



Article Exploring the Early Impacts of the COVID-19 Pandemic on the Construction Industry in New York State

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Abstract: The COVID-19 pandemic severely impacted many industries on a global scale. Expectedly, the construction industry was not left out as non-essential construction was halted, strict health and safety protocols were introduced, and businesses were disrupted. New York City was the epicenter of the pandemic at its onset in the United States, and the pandemic had different impacts on workers based on their work location and role. This study utilized a survey including twenty-five statements to explore the initial impacts of the COVID-19 pandemic on the construction industry in New York State, analyzing its effects on sixty-one construction industry professionals, their projects, and firms, also considering their work location and role in the construction process. The most severe impacts were on construction schedules and in-person meetings. Those who worked in New York City had more difficulty complying with the increased health and safety regulations than those who worked outside the city. Those categorized as builders indicated significantly more contract performance issues. Furthermore, a set of recommendations were highlighted to strengthen the industry's response to future similar disruptions. This study is significant in helping researchers and businesses build more resilient operations to address current and future pandemic-related challenges facing the construction industry.

Keywords: COVID-19 pandemic; construction industry; health and safety; communication; construction projects

1. Introduction

The ongoing pandemic has adverse effects on individuals, families, businesses, organizations, and governments globally. Studies concluded that the economic decline of 2020 caused by the COVID-19 pandemic is the deepest since the Second World War [1,2]. The pandemic's effect on the global economy is disruptive, affecting production, supply chains, and firms [3,4]. Many uncertainties are associated with economic recovery after the pandemic [1,5]. Similar to the impact of natural disasters, the pandemic led to a decrease in business operations. Impoverished neighborhoods were severely hit, and grocery store sales experienced a surge due to a higher demand for necessities [6]. Additionally, manufacturers of non-essential goods experienced fewer orders, and oil prices plummeted as non-essential travel decreased [3,6]. Many of the consequences of the pandemic directly impact the construction industry, which contributes approximately 5% of the overall US GDP [7] (contributed 4.1% in 2019) and 3.1% of the GDP in New York [8]. The construction industry is one of the largest globally [9], and it continues to play a critical role in revitalizing the US economy [10].

Evidently, the COVID-19 pandemic inflicted damage resulting in higher costs, widespread closures, and lockdowns. Furthermore, it has deeply impacted the world in many aspects, such as economies, healthcare systems, and travel and leisure [11]. New York State, particularly New York City, was severely hit at the onset of the pandemic, with New York City



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Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/). becoming an epicenter accounting for hundreds of deaths daily between March and May 2020 [12,13]. New York City held 39.2% of construction industry jobs in New York state in 2019 and had 52.2% of construction job losses in the state [14]. In considering the rates of COVID-19 outbreaks by industry, construction accounted for the second or third highest rates of outbreaks in Washington, Michigan, Utah, and Nashville, Tennessee [15]. The impact of the pandemic is far-reaching, and it continues to affect many lives and sources of livelihood. The full extent of the impact of the ongoing pandemic is still unknown. According to the International Monetary Fund (IMF), "quarantines, regional lockdowns, and social distancing—which are essential to contain the virus—curtail mobility, disrupt supply chains and lower productivity." In addition, "layoffs, income declines, fear of contagion ... and heightened uncertainty ... [trigger] further business closures and job losses" [16] (p. 17). While a few studies have focused on the pandemic's impact on the construction industry, there is a scarcity of research focusing on challenges directly associated with construction business management, construction projects, and the workforce. Additionally, since the nature of the impacts of the pandemic on construction projects and workers is primarily influenced by the location of construction businesses and their assigned projects [17], there is a need to consider differences in the impacts of COVID-19 on the construction industry in different locations and also consider the roles of construction industry professionals.

The overarching research question is as follows: what is the impact of the COVID-19 pandemic on the construction industry in New York State? In addition, this study addressed two additional questions: (1) were certain groups more adversely affected based on: (a) working primarily in or out of New York City; (b) their role in the construction process as builders or non-builders? The second question was: (2) what can the construction industry do to better prepare for future disruptions?

The remaining sections of this paper are organized as follows. First, a background into the impact of COVID-19 on the construction industry considering the main themes of this study is provided, followed by the research methodology, the results, the discussion of the findings, and the conclusion and limitations.

2. Background

2.1. Impact of COVID-19 on the Construction Industry

Compared to other industries, such as hospitality, the impact of COVID-19 on the construction industry was arguably less severe in 2020 [11,18]. This is primarily because most construction was deemed an essential service [19]. In New York State, essential construction services continued during the pandemic. Several definitions qualify as essential construction under New York State Executive Order 202.6 [20]. One definition is "construction necessary to protect the health and safety of occupants of a structure" [20]. Another definition is "construction necessary to continue a project if allowing the project to remain undone would be unsafe, provided that construction must be shut down when it is safe to do so" [20]. After restrictions were lifted, there was an increase in residential construction in the US. The increase in housing-related spending is partly due to more people working from home, lower interest rates, and the increased purchase of second homes [21]. Research further predicts that the construction of single-family residential projects will increase by 7%, commercial projects will increase by 5%, and manufacturing will flatline in 2021 [22]. Despite this glimmer of hope for the construction industry and the availability of government aid, many firms had to lay off workers due to their inability to pay overhead costs, make payroll, and more [18]. There was more than a 40% drop in employment in New York State between March and April 2020 [18]. Alsharef et al. [23] explored the early impact of the COVID-19 pandemic on the construction industry in the US. They indicated significant project and material delivery delays, increased costs of materials, and lower productivity rates [23]. However, the pandemic also brought about some opportunities, including increased prospects of recruiting skilled workers, an increase in the construction of residential buildings, and more medical- and transportation-related construction projects [23]. Choi and Staley [24] identified the challenges faced by the construction industry amplified by the pandemic to include regulatory confusion, vulnerable employee risk, low COVID-19 literacy, and supply-chain shortages.

2.2. Impact of COVID-19 on Construction Projects

In addition to overall impacts on the construction industry, COVID-19 also impacted project timelines and budgets due to delays in lead times [25], limited access to resources [23], supply-chain bottlenecks [24], and international restrictions on travel [26]. The impact of the pandemic extended to suppliers and vendors who could not meet up with demands and, in turn, affected the timeline of construction projects. In a survey of 53 construction contractors in New York State, 81% of them indicated that their projects experienced delays due to longer lead times or shortages of materials, while 62% cited delivery delays [27]. Furthermore, the pandemic may cause breaches in contractual and legal obligations to clients [23]. As of August 2021, the pandemic continues to impact construction projects with a knock-on effect on claims [28]. Chivilo, Fonte, and Koger [17] indicated that the nature of the impacts of the pandemic on construction projects and workers are primarily influenced by the location of the construction businesses and their assigned projects. Some of the direct impacts include project termination or the cancellation of contracts [29]. In total, 62% of contractors in New York State had their projects canceled, postponed, or scaled back for any reason [27]. Several construction activities were shut down in some states depending on whether they were considered essential or not [23].

2.3. Impact of COVID-19 on Construction Firms and Company Management

Globally, construction firms have faced difficulties during the pandemic relating to finances, the loss of projects and clients, budget adjustments, contractual and legal issues, communication, health and safety, inadequate resources, pandemic-related delays in lead times due to restricted movements, and difficulties caused by working remotely [26]. Travel bans have also contributed to material delivery delays, equipment being left on non-operational sites, factories shutting down, and suspensions in the production and distribution of supplies [10]. Such delays jeopardized the profitability of projects, triggered specific contract clauses to take effect [17], and triggered the extension of deadlines [10]. Furthermore, the pandemic caused disruptions in the scheduling and procurement of supplies and services [24,30] and has highlighted the importance of recognizing and mitigating financial and legal risks [17]. In a survey conducted by Turner and Townsend, for the UK, half of the respondents reported an "increase in contractual disputes since the start of the pandemic" [31]. In addition, "83% of respondents reported a pause or temporary site closure because of COVID-19, and 72% reported reduced productivity on projects compared to pre-pandemic levels" [31]. Moreover, 49% of respondents reported adding "up to 10% extra for COVID-19 related costs in bid submissions" [31]. In a 2021 survey of construction contractors in the US, 63% of firms passed on additional costs due to rising material costs [32]. They also reported an increase in the volume of business compared to a year earlier.

The pandemic has led to the rise of short- and long-term trends in the construction industry. The use of digital collaboration platforms has increased due to the need to work remotely [33]. In total, 57% of US contractors indicated an increase in the rate of technology adoption in their firms [32]. In particular, they reported that their firms adopted more project management software. The present short-term trends include contractors using online tools to manage and monitor their employees' productivity and wellbeing, manage resources and cash flow, and conduct online meetings [33]. In addition, contractors are looking toward finding alternative sources and stockpiling supplies and materials in the short term, particularly those with long lead times, to increase resiliency [34]. They are also making connections with new suppliers. In the long term, companies are looking into further investments in technology to increase work productivity and manage workflow [32,33]. As a result, there is an expected increase in the automation of construction and design elements. A push toward sustainability is also expected to occur as the trend for promoting

healthier lifestyles is more prominent now with the pandemic than ever before [33]. This will result in an emphasis on air quality, access to outdoor space, and an increase in the use of sustainable materials [35].

2.4. Impact of COVID-19 on Health and Safety in the Construction Industry

Although many industries and businesses could explore remote working options, most of the construction industry's operations must be on-site and cannot be done remotely [26]. Therefore, the shift to working remotely can only go so far for construction firms. It is also clear that unrestricted work in high-contact industries, such as construction, is associated with a higher level of community transmission, increased risks to at-risk workers, and considerable health disparities among members of certain racial and ethnic minority groups [36]. The pandemic also impacts the mental health of construction workers [37].

The COVID-19 pandemic triggered many public health emergency standards and regulations to be implemented across all industries [23]. These standards and regulations do not replace existing local, state, and federal laws that must be observed. Rather, they are supplemental to existing compliance requirements. Some of these requirements include maintaining six feet of distance between personnel, providing personal protective equipment (PPE) such as face coverings to personnel, limiting in-person gatherings, limiting the number of people allowed to occupy tight spaces such as elevators at any given time, and having employees work from home whenever feasible [38]. Employers were also required to implement disinfectant protocols and mandatory screening assessments [38]. All of the requirements as mentioned above merely scratch the surface of what construction firms must observe. Integrating COVID-19 protocols with existing safety protocols in organizations can increase the effectiveness of the measures adopted by organizations on their projects [37]. Recommendations to manage COVID-19 in the construction industry include preventive measures to protect the health and safety of construction workers and COVID-19 education, where employers keep their workers up to date on relevant information to keep them safe [24].

2.5. Impact of COVID-19 on Communication in the Construction Industry

State and federal guidelines mandated that employees work remotely from home whenever possible [38]. They also required that in-person meetings are limited in the number of people and duration [38]. Therefore, most meetings and conferences shifted from in-person to various telecommunication platforms [39,40]. This could be burdensome for construction firms in some respects, because most of their workforce needs to be on-site. As a result, although remote work is the safer practice to preserve the health and safety of the employees, the project itself may suffer [41].

The number of employees working remotely across the country skyrocketed during the pandemic, and about 50% of US workers that were surveyed reported that they were working from home [42]. While there are many benefits associated with working remotely, such as decreasing overhead costs, reducing travel times to and from work, reducing the carbon footprint and so forth, several disadvantages must be noted [43]. For example, the online workplace can lead to increased mental health issues due to the inability to "unplug" [41]. In addition, some people must juggle the roles of being an employee and parent or caretaker working from home [43]. Furthermore, many employees "do not possess sophisticated systems along with headsets, video cameras, high-speed connectivity, and the skills to manage all" ([44], p. 10). Therefore, working from home can be overwhelming for some individuals. Employees across industries reported that the number of meetings they had on a regular basis increased after the pandemic [43]. Many claimed they experienced mental and emotional exhaustion while working remotely [23]. On the other hand, "almost 60% of Americans think COVID-19 has changed the way we work for the better" [43]. "Close to 99% of respondents ... reported that their employers are showing empathy toward staff" and "85% ... feel that their employers are doing a good

job of communicating and informing staff about the company's situation and ongoing response to the pandemic" [43].

3. Methods

3.1. Research Approach

This study involved multiple steps to address the central research questions (Figure 1). First, a detailed literature search was conducted using the keywords COVID-19, construction, construction industry, construction firm, and construction management in different combinations on the Google Scholar database and Google search engine. Then, relevant articles and gray literature were identified, and the contents were categorized into seven themes: construction firm, construction project, financial/economic, project schedule, health and safety, communication, and supply chain/procurement. These themes were then narrowed to four broader impact categories: company management, construction projects, health and safety, and communication.



Figure 1. Research framework.

Table 1 shows sixteen of the prominent factors identified in the literature through the literature review and distributed among the four impact categories. The factors identified under company management are contracts and legal issues, lack of new contracts, company recovery time, workforce reduction, financial constraints, and new opportunities such as technology adoption. For the construction projects category, the factors were project team size, project suspension or shutdown, schedule interruption and delays, supply chain issues (i.e., material shortage and procurement delays), productivity, and project planning. Under health and safety, two factors were identified, namely COVID-19 health and safety regulation compliance and workplace safety. Finally, the factors under communication focused on virtual meetings and remote work. The identified factors were then converted into twenty-five statements included in the survey to assess the impact of the pandemic on the construction industry in New York State. Surveys were selected to gauge the views of a number of respondents within the study's geographical boundaries in order to address the research questions.

Table 1. Categorization of factors that impacted the construction industry as a result of the COVID-19 pandemic.

Category	Factors	Sources
Company Management	Contracts and legal issues	[17,23,26,31,34,41]
	Lack of new contracts	[23,29]
	Company recovery time	[29]
	Workforce reduction	[18,23,29,34,41]
	Financial constraints	[17,23,25,26,29,41]
	Technology adoption	[26,32,33]

Category	Factors	Sources
Construction Project	Project team size	[23,29]
	Project suspension or shutdown	[23,26,27,29]
	Schedule interruption and delays	[10,23,25,26,31]
	Supply chain issues	[10,23–25,27,34]
	Productivity	[23,29,31–33]
	Project planning	[23,26,41]
Health and Safety	COVID-19 health and safety regulations	[23,24,41,45]
	Workplace safety	[23,24,37,46]
Communication	Virtual meetings	[23,38,40,43]
	Remote work	[23,26,33,38,41,42]

3.2. Survey Design

This study involved a cross-sectional survey created to examine the impact of COVID-19 on the construction industry in New York State. A cross-sectional survey design provides data to draw inferences about a population of interest [47]. The study was submitted to the institutional review board at the authors' institution for approval, and the study was exempt. The participants were selected for the study based on the specified inclusion and exclusion criteria, such as actively working in the construction industry, working in New York State, and having at least one year of construction experience [46]. This study included a survey questionnaire consisting of 6 demographic questions and 25 Likert-scale statements, which measured the impact of various pandemic-related factors on the construction industry in New York State. The 25 Likert-scale statements were grouped under the four impact categories (company management, construction projects, communication, and health and safety). The participants were also asked if they could work from home, if their productivity had changed, and if their firm took advantage of government aid to mitigate the effects of the pandemic on their businesses. The factors in the Likert-scale statements were determined from the literature review, and the survey questions were pilot tested with professionals in the construction industry. Survey participants also had the opportunity to provide recommendations and share any other relevant information.

Based on Nemoto and Beglar [48], analysis has shown that Likert Scales with more than six categories are rarely tenable, possibly because of limitations on human working memory capacity. Losby and Wetmore [49] mentioned that when comparing between a four-point and five-point Likert scale, the overall difference in the responses is negligible, and the authors' decision to use an odd number scale was made to allow the respondents to select a midpoint if they were neutral about the impact of the factor. Therefore, a five-point Likert scale was selected, the questions asked participants to respond according to whether they strongly agreed (5), somewhat agreed (4), neither agreed nor disagreed (3), somewhat disagreed (2), and strongly disagreed (1) to certain pandemic-related statements. The survey data were collected through Qualtrics, an online survey development platform.

3.3. Participants

Participants were selected through the convenience and purposive sampling approaches, which are non-random sampling methods [50]. The survey was sent out to members of a selection of professional organizations in New York, distributed to construction industry professionals on LinkedIn, and through the professional networks of the researchers. The survey was limited to professionals working in the construction industry in New York State. Participants who did not work in New York State and those with no connection to the construction industry were excluded. A total of seventy-nine survey responses were received. Three respondents who answered that they do not conduct projects in New York State were excluded from this study. In addition, fifteen respondents were excluded since their surveys were less than 30% complete and were missing answers

to the background qualifying questions. As a result, a total of sixty-one valid responses were collected.

The participants were asked to indicate their organization type. The majority were working as contractors or working in architecture/engineering firms (Figure 2). The participants were further categorized into whether they were builders or non-builders based on if their work was field-based or office-based. Those who identified their organization as a contractor or vendor/manufacturer were categorized as builders, while the non-builder category included those who worked for architecture and engineering firms and construction project clients. Consequently, thirty were identified as builders, while thirty-one were identified as non-builders.



Figure 2. Participants' organization type.

The participants were also asked to indicate their role within the construction industry; 27.9% were upper management, 24.6% were engineers, 18% were project managers, 8.2% were contractors, 6.6% were architects, and 9.8% held other roles in construction, such as estimators, superintendents, project coordinators, or consultants.

The participants also indicated whether they worked for a private or governmentowned organization. In total, 88.5% worked for a private organization, 4.9% worked for a government-owned organization, and 6.6% selected the "other" category. The majority of the respondents had six to ten years of experience. Approximately 85% of the participants had more than five years of construction experience (Figure 3).

The participants were asked to identify their primary work location. Since New York City was severely impacted at the initial onset of the pandemic, the study aimed to identify whether the impacts of the pandemic differed for those primarily working in New York City. The survey questions were designed to determine where the subjects conducted their primary job duties regardless of where their main offices may be located. In total, 32.8% indicated that they primarily worked in New York City, while 67.2% indicated that they worked in other parts of New York State.



Figure 3. Years worked in the construction industry.

3.4. Data Analysis

Survey data were downloaded and exported from Qualtrics into Microsoft Excel. Each survey response was screened and excluded from analysis under certain circumstances, such as having incomplete responses or participants not meeting location requirements (working in New York State), or not working in construction. The data were preprocessed in Microsoft Excel and analyzed using SPSS version 26 statistical software. For analysis, descriptive statistics and independent samples t-tests were conducted. The central limit theorem holds when a sample size is greater than thirty and a study sample is considered normally distributed [51]. In addition, Mann–Whitney non-parametric tests were used when any variables did not meet the normality assumptions.

3.5. Validity and Reliability

Content validity "can be defined as the ability of the selected items to reflect the variables of the construct in the measure" [52] (p. 166). If an instrument lacks content validity, it is impossible to establish its reliability [52] (p. 166). Therefore, in addition to identifying key factors relating to the impact of COVID-19 on the construction industry in the literature, the survey questions were checked with experts in the construction industry to determine if they covered key aspects of the constructs being measured. Reliability is a concept that measures the extent to which an instrument produces consistent results [53]. Reliability was tested by determining the Cronbach's Alpha of items within the four impact categories.

3.6. Reliability Analysis for Likert-Scale Questions

Table 2 shows the four impact categories for the COVID-related impact statements and their Cronbach's Alpha scores. The impact categories include company management, construction projects, health and safety, and communication. The Cronbach's Alpha for the statements within each category was computed to determine the internal consistency of the variables. Cronbach's Alphas for the nine company management, ten construction projects, three health and safety, and two communication statements were 0.838, 0.810, 0.820, and 0.847, respectively. One of the health and safety statements was excluded to improve the reliability of that category.

ID	Category	Related Impact Statements	Cronbach's Alpha
СМ	Company Management	 CM1: My company experienced contract performances issues due to the pandemic CM2: My company experienced legal consequences due to contractual breaches caused by the pandemic CM3: My company experienced difficulty in obtaining new projects due to the pandemic CM4: My company experienced difficulty in obtaining new clients due to the pandemic CM5: My company's recovery timeline from the pandemic is unknown CM6: The pandemic has forced my company to lay off workers CM7: My company had to cut down expenses due to the pandemic CM8: My company embraced new technology as a result of the pandemic CM9: Overall, my company benefited from changes brought upon by the pandemic 	0.838
СР	Construction projects	CP10: The pandemic reduced the size of my project team CP11: The pandemic has caused active projects to be suspended CP12: The pandemic led to the shutdown of my company's project sites CP13: My projects experienced schedule interruptions due to the pandemic CP14: The pandemic caused project scheduling delays CP15: My project suffered from material shortage due to the pandemic CP16: Material procurement was delayed as a result of the pandemic CP17: My company requested extended project deadlines due to the pandemic CP18: My workload has been reduced since the start of the pandemic CP19: The pandemic increased the number of hours dedicated to project planning	0.810
HS	Health and safety	HS20: COVID-19 Health and Safety regulations were difficult to comply with HS21: The new PPE requirements were difficult to comply with HS22: I felt safer at my workplace due to the new regulations * HS23: There were high COVID-19 positivity rates on my projects	0.820
СО	Communication	CO24: In-person meetings were limited CO25: Some meetings switched to virtual platforms (i.e., Zoom, Skype, Microsoft Teams, etc.)	0.847

Table 2. Reliability analysis for survey questions.

* Statement excluded from the HS Category due to a low Cronbach's Alpha score.

4. Results

4.1. Analysis of Overall Survey Results

The survey participants' level of agreement with certain COVID-related impact statements is presented in Figure 4. In the company management category, while 78.6% of the participants strongly agreed or somewhat agreed that their companies experienced contract performance issues, only 21.3% strongly agreed or somewhat agreed with the statement that their companies experienced legal consequences due to contractual breaches caused by the pandemic. A total of 71.2% of the participants' companies experienced difficulty obtaining new projects due to the pandemic, and 62.7% had difficulty obtaining new clients. In addition, 75.4% strongly agreed or somewhat agreed with the statement that their company had to cut down expenses, and 81.9% of the participants strongly agreed or somewhat agreed that their companies embraced new technology due to the pandemic. Finally, 54.1% somewhat agreed or strongly agreed that their company benefitted from changes brought about by the pandemic.



Figure 4. Responses to statements on the impact of COVID-19 on the construction industry in New York State.

In the construction projects category, 54.1% indicated that the pandemic reduced the size of their project teams, 75.4% strongly agreed or somewhat agreed that the pandemic caused active projects to be suspended, and 72.1% mentioned that the pandemic led to the shutdown of their company's project sites. A total of 93.4% strongly agreed or somewhat agreed that the pandemic caused project scheduling delays. Additionally, 80.4% experienced material shortages and procurement delays due to the pandemic. In total,

73.8% stated that their companies had to request project schedule extensions to meet their project deadlines. Over half of the respondents indicated having reduced workloads and a similar percentage stated dedicating more hours to project planning during the pandemic.

In the health and safety category, 47.5% strongly agreed or somewhat agreed with the statement that COVID-19 health and safety regulations were difficult to comply with, 44.3% indicated that the new PPE requirements were difficult to comply with, 55.7% felt safer at their workplace due to the new regulations, and 24.6% strongly agreed or somewhat agreed that there were high COVID-19 positivity rates on their projects.

In the communication category, 96.7% strongly agreed or somewhat agreed that inperson meetings were limited, and 95.1% strongly agreed or somewhat agreed that some meetings switched to virtual platforms.

The survey asked if the participants had the opportunity to work from home since the beginning of the pandemic. Overall, 65.6% stated to have worked from home, while 34.4% did not work from home. For the question regarding the impact of the pandemic on their productivity, 31.1% of the participants stated that they were less productive, and 32.8% reported that they were more productive (Figure 5). A cross-tabulation analysis revealed that more of those who worked from home reported having an increase in their productivity (40%) compared to those who did not work from home (19%). Furthermore, the authors identified a significant difference between those who worked from home and those who did not when it came to adopting new technology. Those who worked from home reported a higher rate of technology adoption (Mdn = 5.0) than those who did not work from home (Mdn = 1.0). A Mann–Whitney U test indicated that this difference was statistically significant, U(N_{worked-from-home} = 40, N_{did-not-work-from-home} = 21) = 245.00, z = -2.91, p = 0.004.



Figure 5. Impact of the pandemic on work productivity.

In response to whether their company took advantage of government aid to mitigate the pandemic's effects on their businesses, approximately half of the respondents reported that their company had taken advantage of government aid to mitigate the impact of the pandemic on their businesses (Figure 6).



Figure 6. Participants' responses on the use of government aid to mitigate pandemic effects.

Table 3 shows the mean scores for the respondents' agreement with the statements under each category calculated based on the five-point Likert scale previously mentioned in the methodology section. Thus, averages closer to five indicate stronger agreement with the impact of COVID in the particular categories. Consequently, the participants reported the "communication" category as the most impacted by the COVID-19 pandemic, followed by the impact on the "construction projects," "company management," and "health and safety" categories.

Table 3. Descriptive statistics of statement categories.

Category	Ν	Mean	Std. Deviation
Company management	61	3.22	0.84
Construction projects	61	3.94	0.70
Health and safety	61	2.99	1.06
Communication	61	4.66	0.655

4.2. Comparison of Responses for Participants That Worked in New York City vs. Those That Worked in Other Parts of New York State

The data were analyzed using Mann–Whitney tests based on whether the participants worked in or out of New York City (Table 4). The participants who worked in New York City experienced significantly more reductions in their construction project teams. They also had more difficulty complying with the increased health and safety regulations and the new PPE requirements. The same group experienced higher COVID-19 positivity rates than those who worked in other parts of New York State. It is also important to note that fewer people in New York City reported that their companies embraced new technology during the pandemic compared to those in the other parts of New York State. The Mann–Whitney U test illustrated that those who worked in New York City were less likely to work remotely than those in other parts of New York State.

Statements/Question	Work in New York City	Ν	Mean Rank	Mann–Whitney U	Asymp. Sig. *
CM8: My company embraced new	Yes	20	25.00	290.000	0.043 *
technology as a result of the pandemic	No	41	33.93		
CP10: The pandemic reduced the size of	Yes	20	37.92	271.500	0.029 *
my project team	No	41	27.62		
HS20: COVID-19 Health and safety	Yes	20	39.60	238.000	0.006 *
regulations were difficult to comply with	No	41	26.80		
HS21: The new PPE requirements were	Yes	20	38.33	263.500	0.021 *
difficult to comply with	No	41	27.43		
HS22: There were high COVID-19	Yes	20	40.92	211.500	0.02 *
positivity rates on my projects	No	41	26.16		
Ability to supply from home of	Yes	20	37.28	284.500	0.019 *
Adulty to work from home	No	41	27.94		

Table 4. Comparison of responses of those that worked in New York City vs. those who worked in the rest of New York State.

* Significant at a 95% confidence level; ^ question was on a 2-point scale.

4.3. Comparison of Responses from Builders vs. Non-Builders

Independent samples t-tests were conducted to identify significant differences in the pandemic's impact on builders (field-based) vs. non-builders (Table 5). The results illustrate that those in the builder category indicated significantly more contract performance issues. There was also a significantly higher agreement by the builders when asked if their companies requested extended project deadlines. In contrast, the non-builders agreed significantly more than the builders that their companies embraced newer technology due to the pandemic. Finally, the authors identified a significant difference between the builders and the non-builders regarding their ability to work from home during the pandemic. Builders were significantly less likely to work from home compared to the non-builders. However, there was no significant difference between the impacts of the pandemic on the productivity of the builders vs. non-builders.

Table 5. Comparison of responses of builders vs. non-builders.

Statements/Question	Builder	Ν	Mean	Std. Deviation	Std. Error Mean	Sig. *
CM1: My company experienced contract performances issues due to the pandemic	Yes No	30 31	4.30 3.68	0.877 1.351	0.160 0.243	0.037 *
CM8: My company embraced new technology as a result of the pandemic	Yes No	30 31	4.07 4.58	0.785 0.672	0.143 0.121	0.008 *
CP17: My company requested extended project deadlines due to the pandemic	Yes No	30 31	4.37 3.84	0.669 1.241	0.122 0.223	0.043 *
Ability to work from home ^	Yes No	30 31	1.50 1.19	0.509 0.402	0.093 0.072	0.012 *

* Significant at a 95% confidence level; ^ question was on a 2-point scale.

4.4. Survey Respondents' Recommendations for Potential Disruptions

A few participants responded to an optional open-ended question asking for any relevant information on the impact of COVID-19 on their companies and projects. Responses included comments on budget, workforce training, project schedules, and communication. It is also clear that the pandemic's effects may have differed based on the project type and whether projects were considered essential or not. The responses to another optional openended question asking for participants' recommendations for the construction industry to better prepare for future disruptions centered on the following topics:

4.4.1. Contract Language

The respondents indicated a need for clear contract terms and a Force Majeure clause in construction contracts especially related to project delays associated with a global pandemic. The proper documentation of responses to interruptions was suggested, which could be presented as evidence in the case of disputes or claims. The legal implications of COVID-19 in the construction industry have been discussed in other studies, and it is critical to ensure that contract documents are correctly interpreted and the teams on construction projects are aware of their roles in case of similar disruptions [54].

4.4.2. Supply Chain Management

The need for early notification to better prepare for supply chain interruptions and delays was discussed. This can be achieved through data-driven approaches, the Internet of Things (IoT), and data analytics to address possible supply-chain disruptions [55]. The construction industry needs to be more resilient and get better at real-time managing and monitoring of inventory through sophisticated systems, models, and technologies so that disruptions like this will not disarm the construction industry [56,57].

4.4.3. Project Planning and Scheduling

It was recommended to keep relevant stakeholders updated by ensuring clear communication about the status of projects and anticipated changes. Contingency planning was also suggested for materials and trades. The better utilization of construction project schedules through more input and approaches such as critical chain scheduling may help address the needs of different stakeholders as an impactful management tool [58]. Resource loading with the associated leveling of resources can be adopted, ensuring that the data are communicated and shared with relevant stakeholders, including an appropriate level of detail. Planning and management dashboards that analyze resource constraints also benefit construction projects. Overall, it is critical to understand project needs and how to prepare for possible disruptions adequately.

4.4.4. Remote Work Accommodations

The COVID-19 lockdown forced many individuals to work from home; fortunately, non-field-based construction-related tasks could be completed remotely. Several participants mentioned the need to embrace new technology to support remote work and virtual meetings. In line with the current literature, using innovative technologies to improve remote work productivity was beneficial to many, while some individuals needed additional support to overcome technical difficulties as they learned new technologies [23]. It is also important to note that remote work has led to social isolation, negatively impacting the mental health of workers [41]. One of the challenges of the construction industry is the need for in-person work since most field tasks cannot be completed remotely. Thus, there is still a need for more efficient and innovative solutions, including but not limited to technologies involving modular construction, IoT, drones, and 3D printing to improve productivity and reduce overall construction duration and personnel needed on the field [59,60].

4.4.5. Health and Safety Regulations and Guidance

The need to adhere to COVID-19 safety protocols was discussed to keep the workplace safe. One participant recommended that a task force should be formed to develop a central document that the construction industry can refer to for guidance. While the Occupational Safety and Health Administration (OSHA) published an advisory document to control and prevent exposure to COVID-19 for construction workers in 2020 [61], the publication is not yet a standard or regulation and lacks clarity on the circumstances under which it can be utilized. It is also important that construction safety personnel incorporate any

current or future regulatory guidance in their company operational procedures, while the same is expected from site-specific safety plans developed for each construction project. Another suggestion from the survey responses called for more accessible on-site testing for COVID-19 infections. While access to on-site testing has significantly improved since the beginning of the pandemic, there is no central guidance or protocols for construction sites to increase the effectiveness, reliability, and safety of testing or other screening strategies such as temperature checks and employee questionnaires.

5. Discussion

The COVID-19 pandemic has caused significant disruptions to the construction industry, considering company management, construction projects, health and safety, and communication. Similar to other industries, the construction industry had to make significant changes in daily operations, such as mandating some non-field-based workers to work remotely, reducing the workforce on project sites, and utilizing virtual meetings. Participants reported having difficulty in obtaining new clients and projects. Based on the findings in this study, the professionals indicated the most significant impact on meeting modalities, and many companies seemed to embrace new telecommunication technology as a result of the pandemic; also, in-person meetings were limited, which is consistent with the findings from a study of construction professionals in the United States [40]. This could have been due to federal and state mandates during the nationwide lockdowns and the need to meet physical distancing requirements. However, field-based personnel classified as builders benefited significantly less from the remote work opportunities when compared to architects, engineers, and clients due to the nature of their tasks being more field-based. Virtual meetings were not always effective, as most people reported missing personal connections and non-verbal cues [40]. It was recommended that virtual communication should be improved with the use of reliable internet connectivity and effective technology [40].

Many participants did not report their construction firms having legal consequences on their projects due to the pandemic, but builders experienced more contract performance issues than non-builders. Legal consequences could emerge in the future resulting from the COVID-19 pandemic, as Alsharef et al. [23] reported that there would be a significant increase in the number of disputes, litigations, and claims in the construction industry. Therefore, the recommendations to strengthen contract terms and keep proper records would be beneficial. Similarly, Chivilo, Fonte, and Koger [17] suggest providing notices to contractual partners and ensuring the timely exchange of information between all parties. Furthermore, the authors identified non-builders and those who work primarily outside of New York City as more likely to state that their companies embraced new technology as a result of the pandemic. Almost half of the respondents reported that their company took advantage of government aid to mitigate the effects of the pandemic on their businesses. Similarly, Brown, Brooks, and Dong [18] noted that 64% of US small businesses in construction got financial support from the paycheck protection program, while 61% of non-farm industries received the same, so financial assistance was instrumental in offsetting overhead costs in the construction industry.

In their study, Gamil and Alhagar [29] found that the most significant impacts of the pandemic on the construction industry were the suspension of projects, labor impact and job loss, time overruns, cost overruns, and financial implications. In terms of the impact of the pandemic on construction projects, many projects experienced schedule interruptions and delays, which is a result consistent with the findings of Morris [25] and Ogunnusi et al. [26]. While almost all stakeholders involved in the construction industry experienced scheduling delays and material supply issues due to the pandemic [23], our study revealed that builders were more likely to state having contractual issues and extended project schedules. Although the current literature illustrates an overall loss of productivity in the construction industry [23], those who worked from home reported that their productivity increased during the pandemic. It is also important to note that there was no significant difference between the responses from builders and non-builders regarding

their productivity; however, builders were less likely to work from home than non-builders since their work is mainly field-based.

Regarding health and safety on construction projects, the pandemic seems to have been managed well on most construction projects, as very few people reported high COVID-19 positivity rates on their projects, but participants in New York City reported significantly more staff reductions due to higher positivity rates than those in other parts of New York State. Certain PPE requirements and safety protocols were already in place for construction projects prior to the pandemic, and some tasks required the use of nose masks and goggles for safety [37]. Limiting the number of people on project sites also contributed to safer working conditions. The higher rates of COVID-19 reported by those in New York City reflect the statewide rates, especially since New York City was the epicenter of the spread of COVID-19 in the US in the early days of the pandemic in 2020 [13]. Furthermore, those in New York City found it more challenging to comply with COVID-19 health and safety regulations and the new PPE requirements than those in other parts of New York State. It is important to note that this study did not investigate whether the regulations differed in New York City from the rest of New York State. Yet, these findings are consistent with the observations of Bushman et al. [45] from the case report of two construction sites in New York City, emphasizing the construction industry's challenges in complying with health and safety guidelines. The widespread availability of COVID-19 vaccines has brought a glimmer of hope to reduce deaths and hospitalization as individuals and nations work towards recovering from the negative impacts of the pandemic.

6. Conclusions

As industries begin to recover from the effects of the pandemic, effective strategies should be put in place to aid recovery. The findings of this study relate to the pandemic's impact on the construction industry in New York State based on four themes, namely company management, construction projects, health and safety, and communication. This study also explored the impact of the pandemic on builders and non-builders and those working within and outside New York City. Overall, most non-essential construction projects suffered cost and time overruns during the pandemic. The results of this study indicate that the most impacted category was communication, followed by construction projects, company management, and health and safety. In some respects, the pandemic had varying impacts on builders and non-builders and those working in and out of New York City. Therefore, the industry needs to consider such differences as it addresses current and future similar challenges facing the construction industry.

The results of this study highlight several areas of improvement for the construction industry to be more resilient and better prepared for similar future disruptions. These areas include contract language, supply-chain management strategies, project planning and scheduling, remote work accommodations, virtual communication techniques and technology, and health and safety regulations and guidance. Some of the lessons learned in these areas include the need for companies to be diligent with their contract documents and language to ensure clear communication between relevant stakeholders. For companies that choose to primarily utilize virtual communication approaches, it is critical to consider potential connectivity issues and ensure that their platforms are reliable. To ensure the safety of construction workers, robust health and safety guidelines should be followed. Regulatory bodies may need to address such needs to provide guidance and ensure consistency across the industry. There is also a clear need for collaboration among businesses and public authorities to ensure construction workers understand the importance of complying with the guidelines.

As the pandemic wanes or potentially shifts toward an endemic, further studies are needed to determine the true extent of its impact on the construction industry and the daily activities on construction sites in New York State and globally. Such studies would focus on the extent of unexpected disruptions and how the impacts differ among various construction industry sectors and project types. The study's main limitations include the relatively small sample size, which may impact the generalizability of the findings and introduce bias since a non-probability sampling method was used, and the fact that those who chose to participate may not be representative of the entire population of individuals in the building industry in New York State. In addition, approximately 90% of the respondents in this study were employed by private companies, suggesting future research may also focus on the impacts of the pandemic on public agencies that play an essential role in the construction industry in New York State. Finally, this study did not capture the long-term impacts of the pandemic on the construction industry in New York State such conclusions may require longitudinal studies spanning several years.

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