

# Impact of COVID-19 on the Construction Industry: A Case-Study of Disruptions and Recovery Strategies

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## Abstract

The COVID-19 pandemic spread worldwide and affected almost all countries globally. The continuous spread of the virus has had significant impacts on most sectors of the economy, including construction. The construction industry faced severe challenges, such as labor shortages, material shortages, cost escalations, schedule delays, delayed permits, approvals, inspections, travel restrictions, and serious health and safety concerns among others which hindered the timely delivery of the construction projects. As a result, owners were under immense pressure, especially in the public universities as there were limited buildings to accommodate the increased teaching and research activities to meet the current and future needs. However, to date very limited research has been conducted on it. Therefore, this research aims to investigate and understand the challenges faced by contractors and owners due to the pandemic, and what actions were taken for the timely delivery of their Capital Improvement Projects (CIP) to facilitate teaching and research activities. The study employed a case-study based approach to investigate the impact of COVID-19 on a public project at a university in the southeast region of the U.S. The results show that both the contractor and the owner worked together to complete the project, but the owner had to come up with innovative solutions to overcome the critical issues while still risking the timely delivery of the project.

## Keywords

COVID-19 Impact, Construction Industry, Owners, Contractors, Public Projects, Case Study.

## 1. Introduction

The COVID-19 pandemic spread worldwide and affected all countries globally. The virus was first identified in December 2019 in Wuhan, China. Several countries, and organizations like the Centers for Disease Control (CDC) cautioned the public to take responsive care such as handwashing, wearing face masks, physical distancing, and avoiding mass gatherings and assemblies. Lockdown and staying-at-home strategies were put in place to control the transmission of the disease (Sintema, 2020). Even with these preventive measures, the virus continued to spread and brought most of the globe to a halt, toppling the world economies. The pandemic has affected the global economy and, thus, the global construction industry (Rehman et al., 2021). During this global pandemic, contractors and their sureties have faced numerous challenges, such as labor and material shortages, extensive cost escalations, extensive lead time, delayed inspections and permits, etc. (Rehman et al., 2021). These impacts have led owners, contractors, subcontractors, and developers to exercise their contractual rights to mitigate risks for themselves and their companies.

In the United States, businesses deemed as “non-essential” had to completely halt in-person activities and encouraged telecommuting or “work from home” systems. However, construction was deemed as “essential” and was allowed to carry on regular construction activities as long as they complied with the CDC guidelines (Salman et al., 2021). Even with such leniency, the construction industry faced critical challenges such as delays and suspension of existing projects; cancellation of planned and new projects; supply chain complications; production delays and logistic bottlenecks; creation of additional and new risks related to the job sites, and contractual responsibilities; labor shortages, health and safety of construction workers; and financial issues like limited capital availability (Morris et al., 2020). As a result, owners were under immense pressure, especially in the public universities as there were limited buildings to accommodate the increased teaching and research activities to meet the current and future needs. Some studies have explored the impact of COVID-19 on the construction industry (Biswas et al., 2021), but none of these

studies focused on the impact of COVID-19 in a public university setting where the contractor must provide and complete the building in the given time period to facilitate teaching and research needs of various programs. This research aims to investigate and understand the challenges faced by contractors and owners due to the pandemic and develop a list of actions taken for the timely delivery of Capital Improvement Projects (CIP) to facilitate teaching and research activities in the higher education environment. The study employed a case-study approach. Both quantitative and qualitative data were collected and analyzed. Request for Information (RFI) data was collected from the owner and contractor to quantitatively assess the number of COVID-related RFIs. Interviews were conducted with contractor representatives and owner representatives to explore the strategies adopted to tackle the issues (found from the quantitative data analysis) and their effectiveness during the pandemic.

## 2. Literature Review

Many studies have been conducted to explore the impact of COVID-19 on the construction industry from the contractor's perspective (Biswas et al., 2021; Sami Ur Rehman et al., 2021). For example, Rehman et al., (2021) found that the UAE construction industry faced several challenges such as schedule delays, disrupted cashflows, delayed permits, delayed approvals and inspections, travel restrictions, serious health and safety concerns, material, equipment shortages, etc., which hindered the timely delivery of construction projects. A survey conducted by the American Society of Civil Engineers (ASCE), reported the following facts:

- 20% of the organizations had to retract offers to entry-level employees and interns.
- 14% of the organizations were facing potential contract penalties due to project delays.
- 50% of the companies have experienced COVID-19 related delays in receiving material and products from suppliers; and despite the gradual reopening of the national economy, 29% of companies expressed concerns over their long-term viability.

Additionally, these organizations were met with several challenges, including but not limited to, cancellation or delay of contracts, cash flow challenges, hiring freezes, absenteeism, supply chain shortages, layoffs, and furloughs (Stover et al., 2020). Schedule delays have been an issue in the construction industry even from the pre-pandemic time. Al-Wadei (2020) examined several sources to identify the different causes of schedule delays for projects worldwide, with the main focus being on oil and gas projects. Only 52% of projects were completed on time in 2018 and this has remained around 50% between 2011-2018 (Al-Wadei, 2020). Late projects led to cost overruns of thousands of dollars per day for capital projects. The primary causes of project schedule delays were changes within the organization such as changes in the priorities, project objectives, and inaccurate scope requirements. This issue was exacerbated during the pandemic when the manufacturers did not have enough workers to complete the jobs (Castenson, 2021). Another study explored ways for builders, developers, manufacturers, architects, and contractors to overcome supply chain issues by creating a successful path forward with their respective projects. The study proposes to prefabricate certain items before reaching the job site, which not only reduces the direct cost of the project but also solves the labor shortage issue (Stover et al., 2020).

During the pandemic, projects were experiencing an increase in overall cost for several reasons. For example, due to the pandemic, there was a need for additional staff on the job sites to implement new safety guidelines and perform temperature checks, and other activities required or recommended to maintain a healthy work environment (Stover et al., 2020). There was also a need for additional handwashing stations. Labor shortage due to absenteeism was due to several factors such as the quarantine period, issues with public transportation, lack of available childcare, etc. Furthermore, telecommuting; and the reduced on-site staff mandate or government-mandated social distancing also contributed to the labor shortage and a decrease in labor productivity resulting in schedule delays (Stover et al., 2020).

Additionally, the supply chain within the construction industry was highly impacted due to the pandemic. As more countries were under government-mandated lockdowns, manufacturers were fabricating raw materials at a much slower pace which made it hard for vendors to procure materials on time; such challenges were hindering construction work all across the United States (Biswas et al., 2021). Furthermore, material procurement became more expensive as a result of global manufacturing shutdowns (e.g., products made in China), international borders and port shutdowns, and general material transportation delays within the United States (Stover et al., 2020). Due to such issues, lower-tier contractors, subcontractors, and vendors suffered great losses which in turn affected several bonded projects. A research study projected that materials shortages could put the brakes on construction activity, leading to a lack of

supply in 2022 and beyond. The study explains that the cost escalations of steel, lumber, and other essential materials are understated and do not present the severity of the problem (Biswas et al., 2021).

**Research Gap**

There has been significant research worldwide related to the impact of the pandemic on the construction industry, however, very limited studies were conducted in the United States. Additionally, none of the studies go at a micro level to understand the impacts. Collectively many researchers did not communicate with any stakeholders i.e., owners, architects, or contractors to get their perspective to address the COVID-19 challenges. Research should be conducted with each of these stakeholders to analyze the issues and successful mitigation strategies (Biswas et al., 2021). Therefore, this research conducts interviews with the contractor and the owner to document the strategies adopted and their effectiveness.

**3. Methodology**

The study employed a case-study approach and both quantitative and qualitative data were collected to investigate the impact of COVID-19 on a project at a university in the SE region. The RFI data was collected from the contractor and the owner which was quantitatively analyzed to assess the percentage of COVID-19 related RFIs, their solutions, and their impact on the project schedule. Following the quantitative analysis, interviews were conducted to inquire about the strategies adopted to mitigate the COVID-19 related issues with the contractor as well as the owner representatives. Eight semi-structured interviews were conducted; four from the contractor side and four from the owner side to gain both perspectives. The interview questions are given in Table 1. The interview data was analyzed using thematic analysis.

**Table 1.** Interview Questions

Sr. No.	Interview Questions
1	Since March 13th, 2020, how significant were the impacts of the COVID-19 pandemic on project cost and time of XYZ project? And what were they?
2	When did you first start seeing the impacts of COVID-19 on the project? Describe them.
3	When did COVID-19 start impacting the supply chain/ material procurement for this project? How did you resolve the issue?
4	What were the top 3 materials/items on the project that were affected? Were the prices locked? Did the increase in prices affect this project? How did you resolve the issue?
5	What impacts of COVID-19 did you anticipate and what changes did you implement when a national emergency was declared on March 13 <sup>th</sup> , 2020, and when the industry was deemed “essential”?
6	What would you say are the lessons learned from COVID-19 that you could apply to all future projects?
7	Any advantages that come to mind? And what would you do differently if you had to prepare for another pandemic?

**Case-Study Project**

The project selected for the case-study is an academic building. Besides teaching and research, the selected project also blends in retail, restaurants, apartment units, and a luxury hotel in the heart of the town. The 142,000-square-foot complex is designed to promote immersive learning experiences for students pursuing careers in hospitality and culinary sciences. The project started in March 2020 and was severely impacted by COVID-19. The total cost of the project was \$110 million. The data for the case-study was provided by the contractor and owner. The RFI data (Appendix A) was quantitatively analyzed to determine the level of COVID-19 impact on the project. Interviews were conducted with the contractors and owners to understand the COVID-19 impact on the project and strategies adopted to mitigate the impact on project completion.

**3. Results**

For the case-study, 51 RFIs (request for information) were analyzed between 2020 and 2021. The RFIs were first categorized by sub-contractors. Upon preliminary analysis, it was evident that the companies were subjected to the

challenges of material procurement, cost escalations, labor shortages, and supply chain. The language of the RFIs also pointed out the impacts of the pandemic on this project, which predominantly affected either project cost or project time. To quantify all the data available in RFIs, content analysis was conducted. Firstly, all data were categorized based on the types of impacts on the project. For example, supply chain implications such as material shortages and cost escalations; or workforce related issues such as labor shortages, as indicated by the vendor or subcontractor. These categories were then dissolved into the base impacts on project cost and/or project completion time. Lastly, it was determined if the sub-contractor or vendor has listed the RFI as a direct effect of COVID-19 or not. The date the RFI was sent to the contractor and the date the changes were implemented were also noted. Once all data was examined through these parameters, major impacts were identified. Appendix A shows the detailed RFIs analysis.

### 3.1 Quantitative Analysis of RFIs

Out of the fifty-one (51), RFIs sent to the GC, forty-four (44 or 86%) reported that the challenges faced were a direct impact of the COVID-19 pandemic. The other instances (total 7 or 14%) where they faced challenges were due to supply chain backlog caused by hurricanes.

#### Reported Impacts

In this case study, out of the fifty-one instances, the most common impacts of COVID-19 were: (i) cost escalations, (ii) material shortages, (iii) labor shortages, and (iv) an increase in lead times; as shown in Table 2.

**Table 2.** Reported COVID-19 impacts and respective frequency

Reported Impacts	Instances Recorded	Total Instances
Cost Escalations	41	51
Material Shortages	30	51
Labor Shortages	18	51
Increase in lead times	21	51

#### Materials Shortages and Cost Escalations:

The pandemic caused significant challenges for supply chains globally, disrupting the flow of raw materials and finished goods. Current research shows that this disruption is initiating a global shortage of raw building materials, resulting in cost escalations and extended lead times (Biswas et al., 2021). Such challenges also affected the construction of this project. Several material vendors expressed that the pandemic has resulted in product costs skyrocketing. The most common materials affected, and the magnitude of cost escalation reported are presented in Table 3.

**Table 3.** Materials affected, and total percent of reported cost escalation calculated

Materials Affected	Instances recorded	Total Instances	Total % of Cost Escalation
Steel	24	51	272%
Gypsum	4	51	263%
Insulation	17	51	126%

### 3.2 Qualitative Analysis of Interview Data

A total of eight interviews were conducted, four with the contractor and four with the owner's team to explore the mitigation strategies from both sides. The information obtained from these interviews provided similar results, and the consensus was that the COVID-19 pandemic had a significant impact on this project's cost and schedule. Interview questions are shown in Table 1. Thematic analysis was performed on the collected data to explore the specific impact and adopted strategies. Results from data analysis of interview questions have been summarized, analyzed, and presented in this section. Based on the interviews, the contractor faced many issues such as extended lead time, material procurement, cost escalation, labor shortages, health concerns, and contractual issues. Some responses also informed about benefits due to COVID-19 i.e., better collaboration between the project stakeholders since everyone

was available remotely, all stakeholders were able to use the technology to communicate, and the workplaces became cleaner due to health concerns. Both the contractor and the owner had shared and unshared issues, explained below:

**Extended Lead Time and Material Procurement**

Table 4 describes a summary of the issues from the contractor, owner, and the strategies to overcome those challenges. The data analysis shows that the owner had provided assistance in resolving most of the issues discussed in Table 4. For example, in the case of extended lead times and material procurement, the owner had provided a conditioned storage space to procure the material ahead of time and be stored until it is ready to be used on-site. The cost of the storage space was absorbed by the owner. The contractor and the owner had informed difficulty procuring material from Europe, specifically Italy and Germany simply because the factories were closed during the pandemic and later opened with limited workers. One interviewee said, “Supply chain issues will continue to plague all industries until skilled labor and manufacturing plants are back to normal capacity, which will take years to accomplish due to the massive backlog of materials”.

**Cost Escalation**

All responses reported cost escalation of many raw materials as well as other components. Moreover, the project being a hard bid public project, the owner was unable to facilitate any request of contract modification to accommodate the increased prices. However, any change orders were made at the escalated prices.

**Labor Shortages and Health Concerns**

The contractor had reported labor shortages and health concerns for the project team. The project team was allowed to work remotely or have limited individuals in the trailer. There were health concerns for onsite workers. The owner resolved the issue by creating an on-site health and safety guidelines which the contractor followed.

**Table 4.** Results of Interviews with contractor and owner teams.

Contractor	Owner	Strategy Adopted
-Extended lead times	-Extended lead times	
-Material procurement	-Material procurement -Lighting fixtures, Flooring -Furniture procurement	-Owner provided a conditioned warehouse to procure the materials ahead of time to avoid schedule delays.
-Cost escalation in material prices		-Nothing done for the cost escalation due to a hard bid project. -Any change orders were made at the escalated cost.
-Subs and vendors experienced extensive amounts of labor shortages		- Construction site health policy was established by the owner.
-Health concerns	-Health concerns	
	-Delayed project completion -Challenge of starting the new semester and accommodating teaching and research activities	-Partial substantial completion was requested
-Contractual issues: Liquidated damages	- Owner was impacted by the delayed completion	-Owner considered it an act of God and did not employ any liquidated damages

**Delayed Project Completion**

In order to start the academic semester, the owners had requested partial substantial completion to continue the teaching and research activities. Although the building was not fully complete, the owner was granted partial substantial completion. The owner said, “Typically, we wait to open a building, but in this case, we had to start the academic year. We couldn't move the start of the school year. We held out on the hotel and the lease living units because those weren't up against a hard date”. The owner's responses also informed many issues due to the early opening as presented in this comment, “if there was one thing I would do

differently, for a job this size, it would be delayed opening until the spring semester. That would've given the contractor time to work off the punch list". In addition, the owners reported issues with procuring furniture which is still a challenge. The owners had resolved the issue by having temporary furniture in the building until the original is delivered.

### **Contractual Issues**

The contractor presented their concerns about liquidated damages in case of project delay. Although the project was delayed and the owner faced many challenges, however, the owner considered them an "act of God" and did not exercise their contractual right of liquidated damages.

## **4. Future Research**

The results presented a series of challenges in the construction industry i.e., material shortage, labor shortage, cost escalation, and increase in lead time causing delays. The future phases of this research should include multiple projects in the region to investigate whether similar issues were faced in those projects. Based on that, a framework of best practices should be developed to prepare owners for future outbreaks/epidemics/pandemics and have an action plan to follow in times of crisis. Furthermore, future research should also address the issue of material procurement by using AI-driven software which can inform the stakeholders about real-time construction lead times. This can help contractors and owners to track materials/items in real-time and resolve them during their planning and procurement stages.

## **5. Conclusions**

This research investigated the impact of COVID-19 on a construction project in a public university setting and presented the actions taken for the timely delivery of their Capital Improvement Projects (CIP) to facilitate teaching and research activities. The study employed a case-study approach in which both quantitative and qualitative data were collected. The results showed that the pandemic had negative impacts on the construction industry, such as labor shortage, increase in unemployment levels, material and equipment issues and, new contractual risks. Some positive impacts were also reported like increase in technology adoption, better collaboration between the project stakeholders, cleaner workplaces and job sites, and a shift towards more reliance on diversified local suppliers. It also shows that during the time of crisis the owner fully supported the contractor in resolving most of the issues. The case study shows that both the contractor and the owner worked together to complete the project, but the owner had to come up with innovative solutions to overcome the critical issues while still risking the timely delivery of the project. Future research should focus on developing best practices framework that contractors and owners can follow in times of crisis.

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Appendix A: Quantitative data analysis for the RFIs Results

Data Analysis: Raine Culinary Center - RFI's											
No.	Company	Material	Reason for RFI			Changes in Time	Change in Price	Products with changes in price	Effect of COVID?	When was it sent?	When is it implemented?
			Changes in Cost								
			Price Increase	Material Shortage	Labor Shortage						
1	USG	Gypsum	1	0	0	0	20%	All wallboard products, including Sheetrock® Wallboard products and Securock® Glass-Mat products.	1	5/3/2021	6/1/2021
							5%	Durock® brand cement board and glass mat tile backer and Fiberoak® brand			
							5%	All interior finishing products, which includes all Joint Compound, Tape, Texture, Plaster and Accessories			
							10%	All bead and trim products which includes all Paper-Faced Bead & Trim and Metal Bead products.			
							\$2/roll	Fiberoak® brand Floor Protector Paper			
2	American Gypsum	Gypsum	1	0	0	0			1	3/5/2021	4/5/2021
3	ClarkDietrich	Steel	1	1	1	1	10%	All steel products	1	2/1/2021	4/1/2021
4	ClarkDietrich	Steel	1	1	1	1	10%	All steel products	1	12/1/2020	1/4/2021
5	ClarkDietrich	Steel	1	1	1	1	10%	All steel products	1	12/28/2020	2/1/2021
6	ClarkDietrich	Steel	1	1	1	1	10%	All steel products	1	12/28/2020	3/1/2021
7	ClarkDietrich	Steel	1	1	1	1	10%	All steel products	1	3/4/2021	5/3/2021
8	ClarkDietrich	Steel	1	1	1	1	10%	All steel products	1	3/18/2021	6/1/2021
9	ClarkDietrich	Steel	1	1	1	1	10%	All steel products	1	5/3/2021	7/1/2021
10	ClarkDietrich	Steel	1	1	1	1	10%	All steel products	1	9/28/2020	11/1/2020
11	ClarkDietrich	Steel	1	1	1	1	10%	All steel products	1	10/29/2020	11/30/2020
12	CertainTeed	Gypsum	1	1	0	0	5%	All interior finishing products, which includes all Joint Compound, Tape, Texture, Plaster and Accessories	1	5/7/2021	6/7/2021
							10%	Corners products			
13	CertainTeed	Gypsum	1	0	0	0	20%	All core and specialty wallboard products	1	5/7/2021	6/7/2021
							40%	All value added wallboard products			
							\$200/msf	shaftliner products			
14	CertainTeed	Gypsum	1	0	0	0	20%	All Wallboard products	1	2/17/2021	4/1/2021
15	CertainTeed	Gypsum	1	0	0	0	20%	All Wallboard products	1	10/26/2020	1/4/2021
16	CertainTeed	Gypsum	1	0	0	0	5%	All compounds, powders, textures, sprays, glues and tapes	1		
17	CertainTeed	Gypsum	1	0	0	0	6%	Joint compounds, setting compounds, all primers, paints, textures, tape	1	3/17/2021	4/9/2021
18	CertainTeed	Gypsum	0	1	1	1			1	4/29/2021	4/29/2021
19	Cemco	Steel	1	1	0	0	12%	All Wallboard Products	1	9/18/2020	10/16/2020
							5%	All compounds, powders, textures			
20	Georgia Pacific	Steel	1	1	0	0		All Steel Products	1	5/24/2021	5/25/2021
21	Johns Manville	Gypsum	0	0	0	1		Toughrock and Dens Availability	1		5/20/2021
22	Johns Manville	Insulation	0	1	0	1		Light density fiberglass products	0	3/4/2021	3/4/2021
23	Johns Manville	Insulation	1	0	0	0	4%	All residential and commercial Batt & Roll products	0	8/12/2020	10/1/2020
							4%	PSK & FSK			
							4%	Basement Wall			
							4%	All loose fill blowing wool products			
							4%	All manufactured housing products			
							4%	All metal building products			
24	Johns Manville	Insulation	1	0	0	0	4%	Insul-Shield	0	5/7/2021	9/1/2021
							8%	All residential and commercial Batt & Roll products			
							12%	R-15, R-21			
							8%	FSK & PSK, basement wall, All loose-fill blow-in fiberglass products, all manufacturing housing products			
							8%	All metal building products, Insul-SHIELD, MinWool Sound and fire block, TempControl All R-values			
6%	MinWool Sound Attenuation Fire Batts, MinWool Curtainwall, Safing, JM Cladstone Water and fire block										
25							8%	All residential and commercial Batt & Roll products			
26							8%	PSK & FSK			
27							8%	Basement Wall			
28							8%	All loose fill blowing wool products			
29							8%	All manufactured housing products			
30							8%	All metal building products			
31	MarJam Supply Co.	Building Materials	1	1	1	1		Insul-Shield	1	5/24/2021	5/24/2021
32	Marino Ware	Steel	1	1	0	0	15%	All materials	1	4/30/2021	6/1/2021
33	Marino Ware	Steel	1	1	0	0	10%	All steel products	1	5/28/2020	7/1/2020
34	Marino Ware	Steel	1	1	0	0	20%	All steel products	1	3/23/2021	5/4/2021
35	Marino Ware	Steel	1	1	0	0	10%	All steel products	1	12/1/2020	1/4/2021
36	Marino Ware	Steel	1	1	0	0	10%	All steel products	1	8/31/2020	10/1/2020
37	Marino Ware	Steel	1	1	0	0	10%	All steel products	1	10/30/2020	12/1/2020
38	Marino Ware	Steel	1	1	0	0	10%	All steel products	1	2/1/2021	4/1/2021
39	Marino Ware	Steel	1	1	0	1	10%	All steel products	1	4/16/2021	4/16/2021
40	Marino Ware	Steel	1	1	0	0	10%	All steel products	1	1/2/2020	2/3/2020
41	Marlite	Building Materials	1	0	0	0	7%	FRP PVC Trim	1	4/6/2021	5/3/2021
42	National Gypsum	Gypsum	0	1	1	1		ProForm Products	1	3/17/2021	3/22/2021
43	National Gypsum	Gypsum	1	0	0	0	15%	All gypsum wallboard products	1	9/18/2020	10/19/2020
							5%	All ProForm Finishing Products			
44	National Gypsum	Gypsum	1	0	0	0	20%	All Gold Bond Gypsum Wallboard Products	1	3/5/2021	4/5/2021
							5%	All ProForm Interior Finishing Products			
							5%	All PermaBASE Cement Board Products			
45	National Gypsum	Gypsum	1	0	0	0	15%	All Gold Bond Gypsum Wallboard Products	1	5/7/2021	6/7/2021
							5%	All ProForm Interior Finishing Products			
							5%	All PermaBASE Cement Board Products			
							5%	All Gold Bond Plaster Products			
46	SPECON Systems	SUB	1	1	1	1			1	5/28/2021	5/28/2021
47	ClarkDietrich	Steel	1	1	1	1		All steel products	1	5/10/2021	5/10/2021
48	LGH	Steel	1	1	1	1	6%	All steel products	1	4/1/2021	5/31/2021
49	LGH	Steel	1	1	1	1	19%	All steel products	1	6/1/2021	7/31/2021
50	LGH	Steel	1	1	1	1	24%	All steel products	1	8/1/2021	9/30/2021
51	LGH	Steel	1	1	1	1	28%	All steel products	1	10/1/2021	12/31/2022