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Effect of COVID-19 Pandemic on Indian Construction Projects: Reflection on Major Root Cause of Delays and Recommendation to Overcome Current Crises

Sandeep Rai¹ and Anamika Sharma²

¹University of Applied Science Stuttgart, Germany, ² University of Waterloo, Canada
¹sandeep.punj08@gmail.com, ²a446shar@uwaterloo.ca

Abstract: Indian construction sectors play an essential role in economic growth and are the most significant employment generator hub. However, the worldwide spread of the COVID-19 pandemic has caused vast economic slowdown; restrict economic activities, slump global demands. India's construction sector is not unscathed from changing economic impacts. Many findings have revealed that under the ongoing COVID-19 pandemic, India's construction projects are delay due to the migration of laborers and the disrupted supply chain. It is legitimate to determine the most significant factor affecting the performance of construction projects under the COVID-19 pandemic. This study investigates the factor affecting the performance of construction projects in India under the COVID-19 pandemic. A qualitative research method is used to conduct semi-structured interviews with construction industry experts and lawyers to gather information regarding the causes of delays. Data from the interviews highlight the prevailing scenario on the inordinate delays caused in executing construction projects under pandemics. The data analysis identifies that most of the construction projects were affected due to difficulties on operational, financial, and legal issues faced by the project stakeholders under the COVID-19 pandemic. The suitable mitigation measures are suggested based on analysing data to improve construction performance parameters of construction projects by adopting the latest technology like building information modelling, 3-D printing and big data to monitor construction projects more effectively. The findings of this study provide insights into the difficulties faced by the construction industries in the pandemic, lay the foundation for future work of academicians, policymakers, construction firms to encourage social-economic transformation and development across India in case of any future pandemic.

Keywords: Extension of Time, Liquidated Damage, Unforeseen Conditions, Force Majeure

1. Introduction

Earlier, the global economy was under the stress of recovery from several issues related to growing trade protectionism, trade disputes among major trading partners, falling energy prices, etc. As a result, International Monetary Funds (IMF) had projected global economic growth at 3.9 percent (IMF, 2018). However, the situation worsens with the first case of novel coronavirus (COVID-19) pneumonia reported in Wuhan city, China, in December 2019 (World Health

Organization, 2020). The severity and alarming levels of these infectious diseases spread across the globe have resulted in the World Health Organization (WHO) declaring COVID-19 as a global pandemic on 11th March 2021 (WHO, 2020a). Uncertainties about the COVID-19 pandemic have plummeted the global economy (IMF, 2020). Major economies worldwide are experiencing the worst recession since the Great Depression of 1930, with a cumulative output loss of around 9 trillion dollars in 2020 and 2021 (Gopinath, 2020).

In context to India, its economic growth is predominately driven by the construction industry, which is significantly expected to grow at a 15.7 percent compound annual growth rate (CAGR) to reach USD 738.5 billion by 2022 (Nandan et al., 2020). It accounts for 8 percent of India's gross domestic product (GDP) and employs more than 50 million people (ibid). Notwithstanding its economic relevance and employment potential, India's construction industry has been highly impacted by the Covid-19 outbreak (Reserve Bank of India, 2020). Therefore, this validates the need to examine the impact of the COVID-19 outbreak on construction projects in India. Even though several researchers and organization (Chaudhary et al., 2020) has conducted their research on the impact of COVID-19 on several sectors such as tourism, retail, MSME sectors, etc. However, minimal research has been carrying out on the effects of the COVID-19 pandemic on Indian construction projects. Therefore, this study aims to address this gap in the current literature. This study has made a sincere attempt for an in-depth analysis of the problems and arriving at an appropriate solution for overcoming the sluggish growth of construction projects in COVID-19 pandemic situations. The research findings of this study will be helpful to all stakeholders associated with the construction field, such as developers, contracting firms, policymakers, and lending agencies. Out of that, the research question is as below.

"What are the factors affecting the performance of construction projects during the COVID-19 pandemic in India?"

This research aims to assess the reasons impacting the construction projects under the COVID-19 pandemic from the key stakeholder's perspective. Therefore, the researcher has defined two objectives. Firstly, to examine the different viewpoints of project stakeholders to identify the primary root cause of project delays under the COVID-19 pandemic. Secondly, to produce the recommendation to overcome the sluggish performance of construction projects as a mitigation plan.

2. Literature Review

2.1 Impact of COVID-19 pandemic on Construction Industries Worldwide

The world construction industry is projected to grow at a compound annual growth rate (CAGR) of 9.2 percent to reach USD 11,093.7 billion by 2024 (Globe Newswire, 2020). It contributes 6 percent to global gross domestic product (World Economic Forum, 2016). However, the recent COVID-19 outbreak has severely hampered business and consumer sentiments across the globe resulted in a decline in market size from USD 11,217.4 billion in 2019 to USD 10,566.8 billion in 2020 (Globe Newswire, 2020).

Several preventive measures taken by government authorities have restricted mobility by imposing curfew and lockdown, causing shut down of the manufacturing industries, limited working hours, employees pay cuts, which impacts sales and demands of construction projects (Chopra, 2020). COVID-19 pandemic has caused a high risk of unemployment of 45 million jobs

within the European Union (Pouliakas and Branka, 2020) and 7000 jobs cut across construction industries in the United Kingdom (Kennedy, 2020). Amri and Perez (2020) argued that numerous construction contracts across Oman were delay due to the non-availability of expatriates, field specialists and disruption of supply chains.

2.2 Impact of COVID-19 Pandemic on Indian Construction Industries

The infrastructure sector plays a vital role for India to achieve planned target growth of USD 5 trillion by 2025 (Department of Economic Affairs, 2020). However, the COVID outbreak has impeded this trajectory growth, wherein infrastructure projects worth more than INR 60 trillion under different phases are affected due to the COVID outbreak (KPMG, 2020). Several critical infrastructure segments have been hit hard by the ongoing COVID-19 pandemic. For instance, in context to road and highway projects, the National Highway Authority of India (NHAI) has suffered a cumulative loss of INR 2200 crore and toll operators' losses revenue of INR 3450- INR 3700 crore between the lockdown period from March 2020 to June 2020 (Purkayastha and Chauhan, 2020). These losses occurred due to suspension of tolls collection operated by NHAI and towards making compensation to Build Operate Transfer (BOT) concessionaries under force majeure event (ibid). According to the Ministry of Statistics and Program Implementation (MOSPI), out of 1670 projects, 432 projects encountered the cost overrun of INR 4,29,168.28 crore, and 505 projects faced a time overrun of 43.49 months (Shrivastava, 2020). These project delays happened due to land acquisition delays, statutory clearances, and lockdown imposed by nodal agencies under the COVID-19 outbreak (ibid). The Nationwide lockdown set by the Government of India (GOI) has halted construction activities, resulting in laborer's migration and disruption of the supply chain ecosystem (Chaudhary et al., 2020). These projects delays have caused a considerable setback to major Engineering, Procurement, and Construction (EPC) companies engaged in infrastructure projects across India. Several renowned infrastructure companies such as Hindustan Construction Company Ltd (HCC) turnover got plunged to 53 percent decline in Quarter-1 of the financial year (FY) 2020-21 as a result of the COVID outbreak (HCC, 2020). However, despite such a severe impact on the construction sector under the COVID-19 pandemic, the GOI has taken landmark decisions in policy reforms to boost the economy under the COVID pandemic by facilitating INR 40,000 crore under the MGNREGA scheme to provide employments to returned migrants (Ministry of Finance, 2020).

The study review in this section shows that the construction industries have witnessed substantial difficulties on stage-wise lockdowns imposed by the Central and State governments to curb the pandemic. The literature review also reveals that infrastructure companies are facing substantial revenue losses. These findings are essential in determining how the questionnaires are to be designed.

3. Research Methodology

The literature review has given the theoretical background and knowledge regarding the research question. This part will focus on the methodology adopted to solve the research question. The research problems were mainly solved using several attributes, such as divergent and convergent thinking (Lin, 2017). Therefore, under an assessment of research style, the author has undertaken a diverger research style, a form of the interpretivist. The author selected the

interpretative philosophy to get excellent and rich insights about the impact on Indian construction projects under the COVID-19 pandemic; rather than providing a generalization that would be apt to everyone (Saunders et al., 2019).

3.1 Research Approach

There are two research approaches for testing a theory or building a theory: inductive and deductive approaches (Bryman and Bell, 2015). Inductive research allows the researcher to "initiate the research by collecting data to explore the phenomenon and to generate or build theory in the form of a conceptual framework" (Saunders et al., 2019). On the other hand, the deductive approach concludes by forming an opinion based on logical reasoning (Bryman and Bell, 2015). The author has used an inductive research approach to develop a theory on the factors that slowed construction projects' performance under the COVID-19 pandemic by interviewing experts from different construction industry backgrounds across India.

3.2 Data Analysis

The author uses the grounded theory approach (GTA) to collect and analyze the research question. Figure-1 illustrates the logic schematic layout about data collection and its analysis using GTA in this study. The author collected data through semi-structured interviews through face-to-face and telephone interviews. The author has adopted semi-structured interviews to gain/explore the views, experiences, beliefs of individual participants related to this study. To enrich the survey and produce a significant result, the author has included two types of participants, the construction industry experts (CE) and the legal experts (LE) handling construction contractual and legal issues. The author attempted to contact leading 20 construction companies engaged in real estate, infrastructures projects across India for this study. However, only thirteen agreed to participate in this study. These organizations were selected for this study as these firms were heavily engaged in construction activities in the pandemic period with the necessary compliances and social distancing protocol. The demographic details of the interview participants as shown in Table-1. The author has considered the sample size based on factors such as data saturation, credibility, and willingness (Gani et al.,2020).

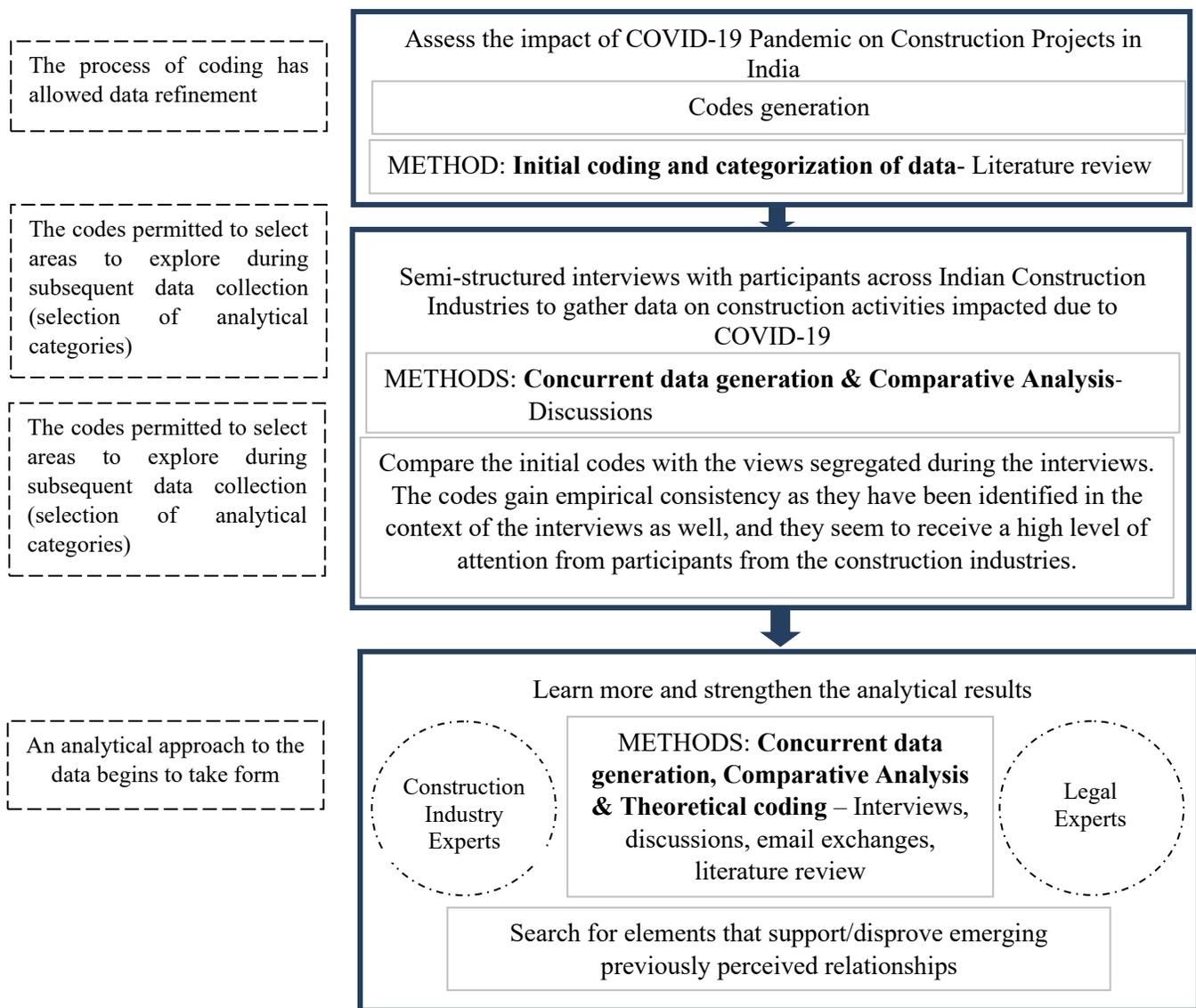
Table 1. The demographic details of the participants

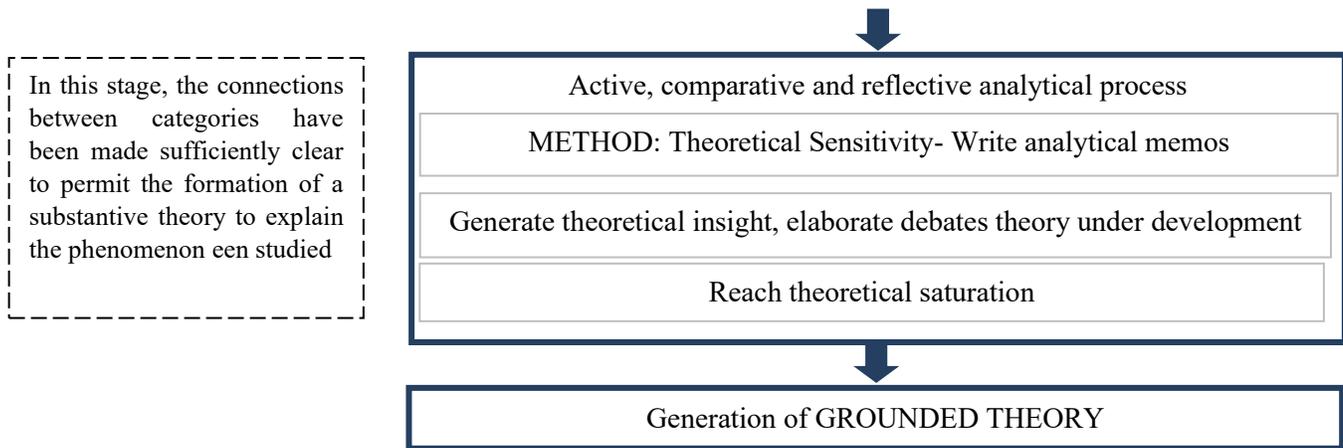
Category of Participants	Type of Organization	Position Experience	Year of
Construction Expert (CE-1)	Real Estate Builder	General Manager- Projects	22 years
Construction Expert (CE-2)	Real Estate Builder	Construction Manager	17 years
Construction Expert (CE-3)	EPC Contractor	Quantity Surveyor	13 years
Legal Expert (LE-1)	Law Firm	Lead Attorney	18 years
Construction Expert (CE-4)	Real Estate Builder	Sr. Contract Manager	14 years
Construction Expert (CE-5)	EPC Contractor	Purchase Engineer	7 years
Construction Expert (CE-6)	EPC Contractor	HSE Engineer	6 years
Construction Expert (CE-7)	EPC Contractor	Planning Engineer	7 years
Legal Expert (LE-2)	EPC Contractor	Senior Inhouse Counsel	11years
Legal Expert (LE-3)	EPC Contractor	Contract Lead	6 years
Construction Expert (CE-8)	EPC Contractor	Project Controller	12 years
Construction Expert (CE-9)	EPC Contractor	Junior Project Manager	5 years
Construction Expert (CE-10)	EPC Contractor	Project Manager	10 years

The author carried out a pilot interview before the commencement of the actual research with the senior management official working with a leading EPC contractor engaged in construction projects; to validate the interviews carried out during this research. The pilot interview allowed the interviewee to express thought and feeling about the questions. It also allows the author to make cosmic changes in question, such as wordings of the questionnaires and their structure (Gani et al., 2020).

The author believes that the interview guide has enabled him for comfortable interaction with the interviewee participants, allowing the participants to facilitate a detailed account of the experience towards the research topic (DeJonckheere and Vaughn, 2019). The author has faced various difficulties while making the research guide, such as the phrasing of complex questions, discussion of sensitive topics related to the reverse migration of laborers, and their social conditions in pandemic (Kross and Giust, 2019). The author has used prompts and probes to explain interviewee participants' responses to interview questions (DeJonckheere and Vaughn, 2019).

Figure 1. Logical scheme of the research and methods applied to obtain the result (Composed by author)





The data collected from interviews were analyzed through GTA as described by (Chun Tie et al., 2019). The data analysis in GTA includes data collection, coding, theoretical sampling, saturation, and generating a theory from relationships (Saunders et al.,2019). In the present research, data collection and analysis were conducted simultaneously, thus helping the author achieve theoretical sampling and building theory (Charmaz, 2014). In this analysis, themes were picked and placed together. These themes are operational constraints, financial issues, legal implications, which have adversely impacted the ongoing construction projects across India during the COVID-19 pandemic. This operational, financial, and legal issue is a result of open coding. A few examples of themes and emergent concepts of this study as shown in below Table-2.

Table 2. The Themes and Emerging Concepts identified during the interview with participants

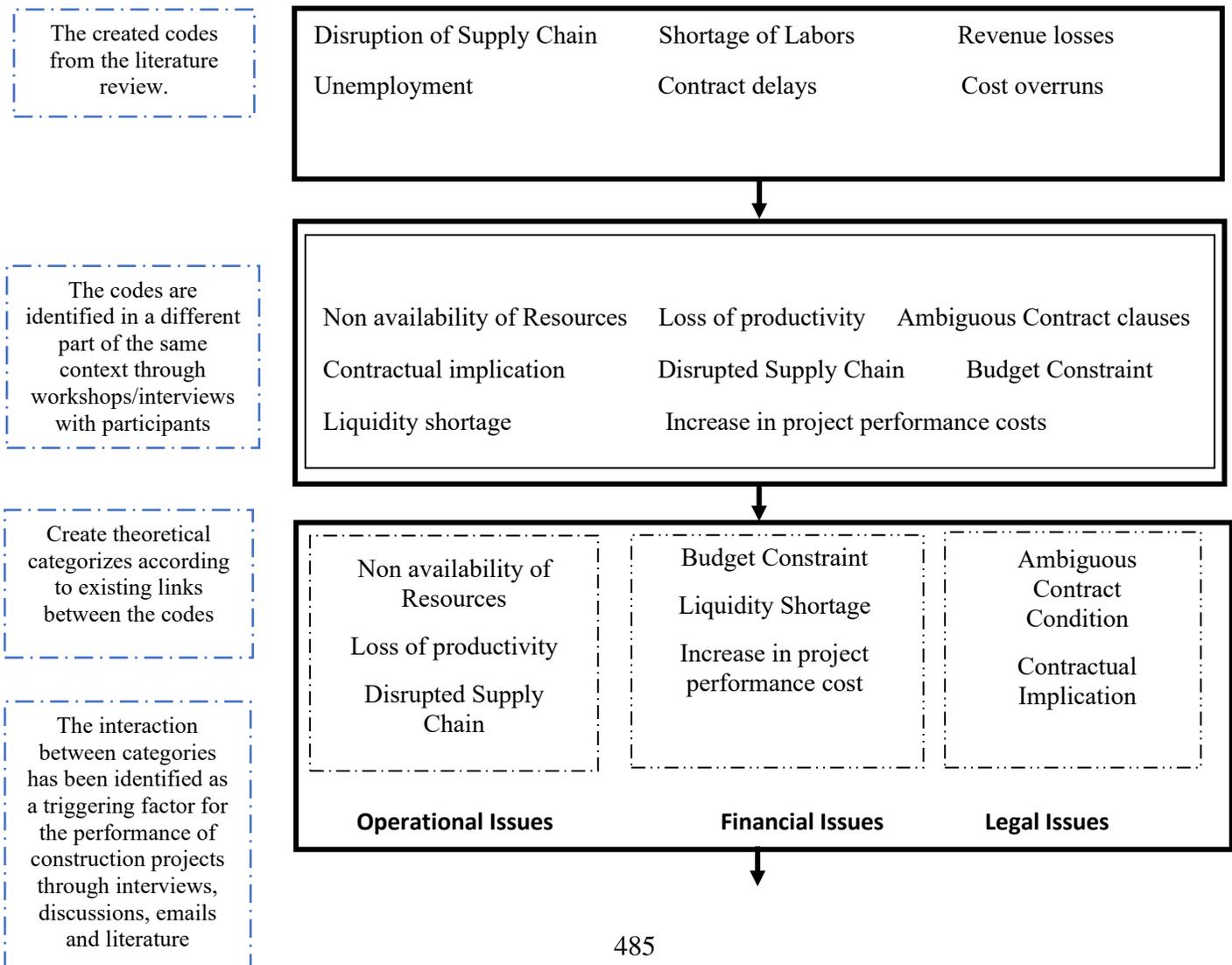
Themes		Emerging Concepts		
Operational issues	Non availability of manpower	Loss of productivity	Impact on supply Chain	Bankruptcy of small MSME vendors
Contractual and Legal issues	Suspension or Termination of contract	Risk associated with Liquidated damages, Extension of Time and delay claims	Site compliance	Insurance Coverage's
Financial issues	Lack of funding	Shortage of working capital from banks and financial institutions	financial burden on Bank Guarantee extension	Investment plunged

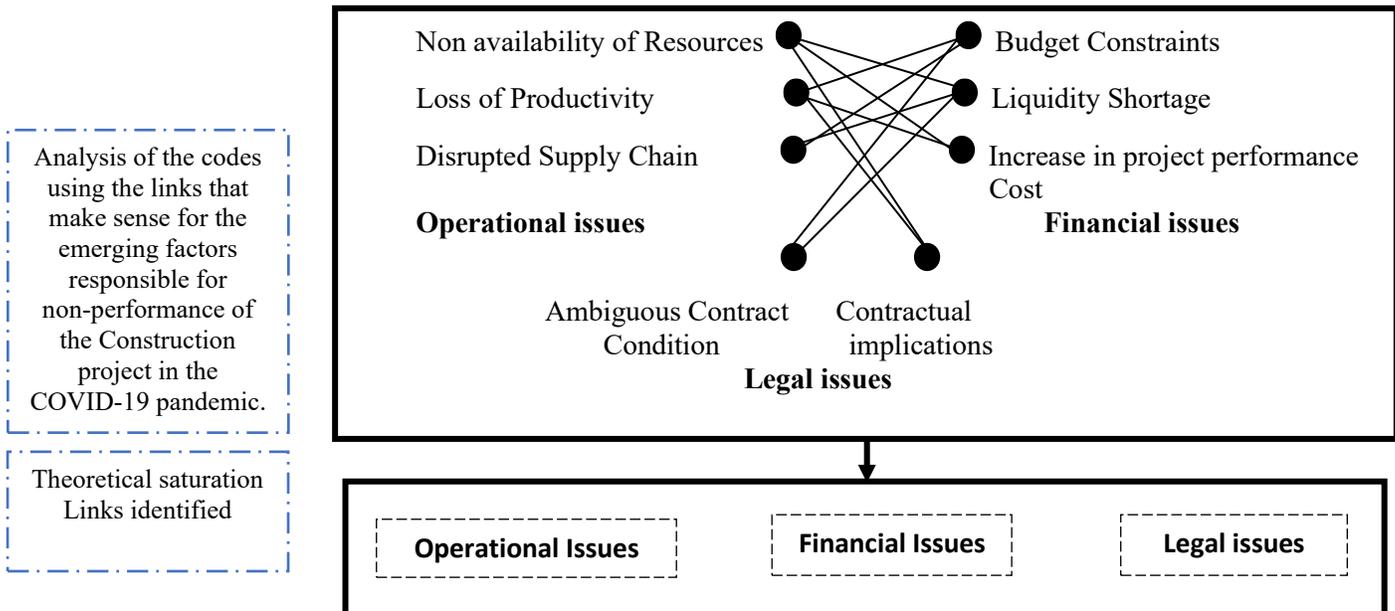
After identifying the themes and emergent concepts in the focused coding phase of analysis, the author selected the most significant and frequent initial codes to categorize the data into a stronger logical sense. The codes have professed as epicenter around which the discussion related

to factors affecting the performance of construction projects in a pandemic is develop. The codes are made after précised comparison and refinement; three categories emerged that impact the performance of construction projects under the COVID-19 pandemic: operational, financial, and legal challenges. Figure-2 will explain the logic of GTA carried out by the researcher under this study.

Under this research, there are several instances wherein, while conducting the semi-structured interview, the author probes into sensational issues like corporate debt restructuring, the social condition of migrating laborers, and their family’s hardships in the lockdown period. Even the author has tried to maintain reflexivity throughout the research process by maintaining privacy, confidentiality, increasing transparency and trustworthiness (Attia and Edge, 2017). The author has contacted participants vide pre-interview phone surveys. The authors believe that the phone survey was a significant move to develop rapport before the phone interviews. Critical criteria used to ensure the research qualities are credibility and conformability (Atta and Edge, 2017). The author has devoted reasonable time per interview participants and conducted pilot interviews to ensure that all the participants possess adequate knowledge on this research subject to establish confidence that results derived from these participants are true and credible.

Figure 2: Logic scheme-based explanation of obtaining the grounded theory (source: created by author)

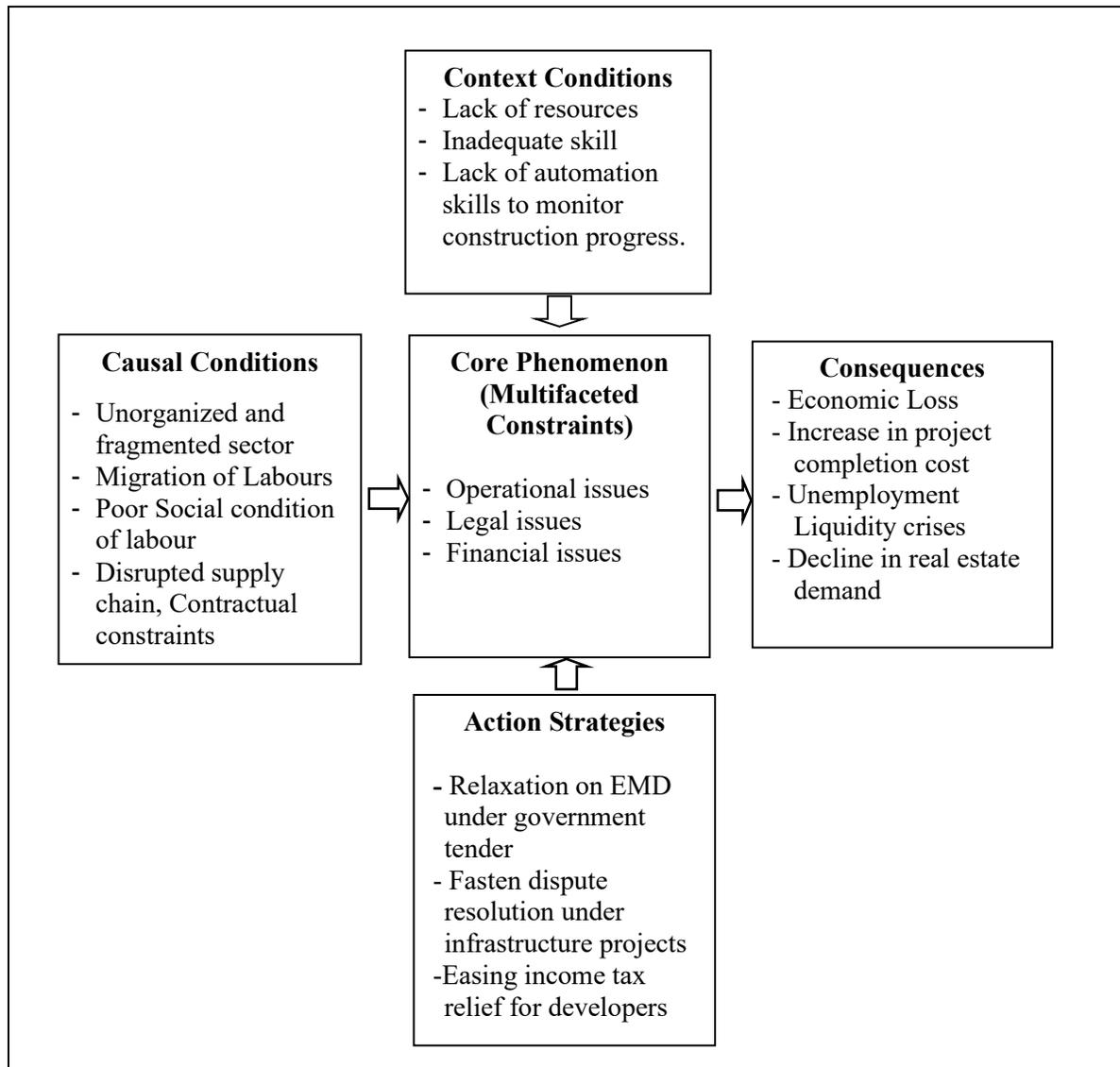




4. Results

This part will show the results of the research methods used for gathering the data. As discussed in the method section, open coding is the first step in the data analysis of a GTA. In the open coding, the author examined the data collected through semi-structured interviews. The purpose of examining data is to identify concepts and categories; and explore their properties and dimension (Strauss and Corbin, 2008). Under this phase, the author has found open codes, which influenced the performance of construction projects in the COVID-19 pandemic period. The open codes are made to demonstrate the development of theory during the data analysis process. Some open codes consist of subthemes, whereas others are integrated into the different themes in investigating the factor responsible for impeding the performance of construction projects. The author has started doing open coding after conducting the first round of interviews with the participants. In axial coding, the author has positioned the categories developed through open coding into the theoretical model based on its conceptual relationships (Vollstedt and Rezat, 2019). The axial coding has been made during this data analysis process to identify the central phenomenon. After that, causal conditions are explored and strategies used to boost the performance of construction projects in post-COVID-19. The causal condition and strategies are used to discuss contextual and intervening conditions shaping the strategies (Hilgers, 2018). A conceptual model illustrated in Figure 3 outlines the challenges faced by the construction professional based on the interviews taken in the COVID pandemic.

Figure 3: Conceptual Model showing the challenges in construction projects in India using GTA
Adapted from Irving et al., (2014, p.65)



4.1 Central Phenomenon – Multifaceted Constraints

The central phenomenon discussed by all participants who had taken part in this study was the multifaceted constraints associated with the performance of construction projects under the COVID pandemic. These multifaceted constraints have impeded the development of construction projects in India, ranging from operational, financial, and legal issues. The tables below show the central phenomenon of factors affecting the performance of construction projects on the operational fronts

Table 3. Central Phenomenon of factors affecting the performance of Construction projects in India under COVID-19 pandemic- Operational Issues

Open Code	Sub Codes	Participants	Participants Example
Shortage of Resources	Labors	CE-1	<p>“Majority of the construction projects in Mumbai and Pune got stalled due to shortage of labors. Hmm... (pause), truly speaking, about 70 to 80% of the workforce have returned to their hometown based in Bihar, Uttar Pradesh and Jharkhand in pandemic period”.</p>
	Materials	CE-2	<p>“In residential building projects, 15 to 20% of work consists of finishing items that include particular types of woods, plaster, glazed partitions, etc. Most civil contracting companies imports these items from China. Since the government-imposed lockdown has delayed the consignment, impacted the project completion schedule, and caused unbilled revenues issue due to delay in completion of project milestones”.</p>
Reduction in Productivity	Anxiety	CE-5	<p>“With the rapid increase in COVID cases and fatalities in Mumbai and nearby localities, many project staff has started avoiding coming to offices. Hmm. [pause]. Further, the company doesn’t have any standard procedure to deal with this pandemic initially. Lack of required staff resulted in productivity losses on a larger scale at construction sites”</p>
	Working Culture	CE-6	<p>“The construction industry is not mature enough like the IT sector, wherein work from home culture suits day-to-day business needs. In context to the construction projects, several daily activities like inspection of reinforcement alignments, quality inspection, fire equipment, etc., which are reliant on external parties, affected the project progress. The same cannot be executed by the agency while working from home.”</p>

Table 4. Central Phenomenon of factors affecting the performance of Construction projects in India under COVID-19 pandemic- Financial Issues

Open Code	Sub Codes	Participants	Participants Example
Budgetary Constraints	Lack of funding	CE-9	““Yes, indeed now the government have poured huge money to boost construction activities, but earlier, several projects faced some funding issues.”
	Financial Burden	CE-2	“The company has supported the workers by providing food and PPE kits during an initial lockdown period of 2 to 2.5 months. It is challenging to manage the funds, as the bills certification against the work carried out in January and February got stalled due to lockdown imposed by the State Government. On the other end, the company has to pour its money from its pocket to keep labors safe and healthy to meet COVID-19 compliance”
Liquidity Crises		Financial Implication	CE-5
	Increase in project completion cost	Labor rate escalation	CE-2
Increase in materials price		CE-6	“The price escalation is a dominant factor that has affected most of the projects under the execution phase. The prices of essential building blocks items required for constructions like cement, steel, and timber got increased multifold time in the market.”

Table 5. Central Phenomenon of factors affecting the performance of Construction projects in India under COVID-19 pandemic- Legal Issues

Open Code	Sub Codes	Participants	Participants Example
Ambiguous Contractual Clause	Force Majeure	LE-2	<i>“In the construction industry, particularly in real estate contracts, most of the contract terms and conditions are trailer made, wherein clauses related to Force Majeure are not present. This tailored contract agreement makes it difficult for any contractor to ask clients to grant Extension of Time and associate claims.”</i>
	Unforeseen conditions	CE-8	<i>“From the project management point of view, it is difficult to mitigate the contractual risks that arise due to the COVID-19 pandemic. On reviewing the contracts, there is no explicit provision that states such pandemic as a part of "unforeseen condition" based on which one can ask the customer to compensate for the idling of resources and additional costs incurred implementing the COVID-19 site safety compliance”.</i>
	Suspension of Contract	LE-2	<i>“Not all, but few customers have temporarily suspended the contracts, as they are also in a dilemma [pause] up to what period the government will extend this lockdown”.</i>
Contractual Implications	Compliance	CE-2	<i>“Covid-19 has also hit the project budgetary cost. In the current project [XXXX], the company has faced substantial monthly charges in complying with the compliance related to worker safety also recent requirements related to PPE kits and site sanitization under the COVID period”</i>
	Claims	LE-3	<i>“Few civil subcontractors in the project [XXXX] have submitted their overstay claims for idled resources at the site in the initial few months of lockdown. Its genuine problems faced by a majority of the subcontractors under the construction sector, as they had already deployed much equipment at the site whose rental charge is high.”</i>

5. Discussion

5.1 Shortage of resources

The shortage of resources is one of the dominant root causes that has caused a significant level of disruption to the ongoing construction projects across India. All participants (CE-1, CE-2, CE-3, CE-4, CE-5, CE-6, CE-7, CE-9 and CE-10) stated that the mass exodus of laborers, and disrupted supply chain have affected their construction projects. Few examples of the relevant responses are provided.

“The acute shortage of laborers has stopped the projects and caused uncertainty over its completion deadline (CE-7). The country-wise lockdown has prevented the essential resources like a site supervisor, engineers, and managers from resuming the construction works, which affects the site operations, delays in inspection and securing permits (CE-9)”.

The participants also narrated the ongoing difficulties they are facing at the site because of the non-availability of construction materials as indicated in the response below.

“The company faces challenges in completing the procurement milestones as the shipment was on hold due to the COVID-19 pandemic (CE-5). The majority of the imported items required for finishing work got stalled for customs at Mumbai port (CE-10)”.

A few participants have admitted that the stringent lockdown imposed by the Government of India (GOI) has disrupted the supply chain and caused a shortage of laborers in the metropolitan cities, thereby resulting in infrastructure activities to standstill across India (Kapoor, 2020).

5.2 Reduction in Work productivity

All the participants highlighted that their team has faced extreme challenges related to productivity losses. The COVID-19 protocols like social distancing, travel restriction, screening, and hygiene have severely impacted construction productivity. Few examples of the responses are provided below

“The primary site activities, such as reinforcement checking, quality control, etc., which rely on the (external) engineering consultant, got delayed due to travel restrictions imposed by the State Government (CE-4). However, the company has split their laborer's workforce into alternative weekdays to follow the local norms related to working with a 25 % workforce, which impacts work progress...(CE-6)”. CE-1 states, that the company has witnessed a drastic reduction in the labor workforce resulted from irregular absenteeism due to the rising number of morality cases resulted from the COVID -19 delta variant.”.

It can be inferred from the responses that most companies face challenges on productivity losses due to travel restrictions imposed by the Government of India, Ministry of Home Affairs. The construction companies have faced huge productivity losses due to travel curtailment, harsh COVID-19 norms by the local authority, and fear of morality (Amri and Perez, 2020).

5.3 Budgetary Constraints

The majority of the interviewee's participants have stated the challenges their organization faced on budget issues under the COVID-19 pandemic. This budget constraint has created a multifold impact on the organization day to day operation productivity.

“CE-2 stated, several construction projects were either slowed down or halted due to the non-availability of funds from the customers in the 2nd quarter of the financial year 2020-21. This budgetary issue is visible as the number of projects under the proposal and bidding phase were either rolled out or temporarily suspended due to fiscal constraints this has affected the business projections CE-9”

It is evident from the interviewer's response that the lack of funds from the customer has a severe impact on the construction project's completion. Many residential real estate projects are either unfinished or unsold due to the Covid-19 pandemic (Krithiga et al., 2021).

5.4 Liquidity Crises

Some participants highlighted liquidity crises their organization faced due to non-certification of running accounts bills and additional costs incurred towards implementing the COVID-19 pandemic protocol at the site and offices.

“CE-2 states that the customers had delayed many RA bills certification due to the sudden lockdown imposed by the government authority after 22nd March 2020. As a result, the organization could not pay the laborers/subcontractors working on a daily wage basis. Several suppliers and vendors are also chasing for their payment against executed works. However, (CE-5) pointed out an additional financial burden their project team faced while complying with the site safety compliance. Their site overheads cost has increased enormously due to extra expenses incur toward site sanitization, screening, and personal protective equipment like masks and gloves, face shield, etc”.

It is interesting to note that cases of construction disputes on delayed payment have been increased under the COVID-19 pandemic, as revealed by some of the interviewed legal experts

“LE-3 states that their project teams have issued the demand letter/legal notices to an ample number of the customers to release the dues/outstanding payments as per the agreed contract agreement. However, their response was discouraging, as very few customers responded with the tentative timeline by which they will release the due payments. This breach in releasing the payments by the customers leads to increase litigation case LE-1”.

5.5 Increase in Project Completion Cost

Some participants highlighted that their organization faces additional financial implications due to increased skilled and semi-skilled labor rates in the COVID-19 pandemic.

“CE-2 states that the COVID-19 pandemic has negatively affected the Indian economy; with the increase in inflation rates, construction materials and workforce prices have suited up. Further, (CE-6) revealed that the costs of local laborers increased multifold times under the urban area due to the mass migration of laborers to their native villages in the COVID-19 pandemic, which has increased the project costs”.

5.6 Ambiguous Contract Conditions

Few interviewed participants having expertise in project legal matters has pointed out that the lack of contract conditions such as force majeure under the agreed contract agreement has resulted in construction disputes between the stakeholders. Few examples of the relevant responses are provided.

“LE-1 states that their organization has faced a series of notices related to liquidated damages, penalty, and contract suspension under the COVID-19 pandemic period from the customers. Further, LE-2 revealed that the tailored made contract agreement mainly doesn't contain the standard provisions related to “FORCE MAJEURE” or “ACT of GOD”, which dealt with the delays resulted from the pandemic, wars, etc. The lack of usage of the standard form of contract like FIDIC, NEC etc., doesn't provide the basis for the contractors to apply the extension of time to complete the balance scope of work under the pandemic situation and avoid the additional liability associated with the liquidated damages as stated by the LE-3 participant”.

It can be inferred from the responses that most contractors face contractual and legal issues regarding unclear contract provisions dealing with the “Force Majeure” and “Act of God” (Krithiga et al., 2021). It is typically difficult for the contractor to demonstrate the project delays incur on account of the COVID-19 pandemic as a part of the Force Majeure event, mainly when this clause is not stated under their contract agreement.

Project Stakeholder Perspective

One of the objectives of this research is to identify the different viewpoints of project stakeholders about the dominant root cause of delays in the construction projects under the COVID pandemic. The several factors that impeded the construction project's progress during the lockdown period from the stakeholder's perspective based on data analysis as shown in Table 6 below

Table 6: Stakeholder perspective on root cause for delays under construction project due to COVID- 19 pandemic (author analysis)

Project Stakeholders Concerns	Factors Impacting Construction Projects	Interviews Participants
	a) Financial Constraints Credit market volatility, increase in project costs and diversification of funds	CE-1, CE-4, CE-7 CE-8, CE-9, CE-10
Owner	b) Operational Constraints Lack of specialized resources due to visa restriction,	CE-1, CE-2, CE-3,

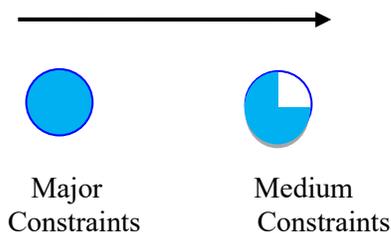
	shortage of equipment's, stoppage of imported materials at ports and customs	CE-4, CE-5, CE-6 CE-7, CE-9, CE-10
	c) Legal Constraints Settlement of time-based claims, safety compliance, price escalation	LE-1, LE-2, CE-4 CE-8, CE-9
Contractor	a) Financial Constraints Funds issue, additional financial implication due to idled resources, maintaining OSHE safety norms at Site, additional costs on account of bank guarantee extension and insurance premium, demurrage charges on inventories and port clearance, price escalation	CE-2, CE-5, CE-6 CE-9
	b) Operational Constraints Lack of manpower's and equipment's, materials shortage	CE-1, CE-2, CE-3 CE-6, CE-7, CE-9 CE-10
	c) Legal Constraints Ambiguous contractual conditions, disputes on grant of Extension of Time, LD and associated costs, partial suspension or termination of the contract, compliance	LE-1, LE-2, LE-3 CE-2, CE-3, CE-7 CE-8

Perceptual Mapping of Project Stakeholders

A stakeholder's primary survey is conducted with real estate developers, major EPC contracting companies, and law firms engaged in construction activities across India. The main objective of the surveys was to identify the impeding factors affecting the performance of construction projects in the COVID-19 pandemic and arranged them on the scale of medium to significant constraints, as shown below in Table 7. This scaling of critical factors was done based on the perception of interviewee participants.

Table 7: Author Analysis on Stakeholders perception matrix

Parameters	Real Estate Developer	Construction Companies	Legal Practitioners
Operational issues: - Non availability of manpower's, disrupted supply chain, loss of productivity			
Contractual issues: Ambiguous contract conditions, contractual implication related to suspension and termination of contract, liquidate damage and site safety compliance			
Financial issues: - Funding constraints, liquidity/working capital crises, increase in project cost			



The rankings of the various factors based on perceptual mapping of project stakeholders is presented in Table 8 below clearly indicate the operational issues (i.e., non-availability of manpower and resources, disrupted supply chain) and financial issues as the prime constraints for delay in performance of construction project during COVID-19 pandemic. These are followed by other key barrier such as contractual constraints for the construction companies.

Table 8: Ranking of major constraints impacting slow progress of construction projects in COVID-19 pandemic based on perceptual stakeholder mapping (author analysis)

S.No	Parameters	Ranking
1	Operational issue: Non availability of man powers, disrupted Supply chain, loss of productivity	1
2	Financial issue: Funding constraints, liquidated capital crises, increase in project completion costs	1

3	Legal issue:	Ambiguous contract conditions, contractual Implications related to suspension and termination of the contract, liquidated damages and compliance	2
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The second objective of this research is to produce the recommendation to overcome the sluggish growth of the construction sector under the COVID pandemic. Few participants have advocated adopting the ongoing technologies like BIM, Radio frequency identification (RFID), 3D printing, and big data to avoid human interaction to stop covid -19 spread.

“CE3 states that the lack of usage of upcoming technologies like BIM in the day-to-day operation of construction projects is also one factor that has affected the project performance. The BIM can boost construction project performance by allowing the project stakeholders to work remotely under a collaborative environment to curb the COVID-19 spread. Similarly, CE7 indicated that Radio Frequency Identification (RFID) could track the construction devices, equipment, vehicles etc. CE-8 states the usage of drones at the construction site for capturing the updated images of construction sites, thermal imaging to monitor the staff, workers implementing COVID-19 protocol like wearing masks, maintaining social distancing at work station etc”.

To implement the digital transformation in construction, BIM plays an essential role (Boton et al.,2020). Several other technologies like the Internet of Things, additive manufacturing, 3D printing, and big data play a critical role in transforming the construction sector towards digitalization (ibid).

6. Study limitations and future research directions

The present study has few limitations. First, the data gathered from the interview participants are limited to real estate and infrastructure construction projects only. As a recommendation for future study, the author strongly recommends to the future researcher to make one step further and investigate in detail the associated impact of the COVID-19 pandemic on other construction segments such as heavy industrial construction such as onshore construction, mining, refineries, chemical processing, and power plant construction projects. Acknowledging this will enable both private and public sectors to make the necessary road map to overcome project delays from tendering to handing overs phase of the construction projects.

7. Conclusions

This study has attempted to bring out the various impediment faced by construction companies during the COVID pandemic. Majority of construction firms have faced the operational related issues related to shortage of manpower and materials at project sites. The mass exodus of migrant workers back to their native places has resulted in shortage or non-availability of skilled and semiskilled workers within metropolitan cities like Mumbai and Pune, resulting in stoppage of construction activities at site. Further, due to worldwide lockdown imposed by the governments has affected the supply chain drastically and have severe impact on the construction projects, as lot of long lead imported items were laid at port for entire lock down period. Since

majority of factories across the world and especially in China were either closed or operate with low capacity resulted in paucity of certain import items used in construction such as finishing items within local market. These disrupted supply chain has caused drastic increase in material prices, which in turn increase the performance cost of the construction projects in India. Further, with increasing number of deaths in metropolitan city that has put the company employees under stressed and resulted in absenteeism at working station which affects the project productivity at offices and sites. Secondly, author has identified that the contractors suffered from the liquidity crises and budgetary constraints. They incurred huge cost overrun on account of idling of resources and in implementing health safety compliances at site. Thirdly, author has identified that unclear contractual provisions within the contract related to force majeure, unforeseen event has resulted in a breeding ground of disputes between owner and contractor for granting of extension of time and associated compensations. Several participants recommend usage of latest technology such as BIM, 3-D printing and RFID to monitored construction projects. Further, the present investigation has few limitations. First, the data gathered from the interview participants are limited to real estate and infrastructure construction projects only. As a recommendation for future study author strongly recommend to future researchers to make one step further and investigate in detail about the associated impact of COVID pandemic on other construction segments such as heavy industrial construction which includes onshore construction, mining, quarrying, refineries projects. The acknowledgment of this will enable both private and public sector to make the necessary road map to overcome project delays.

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