical factors affected by COVID-19 in building projects. The quantitative design method of this study included the use of smart partial least squares structural equation modeling (PLS-SEM), one of the statistical tools. Information like the fundamentals of the project, its state, etc., have been considered. 104 valid responses were received out of 130 questionnaires distributed supported at less than 1 % significance level. The inner structural model analysis, with a highest value of 7.014 and a beta value of 0.474, highlights the significance of the relationship between safety and risk management factors and COVID-19 effect in building construction projects. This relationship stands out as highly significant when compared to other constructs examined in the study. The findings underscore the crucial role of safety and risk management practices in mitigating the effects of the pandemic on construction projects.

KEYWORDS: COVID-19; Lockdown; Construction; Health and Safety; Supply chain; Contractual Issues; Financial Market.

INTRODUCTION

COVID-19- Lockdown

Over the years, the construction industry has developed a reputation for being associated with significant safety and health risks. The introduction of COVID-19 has resulted in an additional threat that poses substantial risks to the safety and well-being of its workers in the construction industry. In order to stem the spread of COVID-19 inside the industry and lessen its effects on construction workers and overall progress, a number of safeguards have been put in place due to the extraordinary nature of this once-in-a-century event. The usefulness and viability of the laws that the Centers for Disease Control and Prevention (CDC) and

Occupational Safety and Health Administration (OSHA) have recommended and put into place to safeguard the safety of construction workers are subject to disagreement within the industry (Nnaji et al. 2022).

The COVID-19 pandemic's onset had wide-ranging effects on the social, political, and economic sectors, as well as on health. As a result, the global economy suffered a severe downturn and entered its most critical situation in decades, with the building industry suffering the most severe effects. These included delays in the supply chain for essential building materials, as well as the suspension or cancellation of construction activities, increased uncertainty about upcoming projects, work force issues, rising costs, extended project timelines, and a wide range of legal complexities (Husein et al. 2021).

Different stakeholders in the construction sector, including owners, developers, contractors, subcontractors, and supply chain suppliers, have been impacted differently by the COVID-19 outbreak. The type of effects and scope of consequences are largely influenced by the locations of the underlying projects and the corresponding businesses (Chivilo et al. 2020).

Since World War II, the pandemic has caused the worst worldwide recession. As per the IMF report dated on April 2021, the global economy shrank by 3.5 percent in 2020, which is a 7 percent decline from the 3.4 percent growth prediction provided in October 2019. Even while every country the IMF surveyed witnessed negative growth in 2020, the effects were more pronounced in the world's poorest regions (Yeyati et al. 2021). The construction industry has been significantly affected in numerous ways including both personal and professional levels. These new realities have an impact on nearly every aspect of the construction process, particularly those related to contract or project notices for default, scheduling, adjustments; project suspension, termination, and reinstatement; OSHA and workplace safety compliance; work force management; material, subcontractor, and supply chain delays and impacts; risk management and insurance; claims avoidance or management; and the dispute resolution process (Holland & Knight 2020).

In Nepal, the COVID-19 pandemic has led to employment losses and disruptions in the food supply chain, putting thousands of people who depend on daily wages at risk of hunger and poverty. The nation's efforts to meet its 2015 UN Sustainable Development Goals targets have also been hampered by the pandemic (Joshi 2021).

Similarly, the pandemic has caused labor shortages and delays in Nepal's construction projects as a result of infected and quarantined workers. These issues remained even after lockdowns were lifted due to supply chain problems, border closures with India (Timilsina et al.2021).

Large-scale infrastructure projects in Nepal, such as those promoting national pride, were severely impacted by the COVID-19 outbreak and its lockdown. As a result, there have been projections that the time and cost required to complete these projects would overrun.

An assessment concluded the contractors lost their income in site management, staff salary, and rent. Likewise, the machinery used in the construction sector also resulted in a big loss. As a result, it has been estimated that 65 million will be required within the next three months to resume construction work (FCAN 2020).

According to the post-pandemic adjustment of national accounts, production of the construction sector is anticipated to be Rupees 488 billion for the fiscal year 2019–20, down 0.31 percent from the previous year (The Asia Foundation 2020).

Previous research and literature have shown that critical factors, including building construction projects, can have a substantial impact on the construction industry during COVID-19 pandemic. Existing research, on the other hand, has mostly focused on the overall impact on construction projects, demanding a more in-depth investigation of the consequences on the building construction sector. Adopting thematic approaches is vital for effectively identifying and measuring the impact of critical aspects on building construction. It is critical to recognize that the impact of COVID-19 on individuals in the construction industry will vary depending on organizational features and management methods. Because of the specific nature of building projects and work arrangements, implementing COVID-19 procedures in the construction industry can present practical obstacles. Future research initiatives should prioritize closing this knowledge gap.

As each project is unique in its own nature, identifying the root cause of the issues and challenges brought on by COVID-19 and exploring the possible measures to minimize the effects of the pandemic could be a breakthrough.

Major Critical Factors

Numerous studies have been conducted to investigate the effects of COVID-19 epidemic on construction industry. These studies have carefully considered many implications and difficulties, the industry has faced as a direct result of the pandemic.

The effects of COVID-19 on the construction industry are both immediate and long-term. The workforce-related issues include worker shortages brought on by infections and preventive quarantines as well as worker layoffs caused by project cancellations and delays. The project and workplace-related issues include implementing new workplace practices and policies; procurement and supply chain issues include restrictions and closures in international exchange markets; and the consequences of contracts, laws, and insurance, including relevance about the force majeure clause (Assaad & El-adaway Islam 2021).

Sierra (2021) discussed on undergoing period of shrinkage of the construction industries in the context of a pandemic that is constantly evolving and creating an uncertain situation with many interrelated factors to take into account. These factors include sudden slowdowns or interruptions of on-site work, lack of manpower, disruptions with supply chain and subcontractors' work, rise in insolvency, complicated contractual exposures, and a decline in cash flow.

Hence, an extensive literature review and KII were undertaken in order to identify and comprehend the main consequences of COVID-19 on the building construction sector, which resulted in the identification of 24 thematic impacts.

Construction Financial Market:

Zamani (2021) summarized about the operational and financial issues that COVID-19 has caused in the building industry. The study covered the material delays brought on by cross-country procedures, supply limitations caused by the supplier company's operations being halted and the increased demand for supplies. Moreover, it discussed how industry struggled with shortage of skilled worker, particularly international labor and how labor shortages caused delay in construction projects. A few recognized variables, such as the costlier materials and COVID-19 test processes, have driven up the project's cost. Fluctuations in foreign exchange rates, along with a surge in demand for supply, have led to increased material costs associated with the COVID-19 test processes, increasing the company's costs. The second COVID-19-related challenge is financial. Late payments, rising project costs, and fewer projects are three elements that contribute to financial issues during COVID-19.

According to Timilsina (2021), COVID-19 has caused a decrease in construction projects as result of government budget cuts. Moreover, the contractors are facing financial difficulties due to the industry's poor financial performance, along with issues of delayed payments and project cost overruns. Also, the influence of COVID-19 on the building construction business has been demonstrated by Zamani (2021) due to financial concerns. To deal with their financial problems, the majority of businesses need financial assistance.

Hypothesis 1: *Effects of COVID-19 is directly associated with the construction financial market*

Contractual Implication

Construction projects are being significantly impacted by COVID-19, although the legal effects will differ between countries and contracts. Events like the COVID-19 pandemic often typically activate contractual clauses addressing the effects of unforeseen events (White & Case LLP 2020).

It depends on the precise clauses and interpretation of the contract itself as to how COVID-19 would affect contractual obligations regarding its uncertainty.

Only 40.7% of engineers in the study of COVID-19's effects on Jordanian civil engineers were aware that legal contract regulations contained a Force Majeure clause, but defining COVID-19 as a Force Majeure would depend on the types of contracts that were approved. According to Bista (2021), the most significant contractual challenges associated with the pandemic were time extension cost increment, claim and conflicts.

In many Public-Private Partnership (PPP) contracts spanning foreign countries, force majeure clauses frequently use unclear language and result in hazy risk checklists rather than precise legal definitions. It is challenging to respond since, in practice, the phrasing of the clause, the nature of the contractual duty, and the

actual impact of the pandemic, all matters. Reduced tax collection, fluctuating currency values, and significant stimulus spending are causing governments to have financial problems. Government treasury income have decreased as a result of the pandemic's abrupt and significant effects, which could make it more difficult for public agencies to meet all of their contractual responsibilities (Cassady & Baxter 2020).

Nair & Suresh (2021) noted how idle resources, including equipment and manpower, could delay project completion and raise consumer complaints, or lead the bank to confiscate property if a loan is not repaid during the lockdown. This underutilization of renewable resources effects legal issue indirectly.

The primary contractual issue that arises frequently in construction projects include inconsistent language and ambiguity in the contract documents, a lack clarity in the project's scope, ineffective negotiation techniques, and inadequate contract communication. Legal ramifications of these issues may include fines and lawsuits for breaking contract conditions, invalidating contracts that do not follow current laws, and strained relationships between project parties (Al-Mhdawi et al. 2021).

Sierra (2021) emphasized the lack of a definite legal definition for force majeure, as well as the interpretation of such provisions being dependent on the contractual language. In light of the COVID-19 outbreak, many contractors have cited "force majeure" to justify deadline extensions, despite the fact that courts have generally construed force majeure terms narrowly, admitting them only when the outbreak was directly stated in the contract. Therefore, this is a grey area. Hence, contractors need to take caution when implementing force majeure clauses in contracts while stakeholders should exercise caution when thinking that filing a claim for force majeure will immediately remove them from their contractual obligations.

Hypothesis 2: *Effects of COVID-19 is directly associated with the Contractual implication*

Health and Safety risk management

The research on the Impact of COVID-19 on Construction Projects in Developing Countries indicated that safety and risk management were the construction themes most impacted by the pandemic (Al Mhdawi et al. 2021). The research's findings draw attention to several issues in risk management. These comprise: (1). inadequate necessary knowledge, (2) lack of systematic approach to risk management, and unawareness of standard procedures and methods for risk identification, analysis, and response, and (3) risk management based primarily on subjective judgment. During the pandemic, these challenges have been particularly the key obstacles, hindering the application of effective risk management approaches.

Workplace safety literacy and risk perception in the construction sector have been impacted by a number of variables, such as safety training, hazard recognition, risk-taking behaviors, attitudes, and the industry's dynamic character. The inability of workers to communicate effectively enough to identify and discuss COVID-19 concerns in the construction industry is an additional problem. From the standpoint of the construction business, there is little data available on workplace COVID-19 literacy, risk perception, and infection probability (Choi & Staley 2021). The limitation of fieldworkers' viewpoints on safety and health initiatives put in place in response to a pandemic like COVID-19 was underlined by Nnaji (2022).

The construction sector's poor safety culture and climate have been linked that highlighted the difficulties in successfully implementing safety interventions. This has led to inadequate conditions for the actual application and enforcement of safety resources to workers (Nnaji et al. 2022).

For field employees in the construction business, the lack of a safe working environment and health and safety issues have created a stressful work environment. Restricted access to tools and equipment can make it harder for employees to do their jobs, and a non-secure workplace can expose workers to the COVID-19 virus. Additionally, the social isolation brought on by teleworking can cause workers to experience mental health problems (Pamidimukkala & Kermanshachi 2021).

Hypothesis 3: *Effects of COVID-19 is directly associated with the health and safety risk management*

Supply chain operation

The COVID-19 pandemic has notably impacted the construction industry, manifesting operational-level challenges such as compressed construction timelines, delayed approvals, scarcity of skilled workers and supplies, and logistical difficulties. These factors have collectively influenced the overall execution of building construction projects (Zamani et al. 2021).

According to Timilsina (2021), the COVID-19 pandemic's operational level impact on the construction sector includes project completion delays, supply chain issues, workers health and safety concern, workforce management challenges, and insufficient support from government and professional association. The study also shows the scarcity of qualified local labor in the building industry.

In the research on how the COVID-19 pandemic has affected Pakistan's construction industry, the problems related to budgetary constraints, inflation of material costs, unavailability of labor, difficulty in following the Standard Operating Procedures, logistics disruption and psychological issues was identified. One issue that stands out is the fund problem due to the imposed shutdown as many industries failed to pay their debts, ultimately resulting in bankruptcy (Nadeem et al. 2022).

Projects have been delayed or suspended as a result of COVID-19's shortage of labor, disruptions in the construction industry's supply chain, and subcontractor work. To reduce risks and be ready for supply chain interruptions, contractors must maintain communication, evaluate suppliers and subcontractors, and explore for alternate options (Sierra 2021).

Hypothesis 4: *Effects of COVID-19 is directly associated with the Supply chain operation*

METODOLOGY

Questionnaire Design

According to the Likert scale, which has five ordinal measurements of agreement for each item, the replies to structured questionnaires range from one (1) to five (5), with five being the strongest level of agreement (5=strongly agree; four=agree; three=no opinion; two being the weakest level of disagreement); and one being the least.

Respondents chose a number from a range of five on a Likert scale based on their opinions and work environment. The questionnaire was designed based on the criteria used to determine the critical factors impacted by COVID-19. This study surveyed 104 construction industry professionals in Nepal to determine the critical factors affected by COVID-19 and compare the extent of its impact on projects. The respondents were from reputable construction firms, government organizations, and non-governmental organizations. Out of 130 questionnaires distributed, 104 valid responses were collected.

Table 1. Latent factors and corresponding indicators

Latent factor	Code	Indicator	Supporting Sources
Construction financial market	CFM1	Limitation of insurance coverage available	(Assaad & El-adaway 2021)
	CFM2	Government fiscal year faced challenges due to sharp declines in project revenues	(Casady & Baxter 2020)
	CFM3	Increment of Building material and Construction equipment prices	(Zamani et al. 2021, Alsharif et al. 2021)
	CFM4	Increased labor costs resulted choosing from limited pool	(Zamani et al. 2021)
	CFM5	Financial obligations of contractor and consultant has increased	(Alsharif et al. 2021)
Contractual implications	CIF1	Increment of legal claims and disputes	(Alsharif et al. 2021)
	CIF2	Poor interpretation of the contract language addressing the effect of COVID -19	(Casady & Baxter 2020)
	CIF3	Lack of clarity in understanding of contractual obligation	(Casady & Baxter 2020)
	CIF4	Failure To apply Force majeure condition of contract	(Sierra 2021)
	CIF5	Insufficient coordination between contracted parties	(Alenezi et al. 2020)
Safety and risk management	SRM1	Improper implementation of health and safety guideline	(Nadeem et al. 2022)
	SRM2	Increased costs and workload implementing safety management measures	(Alsharif et al. 2021, Nnaji et al. 2022)
	SRM3	Limited detail risk management practices in design and construction	(Choi & Staley 2021)
	SRM4	Work redesigned to improve safety	(Alsharif et al. 2021)
	SRM5	Review health and safety policies and protocols complying the Labour Law	(Nnaji et al. 2022)
Supply chain operations	SCO1	Disruption with shortages of raw materials and other inputs	(ILO 2021)
	SCO2	Worker shortages due to infections, preventive quarantines, layoffs	(Zamani et al. 2021)
	SCO3	Bankruptcy of sub-contractors due to the supply chain disruptions	(Nnaji et al. 2022)
	SCO4	Idle equipment left on inoperative sites	(Alsharif et al. 2021, Ilyas et al. 2022)
	SCO5	Delay issues due to cross-country procedures and suspension of operations	(ILO 2021, Nair & Suresh 2021)
Effect of COVID-19	EC1	Diversification and innovation in construction sector	(Zamani et al. 2021)
	EC2	Vulnerable condition of migrant construction workers	(ILO 2021)
	EC3	The construction industry is undergoing a period of shrinkage	(Sierra 2021)
	EC4	Crucial duty of Governments and policymakers in improving resiliency of contractors	(Sierra 2021)

Likert's-scale is significant to understand respondents' opinions or attitudes. A rating scale must be used by the responders to indicate how closely perception match the question or statement.

The questionnaire was designed taking into account the crucial factors that were identified as being impacted by the COVID-19 pandemic. Likert's scale of five ordinal measurements of agreement toward each item from one (1) to five (5) according to amount of frequency is used to calculate replies to structured questionnaires (5=strongly agree; 4=agree; 3=No opinion; Disagree=2; strongly disagree=1).

Additionally, a pilot survey was consulted with experts to ensure that the questions were clear, and in response to the input obtained, the questions were modified to ensure content validity. Out of total 130 questionnaires distributed; 104 responses submitted the response. Therefore, 104 out of 130 responses were taken as legitimate responses. The data were collected from field, emails, person, phone and virtual interviews – based data collection methodology.

RESULTS

For this study, the quantitative design approach, using statistical tools i.e., Smart PLS-SEM was applied. Information like basic project details, project status etc. have been taken into account.

A questionnaire survey and interviews with five carefully chosen construction industry experts were used to gather primary data. To evaluate the condition of the construction sector during the middle of the pandemic, their perspectives and views were sought after. The comprehensive literature review was conducted which was associated and converted into a questionnaire, including the expert's insights for supporting the methodological framework. The findings of the questionnaire were quantitatively analyzed and justified with the previous findings.

The data collected from both primary and secondary source were summarized, classified, tabulated and categorized in several categories. All data from individual projects have been analysed separately and analysis of all projects were done compiling together. Computer software such as SPSS, MS Excel have been used for the derivations of the data. And the logically interpreted outcomes have been presented in tables, charts, graphs.

PLS-SEM Model Testing and Results

Partial least squares structural equation modelling (PLS-SEM) is a statistical method used for analysing the links between observed variables and latent constructs. Unlike traditional methods, PLS-SEM calculates these relationships simultaneously and is especially effective for studying complex models with many variables, small sample sizes, and non-normal data (Hair et al.2011).

The partial least squares (PLS) method was used to statistically test the hypothesis based on structural equation modelling. In contrast to latent variables, which are inferred from observed variables, while observed variables are measured directly using SEM. A structural equation model is made up of structural models and measurement models.

It used specially identified constructs for this study. The initial criteria used to evaluate the measurement model are consistency reliability, indicator reliability, discriminant validity, and convergent reliability. And, using a structural model multi collinearity issue, structural path coefficient and hypothesis assessment is examined.

The measurement model and structural model were evaluated for validity and reliability using Smart PLS version 3 software.

Analysis and Validity of the Measurement Model

In reflective measurement models using PLS-SEM, evaluating convergent and discriminant validity is essential to ensure accurate measurement of latent variables. The measurement model in PLS-SEM validates the precision of latent variable measurement through evaluation of composite reliability, measurement item loadings, and average variance extracted (AVE). Cronbach's alpha is commonly employed to estimate the internal consistency reliability, assuming equal reliability among all indicators. Cronbach's alpha, is a reliable measure of internal consistency, providing standardized loadings for observed variables within a latent construct. Numerous research concluded that Cronbach's alpha values above 0.7 and composite reliability levels exceeding 0.7 indicate a stronger and more reliable measurement model (Hair et al. 2011).

AVE of the measurement items is used to evaluate convergent validity. The latent variable's variance capture is measured by AVE in relation to measurement error in the corresponding manifest variables. Measurement item loadings over a cut-off of 0.7 are advised (Fornell & Larcker 1981). While the latent variable's AVE value should be more than 0.5 in order to ensure convergent validity (Hair et al. 2011).

Discriminant validity is determined by ensuring the cross-loading value of a latent variable is higher in its corresponding construct compared to other constructs. This confirms that each construct is distinct and accurately represents its intended latent variable (Chin 1998).

Indicators SCO4, CFM3, CIF1, and SRM1 were removed from the analysis as they exhibited outer loadings below 0.6 and AVE values below 0.5. This was done to enhance the reliability and convergent validity of the constructs. Table 2 shows enhanced results for CR, AVE, and Cronbach's alpha in the PLS software after the removal of inappropriate indications. With these updated values, the measurement model now satisfies the minimal standards for convergent validity and reliability.

Moreover, HTMT calculations are performed to evaluate the discriminant validity. When evaluating discriminant validity, HTMT calculation is used to determine the correlation between indicators within the same construct. A HTMT result below 0.85 is typically seen as proof of excellent discriminant validity (Radzi et al. 2011, Henseler et al. 2015).

Table 2. Result of Indicator and Convergent Validity

Construction Theme	Items	Loading	AVE	CR	CA	
Safety and risk management	SRM2	0.816	0.554	0.830	0.732	
	SRM3	0.916				
	SRM4	0.427				
	SRM5	0.636				
	Supply chain operations	SCO2	0.856	0.529	0.815	0.70
	SCO3	0.827				
	SCO4	0.727				
	SCO5	0.582				
	Effect of COVID-19	EE1	0.882	0.739	0.895	0.827
	EE2	0.823				
	EE3	0.873				
	Contractual Implications	CIF1	0.688	0.571	0.839	0.743
		CIF2	0.746			
CIF3		0.573				
CIF5		0.871				
Construction financial market	CFM1	0.766	0.523	0.804	0.738	
	CFM2	0.774				

	CFM3	0.584			
	CFM5	0.830			

Strong internal consistency reliability is shown in Table 2 by CR and CA values exceeding 0.7 (Gefen et al. 2000). The optimal value for the AVE measure, which evaluates convergent reliability by measuring the variance of indicators, should be 0.50 or greater. The AVE value above 0.5 confirms convergent validity (Fornell & Larcker 1981, Bagozzi & Yi 1988).

In Table 3, the cross-loadings of all indicators on their respective latent variables are higher compared to their cross-loadings on other latent variables (Chin 1998, Chin 2010). The bolded diagonal parts show how the indicators are cross-loaded on their respective constructs.

Table 3 Discriminant validity: Heterotrait -Monotrait Ratio (HTMT)

Factors	SRM	SCO	Effect of COVID	CIF	CFM
SRM					
SCO	0.609				
EC	0.390	0.572			
CIF	0.477	0.449	0.565		
CFM	0.725	0.506	0.458	0.360	

Note: In Table 3 correlations between the model constructs are shown as HTMT ratios. The reported values fall below (Henseler et al. 2009) cutoff of 0.9.

Analysis and Validity of the Structural Model

The structural model examines how the evaluated constructs relate to one another. Utilizing the collinearity test, the significance and applicability of the structural model coefficient, the structural model validity is evaluated (Hair et al. 2011). At 6% significance level, the t-value should be more than 1.96 and a higher beta value indicates a stronger relationship.

In the structural equation model, multicollinearity is found using the inner variance inflation factor (VIF) values and tolerances. VIF values below the threshold of 5 indicate the absence of multicollinearity issues (Cassel 1999, Henseler et al. 2009, Hair et al. 2011).

Table 4 Result of Collinearity Assessment

Predictor Construct	Dependent variable	Variance Inflation Factor (VIF)
Safety and risk management	Effect of COVID	1.478
Supply chain operations	Effect of COVID	1.310
Contractual implications Factors	Effect of COVID	1.836
Construction financial market	Effect of COVID	1.917

In the structural model, the expected change in the endogenous construct for a unit change in the predictor construct is represented by the path coefficient. The structural model's beta value quantifies the strength of the relationship between the predictor and dependent variables. The effect of the predictor variable on the dependent variable is stronger when the beta value is higher. Based on the t-test result, which is obtained using non-parametric bootstrapping, the beta value is determined. The study used 5000 bootstrapped samples to compute t-values (Hoonakker et al. 2010, Henseler et al. 2016). For a two-tailed test with p-values of 0.05, 0.01, and 0.001, respectively, significance of the beta value was evaluated using recommended threshold

values of 1.96, 2.58, and 3.29 (Hair et al. 2011). At a 5% level of significance, every path in the model showed t-values over the cut-off of 1.96, indicating a significant impact on safety performance. Additionally, with highest beta value of 0.474, the effect of COVID-19 in building construction projects and Safety and Risk Management factor were observed to be strongly correlated.

Additionally, all parameters exceeded the threshold values and were in the excellent range in the model fit test. Both the outer measurement model and the inner structural model had notable reliability and validity. Table 5 presents the results of all four hypothetical paths (H1-H4), highlighting the importance of the SEM model. Also, all four hypotheses were supported at less than 1 % significance level.

Table 5 Hypothesis Testing in the Structural Model (Direct)

Hypothesis	Relation	Beta	LLCI (5%)	ULCI (95%)	(STDEV)	T Statistics (O/STDEV)	Values	Decision
H1(a)	EC -> SRM	0.474	0.321	0.546	0.059	7.014	0.000* **	Supported
H2(b)	EC -> SCO	0.445	0.338	0.613	0.070	6.807	0.000* **	Supported
H3(c)	EC -> CIF	0.411	0.320	0.601	0.074	6.030	0.000* **	Supported
H4(d)	EC -> CFM	0.381	0.212	0.569	0.088	4.317	0.000*	Supported

Note: t- value ≥ 1.96 at $p=0.05$ level*, t value ≥ 2.58 at $p=0.01$ level**, t- value ≥ 3.39 at $p=0.001$ level***

DISCUSSION AND IMPLICATIONS

The analysis of path coefficients in the inner structural model demonstrated a highly significant relationship between safety and risk management factors and the impact of COVID-19 in building construction projects, surpassing other constructs with a maximum value of 7.014 and a beta coefficient of 0.474 (Choi et al. 2021, Husien et al. 2021, Timilsina et al. 2021).

Likewise, the supply chain operation factor demonstrated the second highest significance to the impact of COVID-19 in building construction projects, with a t-value of 6.807 and a beta value of 0.445. This result is in line with earlier studies, supply chain operation parameters indicate the impact of COVID-19 in the construction industry studies (ILO 2021, Husien et al. 2021, Sierra 2021, Zamani et al. 2021, Timilsina et al. 2021, Rani et al. 2022). The COVID-19 has caused hindrance in the material supply chain, resulting significant challenges for equipment rental businesses that have reported problems with damaged equipment at sites (ILO 2021).

Likewise, with 6.030 of t-value and 0.411 of beta value, contractual implication factors showed third significance to COVID-19 effect in building construction projects. Many past reports suggested that contractual implication factors are a predictor of COVID-19 effect in construction (Al-Mhdawi et al. 2021). The applicability of force majeure clauses in contractual agreements, particularly in the context of building, has received a lot of attention ever since the COVID-19 outbreak started. The purpose of force majeure clauses, along with other provisions addressing excused delays, aim to handle delays and effects brought on by events outside the control of the contracting parties.

Moreover, construction financial market factors showed last significance to COVID-19 effect in building construction projects with a t- value of 4.317 and a beta value of 0. 381. Past report suggested that Construction financial market factors is a predictor of COVID-19 effect in construction. Due to COVID-19, it was seen that the contractors' financial situation was getting worse due to the industry's subpar financial

performance. Additionally, contractors had to deal with late payments and project cost overruns (Timilsina et al. 2021).

CONCLUSIONS

Construction is a natural cyclical industry, and the COVID-19 epidemic had a significant negative impact on it, while the recovery process may span several years. This led to the anticipation that many public projects would be postponed or cancelled, which left limited room for the formation of new public projects. Also, the impact of the COVID-19 pandemic on building construction projects has been recognized by stakeholders, given the diverse circumstances of its development and the institutional frameworks involved. Consequently, taking preventative measures into account while planning building projects has become crucial. Hence, the subjects must be thoroughly studied and investigated in order to recognize and overcome their effects in addition to mitigating measures, allowing the construction of the buildings to go without interference.

Based on the identified factors, it might be useful for the various parties engaged in the construction industry to map out their short- and long-term planning and decision-making processes in adverse condition. It can be related to prioritization for project, revisiting of the scope of the project and delivery strategy in post pandemic time period. Further studies in this may help to strengthen various contractual provisions, health and safety provision, supply chain operation and financial market related to construction related to the issues of similar kind.

This study utilizes SEM-PLS modeling to explore the relationship between the effects of COVID-19 and major critical factors in building construction projects, aiming to provide a comprehensive understanding of their correlation. Positive path coefficients are found in all relationships within the hypothesis, indicating that they have a positive influence on the entire hypothesis.

The study exhibit that the COVID-19 pandemic had an impact on a different factor in the construction sector. Based on their interrelationships and common themes, these issues were divided into four themes: contractual implications, construction finance market, supply chain operations, and safety and risk management.

The findings of the study indicate that the safety and risk management was the most impacted theme by the pandemic, implying that the industry had significant challenges in managing safety and mitigating risks during the pandemic.

Interestingly, the theme of construction financial market was discovered to have the least impact, showing that the pandemic had very modest repercussions on the industry's financial aspects. These findings have significant implications for policymakers and professionals giving vital insights for developing ways to limit the consequences on the construction business.

Based on our study result and findings, Safety and Risk management factor appeared to be the most critical factor impacted which has also been supported and validated by experts and previous research finding. Furthermore, our results concluded that to effectively face the pandemic, a thorough understanding of the effects and need for response strategies is necessary.

It is anticipated that redefining safety procedures for workers to create a healthy workplace environment during disease outbreaks like COVID-19 is crucial (Stiles et al. 2021). However, limitation in the proper explanation to respondent through questionnaire survey, the result may have been distinct on its own way. Stiles (2021) shows that in the light of COVID-19 guidance, it has underlined the necessity of work re-design and procedures, giving a chance for total work re-design prospect to improve safety. This method can be supplemented by incorporating COVID-19 management measures into current risk management frameworks, resulting in cost savings and increased familiarity with the essential procedures. Practical guidance can be given to organizations to help them adopt these methods more effectively.

Also, this study illustrates how this pandemic situation has changed the concept of workplace safety with the introduction of new provisions and act in order to cope and minimize the risk of health hazards with long term

resiliency. This can clearly illustrate from the indirect increment in cost related to safety and safety management in projects.

New procedures have been circulated to prioritize the safety of construction employees. These procedures aim to reduce the threats posed by the COVID-19 pandemic while improving worker safety. Many solved and unsolved contractual issues and claims are being faced by the involved parties in projects. Research of this nature will be helpful to study about the issue of this nature and support to strengthen the contractual provisions in future days. Also, it will be helpful to understand and assess various seen and hidden factors that persist as a challenge due to pandemic situation of this kind in construction sector.

The study will provide an insight to the stakeholders in developing contingency plans to address future pandemics or comparable crises, as well as in minimizing problems and issues in construction projects. Lastly, the research paper could act as a bottleneck in the identification of thematic critical factors and proposing preventive measures for each factor in the building construction sector in Nepal.

RECOMMENDATIONS

The issues that this pandemic raise is many, both in the immediate and long term. Various studies, and research work is ongoing and is still in the phase of continuous change. The uncertainty related to the direct and indirect effect in terms of time and cost of the COVID-19 is incomprehensible.

Aside from the inherent risks associated with construction projects, the ongoing and long-term repercussions of the COVID-19 epidemic have introduced an entirely new set of risks that were previously inconceivable. Furthermore, owners and contractors face the challenge of identifying and effectively managing these risks amidst the complex landscape of continually evolving and sometimes conflicting state, country, and local directives that impose restrictions or even temporary halts on construction projects.

COVID-19 should be included, reinforced and promoted as part of a broader risk management plan. The effectiveness of mitigation efforts can be improved by introducing measures into existing safety processes.

Government officials and policymaker should be proactive in implementing and balancing risk management practices in the building construction business. This entails completing timely risk assessments and developing practical guidelines and steps to limit pandemic effects. They can successfully mitigate the negative effects on the construction sector by prioritizing the development of appropriate strategies. Likewise, the bucket approach for addressing the problems uniformly may not be sustainable.

Despite similarities in work nature, the disparities in impact felt across projects, highlight the importance of field-specific techniques. Recognizing the unique characteristics of each project enables to effectively address the industry's particular difficulties. Hence, theme-wise approach for addressing the identified major critical factors along with preventive measures may ensure developing a sustainable way-out while construction managers, policymakers, and systems should implement tailored tactics.

REFERENCES

- ACERIS LAW International Arbitration Law Firm. COVID-19 and Construction Disputes: Claims for Time and Money. Retrieved from <https://www.acerislaw.com/covid-19-and-construction-disputes-claims-for-time-and-money/>
- A. R. Radzi, R. A. Rahman, and S. Almutairi, "Modeling COVID-19 Impacts and Response Strategies in the Construction Industry: PLS–SEM Approach," *International Journal of Environmental Research and Public Health*, vol. 19, p. 5326, 2022.
- Alsharef, S. Banerjee, S. M. J. Uddin, A. Albert, and E. Jaselskis, "Early Impacts of the COVID-19 Pandemic on the United States Construction Industry," *Int J Environ Res Public Health*, vol. 18, Feb 6 2021.
- A. Pamidimukkala and S. Kermanshachi, "Impact of Covid-19 on field and office workforce in construction industry," *Project Leadership and Society*, vol. 2, p. 100018, 2021.

- A. Pamidimukkala, S. Kermanshachi, and T. Jahan Nipa, "Impacts of COVID-19 on health and safety of workforce in construction industry," in *International Conference on Transportation and Development 2021*, 2021, pp. 418-430
- B. Adhikari, A. Ozaki, S. B. Marahatta, K. R. Rijal, and S. R. Mishra, "Earthquake rebuilding and response to COVID-19 in Nepal, a country nestled in multiple crises," *J Glob Health*, vol. 10, p. 020367, Dec 2020.
- B. N. Nguyen, T. Q. Nguyen, H. T. Dinh, and A. T. Chu, "The Impact of the COVID-19 on the Construction Industry in Vietnam," *International Journal of Built Environment and Sustainability*, vol. 8, pp. 47-61, 2021.
- C. B. Casady and D. Baxter, "Pandemics, public-private partnerships (PPPs), and force majeure | COVID-19 expectations and implications," *Construction Management and Economics*, vol. 38, pp. 1077-1085, 2020.
- Chivilo, J.P., Fonte, G.A and Koger, G.H. 2020. A Look at COVID-19 Impacts on the Construction Industry / Insights/ Holland & Knight . Available from: <https://www.hkclaw.com/en/insightspublications/2020/05/a-look-at-covid19-impacts-on-the-construction-industry>.
- Chakraborty and P. Maity, "COVID-19 outbreak: Migration, effects on society, global environment and prevention," *Science of The Total Environment*, vol. 728, p. 138882, 2020/08/01/ 2020.
- C. Nnaji, Z. Jin, and A. Karakhan, "Safety and health management response to COVID-19 in the construction industry: A perspective of fieldworkers," *Process Safety and Environmental Protection*, vol. 159, pp. 477-488, 2022/03/01/ 2022.
- D. P. Upadhyaya, R. Paudel, D. Acharya, K. Khoshnood, K. Lee, J.-H. Park, *et al.*, "Frontline Healthcare Workers' Knowledge and Perception of COVID-19, and Willingness to Work during the Pandemic in Nepal," *Healthcare*, vol. 8, p. 554, 2020.
- D. Sukamani and J. Wang, "SEM Model for Investigating Factor of an Accident Affecting Safety Performance in Construction Sites in Nepal," *Engineering Letters*, vol. 28, 2020.
- Federation of Contractors' Associations of Nepal (FCAN), Kathmandu (2069, Mangsir,), Capacity Building of Construction Industry- Project Level, Nepalese Construction Souvenir, Vol: 18, No.21
- G. Nair and M. Suresh, "Challenges faced by Construction Organizations during Covid-19 Era," *IOP Conference Series: Earth and Environmental Science*, vol. 796, p. 012004, 2021.
- Hair, J.F., Ringle, C.M. and Sarstedt, M. 2011. PLS-SEM: Indeed, a Silver Bullet, *Journal of Marketing Theory and Practise*. 19(2), pp.139-152.
- H. A. Rani, A. M. Farouk, K. S. Anandh, S. Almutairi, and R. A. Rahman, "Impact of COVID-19 on Construction Projects: The Case of India," *Buildings*, vol. 12, p. 762, 2022.
- Henseler, J., Ringle, C.M. and Sinkovics, R.R. 2009. The use of partial least squares path modelling in international marketing in: R.R. Sinkovics and P.N.
- Ghauri, eds. *Advances in International Marketing* [online], Emerald Group Publishing Limited, pp 277-319. (Accessed 10 June 2022). Available from: [7979\(2009\)0000200214/full/html](https://www.emerald.com/insight/doi/10.1108/0000200214/full/html).

- Holland & Knight 2020, Retrieved from <https://www.hklaw.com/en/insights/publications/2020/05/a-look-at-covid19-impacts-on-the-construction-industry>.
- Honnakker, P., Carayon P. and Loushine, T.2010.barriers and benefits of quality management in the construction industry: An empirical study. *Total Quality Management & business Excellence*.21(9), pp.953-969
- Husein, I.A.,Borisovich, Z. and Naji, A.A. 2021.COVID-19 : Key global impacts on the construction industry and proposed coping strategies P.Alimob,N.Vatin,A.Tusnin,&A.Doroshenko,eds.E3SWeb of Conferences.263,p.05056.
- Hulland, J.1999. Use of partial least squares(PLS) in strategic management research: a review of four recent studies.*Strategic Management Journal*.20(2),pp.195-204.
- H. Wei, "Liabilities and remedies of the changed circumstances caused by the COVID-19 in construction projects around the world," *Derecho & Sociedad*, pp. 367-382, 2020.
- ILO 2020.covid-19 Labour market impact in Nepal.pdf. IMPACT OF COVID-19 on Workers and Employemnet in Nepal.pdf(July, 2020).Nepal Labour Academy, Nepal
- Joshi,T., et al. (2021). "Nepal at the edge of sword with two edges: The COVID-19 pandemics and sustainable development goals." *Journal of Agriculture and Food Research* 4: 100138.
- J. W. Creswell and J. D. Creswell, *Research design: Qualitative, quantitative, and mixed methods approaches*: Sage publications, 2017.
- M. K. S. Al-Mhdawi, Mario P. Brito, Mohamad Abdul Nabi, Islam H. El-adaway, Bhakti Stephan Onggo. "Capturing the Impact of COVID-19 on Construction Projects in Developing Countries: A Case Study of Iraq", *Journal of Management in Engineering*, 2022
- MOHAMED A. TANTAWY. "Impact of Corona Virus on Constriction Projects." *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)*, 17(6), 2020, pp. 35-41.
- M. Nadeem, U. Ilyas, A. Umer, A. Raffae, S. B. Ajmal, Z. Ali, *et al.*, "Impact of Lockdown due to Covid-19 Pandemic on Construction Industry of Pakistan," *Pakistan Journal of Engineering and Technology*, vol. 5, pp. 42-48, 2022.
- N. Alenezi, "The Impact Of Covid-19 On Construction Projects In Kuwait, International," *Journal of Engineering Research and General Science*, vol. 8, 2020.
- R. Assaad and H. El-adaway Islam, "Guidelines for Responding to COVID-19 Pandemic: Best Practices, Impacts, and Future Research Directions," *Journal of Management in Engineering*, vol. 37, p. 06021001, 2021/05/01 2021.
- S. D. Choi and J. A. Staley, "Safety and health implications of COVID-19 on the United States construction industry," *Industrial and Systems Engineering Review*, vol. 9, pp. 56-67, 2021.
- Sierra 2021.COVID-19: main challenges during construction stage. *Engineering, Construction and Architectural Management*
- SHARMA, K., BANSTOLA, A. & PARAJULI, R. R. 2021. Assessment of COVID-19 Pandemic in Nepal: A Lockdown Scenario Analysis. *Front Public Health*, 9, 599280.
- S. K. Brooks, R. Dunn, R. Amlôt, G. J. Rubin, and N. Greenberg, "A systematic, thematic review of social and occupational factors associated with psychological outcomes in healthcare employees during

- an infectious disease outbreak," *Journal of occupational and environmental medicine*, vol. 60, pp. 248-257, 2018.
- Stiles, S., Golightly, D. and Ryan, B., 2021. Impact of COVID-19 on health and safety in the construction sector. *Human factors and ergonomics in manufacturing & service industries*, 31(4), pp.425-437
<https://doi.org/10.1002/hfm.20882>
- T. Bista, U. Neupane, and P. Shahi, "Impact of Covid-19 Pandemic on Construction Sector of Nepal," *IOSR Journal of Mechanical and Civil Engineering*, vol. 18, pp. 25-30, 02/11 2021.
- The Himalayan Times, 2020 <https://thehimalayantimes.com/business/construction-deadline-of-all-projects-extended-by-six-months/>
- TIMILSINA, S. P., OJHA, S. K. & DHUNGANA, B. R. 2021. Impact of Covid-19 on Construction Industry of Nepal. *Modern Economy*, 12, 1232-1244.
- YEYATI, E. L. & FILIPPINI, F. 2021. <Social-and-economic-impact-COVID.pdf>. *Brookings Global Working Paper #158 Global Economy and Development program at Brookings*.
- WHO 2020a. Considerations for public health and social measures in the workplace in the context of COVID-19. Annex to Consideration in adjusting public health and social measures in the context of COVID-19
- WHO 2020b. Coronavirus disease (COVID-19), Available from: <https://www.who.int/westernpacific/health-topics/coronavirus>.
- WHO 2022. Focused COVID-19 Media Monitoring Nepal.
- W. Bank, "Nepal Development Update: Global Challenges and Domestic Revival," ed: World Bank, 2022.
- Zamani, S.H., Rahman, R.A., Fauzi, M.A. and Yusof, L.M. 2021. Effects of COVID-19 on building construction projects: Impact and response mechanisms. *IOP conference Series: Earth and Environment Science*. 6821(1), p.01204