COVID-19 Effects on Construction Industry

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Abstract

The COVID-19 pandemic has significantly impacted a wide variety of industries including construction management. The scope and magnitude of these effects may vary based on geographic location and section of industry. Our motivation to conduct a research study, by collecting the industry professionals’ opinions and feedback about COVID-19 impacts on construction, was derived from the growing uncertainty caused by the pandemic. The objectives of the survey are to measure how the industry has been affected by the pandemic and investigate if the outbreak would affect the future of construction industry. The survey was sent out to approximately one thousand professionals working in different sections of the industry across the United States, and 83 responses were collected in late 2020 and early 2021.

The results of the survey suggest that economic uncertainty, safety, and communications are the worst challenges that the construction industry faced so far due to the pandemic. Industry professionals identified cancellation or delay of contracts and supply chain shortages as the main negative impacts of the COVID-19 outbreak on the construction. Currently, the construction industry is experiencing a sharp recovery while suffering from supply chain disruptions, skilled labor shortages, escalating inflation rate, and higher risk of COVID-19 infections compared to other industries due to the lower vaccination rate.

This study shows that the pandemic had a silver lining that forced construction companies to adoption of new technologies and increasing the productivity rate. It provides new opportunities to build more manufacturing and warehouses within the states, and create more domestic job opportunities while avoiding uncertainty associated with outsourcing. This research provides academia with insight to better prepare new generation for upcoming changes and have these new technologies and trends included in the curriculum.

Introduction

COVID-19 affected the whole world during the last couple of years. The outbreak’s effects on the industry is changing as the pandemic continues. As the pandemic started, for a relatively short period of time, construction managers were not allowed to inspect the jobsites. Therefore, they relied more on new technologies to maintain efficiency while working remotely [1]. Additionally, the construction industry has been suffering from lack of skilled labor for a long time. The pandemic worsens the situation since the construction workers are older than workers in other industries. It makes them prone to be considered as workers with underlying conditions [2].
China plays a major role in the construction supply chain since it manufactures a considerable amount of rebars, Portland cement, and elevators. Manufacturing companies have been shut down in China and other countries, including the U.S. and Canada, which substantially impacted the construction industry. Moreover, the measures taken after reopening dramatically affected the productivity and price of the final products from the suppliers. At the same time, construction owners are not willing to pay extra cost while bearing the burden of delays. These are just a few implications of COVID-19 outbreak on construction industry in the U.S. and worldwide. Therefore, it is essential to thoroughly investigate the effects of the pandemic on the industry, and to foresee the future of the industry and everlasting changes that have happened in the last couple of years.

In this research, we have investigated the impacts of COVID-19 on construction industry within the U.S. We created a survey to study what challenges the industry is facing due to the current pandemic. Furthermore, we evaluated how the pandemic will shape the future of industry and identified the silver linings of the outbreak.

**Literature Review**

The pandemic not only caused health crisis in the U.S., but also greatly impacted the construction industry. A study shows that the working hours of construction management students have been increased dramatically compared to before the pandemic [3]. However, in April 2020, the United States experienced a record high unemployment rate of 14.7% primarily due to COVID-19 related job loss. An investigation revealed that construction workers had the highest number of positive COVID-19 cases compared to other industries such as transportation, healthcare, and manufacturing [4]. Moreover, another study indicates that construction workers have five times higher chance to be hospitalized due to contracting coronavirus [5]. It is not surprising since construction workers are generally older than other industries’ workers. The data shows that the vaccination rate for construction workers is 57% which is very low compared to the vaccination rate for other occupations, which is 81% [6].

Construction workers are not being financially supported to report any exposures or positive tests which is increasing the spread rate. Moreover, some construction companies, especially smaller firms do not have enough resources to implement safety measures. It is not known yet if the outbreaks among construction workers are the result of their jobsite interactions or socializing away from work. A research conducted by the National Institute for Occupational Safety and Health recommends that construction workers have higher prevalence of unhealthy habits such as smoking, binge drinking, lack of physical activity in leisure-time and enough hours of a sleep a day [7].
A research was conducted by telephone interviewing of 34 project managers, engineers, designers, and superintendents in construction industry to measure early impact of the pandemic on the U.S. construction industry. That research found that the adverse effects were delays on project, unsecure material delivery time, productivity rate deduction, and material price escalations. It also found that new opportunities were emerging due to the COVID-19 outbreak, specifically with the construction of medical facilities, residential building, transportation-related work, and recruiting of skilled workers. Additional safety measures were applied on jobsites including requiring facial masks, social distancing, and the staggering of operations [8].

Even after about two years since the pandemic started, 89% of contractors are struggling to hire craft workers, 88% of them are being impacted by delays in their projects, and 93% are suffering from rising materials prices. This problem worsened when more than one-third of contractors could not be compensated by the owners for the cost difference [9].

Although the pandemic had positive impacts on some sectors of industry and home sales increased by 24.7% in September 2020, it may take more than five years until all industry sectors can return to the 2019 contribution level to GDP (Gross Domestic Product). However, it is predicted that it will not be until the end of 2022 that the construction industry sector of the economy will have fully recovered. This recovery will be felt differently by different sectors of the construction industry. Specifically, it would be growth in manufacturing, distribution, communications and data center, and intelligent transportation systems sections. On the other hand, lodging, commercial, amusement and recreation, and the office sector will decline. In addition, the geographic standpoint will affect the recovery rate as well. Infection rate, risk factor, resiliency factor, and implemented policy are the main causes of these differences [10].

A study shows that the pandemic made some everlasting changes to the industry. It suggests that jobsites will be cleaner and neater while technology and telework will help to keep distancing and defined procedure substitute group activities. Other changes are increasing union influence and change the demand for different types of projects. This is mainly due to unreliable sources of building products imported from China, which supplied 30% of U.S. building materials before pandemic started [11].

A survey conducted by Turner & Townsend Suiko states that the labor shortage and social distancing were responsible for a 7% productivity loss during the pandemic. Another study shows that the pandemic had positive and negative impacts on engineering, architecture, and construction. The negative effects include workflow and supply chain disruption, new policy issues, and positive impacts including modern procurement planning, virtual working, and unique design considerations [12].
Although the literature highlights some challenges that construction industry faces due to the COVID-19 pandemic, there are still plenty of issues that need to be addressed. This paper focuses on these issues and investigates how the industry was affected by the pandemic from professionals’ standpoint, and how the future of industry will embrace the changes.

**Methodology**

Although construction has been deemed as an essential business during the pandemic, it has been shut down from weeks to months in different states and at different times. The outbreak impact on the industry may not be completely revealed until 2022. This uncertainty shows the importance of conducting research in order to benefit from industry professionals’ opinions and feedback about COVID-19 impacts on construction and how it changed the future of the industry. It also provides us with an insight to be better prepared for similar unprecedented challenges in the future. Imbedding these changes in construction management and engineering program curriculum in academia will better prepare the young professionals to achieve their career goals.

A survey was conducted to collect professionals’ opinions about the COVID-19 pandemic effects on construction. The survey objectives were to measure how construction industry has been affected by the pandemic, and to investigate if the pandemic would affect the future of construction industry. The survey questions were validated by industry professionals. The questions, analysis, and findings will be discussed in the next section.

Total respondents were 83 professionals in the United States out of about one thousand of emails sent out between late 2020 and early 2021. The distribution of the respondents and their industry experience are presented in Table 1 and 2.

**Table 1. Distribution of Survey Respondents**

<table>
<thead>
<tr>
<th>Title</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive</td>
<td>34%</td>
</tr>
<tr>
<td>Project Manager</td>
<td>20%</td>
</tr>
<tr>
<td>VP of Engineering, Project/Executive/Superintendent/Engineer</td>
<td>46%</td>
</tr>
</tbody>
</table>

**Table 2. Industry Experience**

<table>
<thead>
<tr>
<th>Industry Experience Years</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>&gt;20</td>
<td>36%</td>
</tr>
<tr>
<td>15-19</td>
<td>11%</td>
</tr>
<tr>
<td>5-14</td>
<td>29%</td>
</tr>
<tr>
<td>1-4</td>
<td>24%</td>
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</tbody>
</table>
As the table indicates, more than one third of respondents have an executive position and about half of the respondents have more than 15 years of job experience in construction industry. Commercial construction accounted for 53% of the responses, with 8% in residential, 11% in specialty trade contractors, 12% in heavy civil, and the rest in research, geotechnical, and consulting sectors. Therefore, the data collected from experienced professionals in a wide variety of industry sectors (Table.3).

Table 3. Distribution of Different Industry Sectors

<table>
<thead>
<tr>
<th>Industry Section</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Residential construction</td>
<td>8%</td>
</tr>
<tr>
<td>Commercial construction</td>
<td>53%</td>
</tr>
<tr>
<td>Heavy civil</td>
<td>12%</td>
</tr>
<tr>
<td>Specialty trade contractors</td>
<td>10%</td>
</tr>
<tr>
<td>Others (Research, consultant, geotech, telecom,...)</td>
<td>17%</td>
</tr>
</tbody>
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Data Analysis

Thirty-five questions were designed on the Qualtrics online platform and were distributed by emails and LinkedIn messages. The questions can be categorized in two groups, “Pandemic effects on construction industry”, and “Future of construction industry after the pandemic”.

1- Main Challenges

We asked professionals, “What were the main challenges during the pandemic?” The results show that economic uncertainty, safety, and communications are the most concerning challenges they were confronted with during the pandemic. They reported other challenges such as work from home, employee morale, and tech issues (Fig.1). Industry outlook was unclear at the beginning of the pandemic and has remained unclear as to how the material prices will fluctuate in upcoming months and years. Supply chain still have not picked up and working from home was integrated with homeschooling children and other distractions.
Figure 1. Main Challenges during the Pandemic

2- Worst Impact

The construction industry has been impacted through many venues by the pandemic. One-third of professionals found cancellation or delay of contracts as the main negative impact on their companies because of COVID-19 and one-fifth of the respondents perceived supply chain shortages as the primary impact of the pandemic. Cash flow challenges, absenteeism, layoffs and furloughs, as well as hiring freezes, were ranked after these first two as additional major impacts of the pandemic on the company (Fig.2).

These professionals believe that the shortage of construction parts, materials, equipment, and lack of skilled workers, are the main reasons for project delays. More than a quarter of respondents stated that they experienced contract penalty as the result of delivery delays and about two-thirds of respondents halted or cancelled a project due to the pandemic.

Figure 2. Worst Impact of Pandemic on the Company
3- Other Impacts of Pandemic

The construction industry felt multiple negative impacts as a result of the pandemic. Twenty percent of the respondents stated that they cancelled any offers to entry-level employees or interns due to COVID-19. New regulations and safety measurements affected the productivity of the projects as well. All professionals believed that the pandemic dropped their productivity to some extent. About two-thirds of respondents claimed that the outbreak has decreased their productivity 0%-25%. Another 18% believed their productivity has been dropped by 25%-50%, and the rest saw more than a 50% decrease on the productivity due to the pandemic.

The pandemic has taken a toll on the supply chain as well. One-third of the respondents stated that they have resumed placing order from China, as China plays a primary role in supplying construction materials. To better understand China’s role as a supplier, it produces 53% of world’s rebar and 70% of the world’s Portland cement (Ibbs, 2020). Thirty percent of the respondents considered backup resources for the material procurement. They deployed other resources from U.S., Spain, Thailand, Canada, and Mexico. The professionals also were willing to shift their orders to other countries as listed in Table 4.

Table 4. Alternative Resources for Construction Material

<table>
<thead>
<tr>
<th>Country</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>U.S.</td>
<td>47%</td>
</tr>
<tr>
<td>Mexico</td>
<td>16%</td>
</tr>
<tr>
<td>Asian countries</td>
<td>14%</td>
</tr>
<tr>
<td>Others</td>
<td>23%</td>
</tr>
</tbody>
</table>

4- New technology and pandemic

The construction industry is more challenging compared to other industries since it deals with unique products and big financial resources. However, the industry is suffering from lower productivity rate and lack of new technology application. The pandemic worsened the problem, and as it was discussed earlier, it dropped the productivity rates dramatically due to new safety regulations. However, it assisted the industry to catch up with technology. Professionals stated that they used new technologies, which they had never used before pandemic started. Twelve percent of professionals used drone inspection, 24% applied virtual reality, and 64% utilized webcams on their jobsites. In addition, two-thirds of respondents are monitoring sites remotely. Moreover, about one-third of professionals moved to offsite/prefabrication due to the pandemic.

5- Pandemic effects on the future of construction

The pandemic has not necessarily impacted the industry in a negative way. The majority of respondents stated that they either started or extended a project due to the outbreak. Forty-eight percent of projects were medical, 22% utility infrastructure, 7% highway, and 23% retrofit, pharmaceutical and institutional. The outlook of construction has changed dramatically as the result of pandemic. Eighty-one percent of professionals believed that union influence is growing and more than 50% percent of them see the demand for the type of project will change. In addition, they specified upgrading HVAC, adding more waiting and personal spaces, changing office
layouts, adding more ventilation and air purification systems, and increasing average office space per employee as upcoming trends in new or renovation projects.

**Discussion and Conclusion**

Construction projects in different stages experienced different obstacles due to the COVID-19. Some projects at very early stages have even been cancelled while others at the later stages were facing shortage of skilled labors and materials, as well as, dealing with addendums and possible penalties and delays. The data suggests that project at the beginning stages had more opportunities to mitigate or offset the effect of the pandemic.

This study depicts that economic uncertainty, safety, and communications are the greatest challenges that construction industry faced so far since pandemic started. As the result, industry professionals believe that cancellation or delay of contracts, and supply chain shortages are the main negative impacts of the outbreak on the industry. They stated that shortage of construction parts, materials, or equipment, and lack of skilled workers are the main culprit of project delays which led to contract penalty or cancellation/halt of a project. Moreover, COVID-19 dramatically impacted the productivity rate when safety measures were applied.

Although the industry is experiencing a relatively sharp recovery compared to the economic recession in 2009, it is still suffering from multiple channels. Escalating inflation, supply chain disruption and long lead times, construction labor shortage, and risk of exposure to COVID-19 due to lower vaccination rate compared to other industries, are the main issues the industry is now facing.

However, the pandemic had a silver lining primarily in the expanded adoption of new technologies in construction projects, which should continue to increase productivity rates. Construction is going to utilize more manufacturing technologies and moving more toward automation while applying 3D printing, modularization, and prefabrication. Moreover, COVID-19 shifted the demand to remodeling since some office spaces are not needed anymore as well as local distribution center and data centers due to more online shopping. The demand for K-12 will continue; however, it will drop for higher education as an increased understanding and use of online learning will decrease the need for traditional infrastructure required for instruction.

There will be more manufacturing and warehouse opportunities available in the U.S. to deal with the uncertainty associated with relying on international resources in similar unprecedented situations in the future. Additionally, contracts will predict and embody more unforeseen challenges in the future to prevent burden of potential addendum and penalties. Buildings will have more open floor plans, increased ventilation, and active air purification systems. Meanwhile remodeling, local distribution centers, and data centers will fare well while retail, office, higher education, lodging, and travel-related sectors will experience less demand in the long-run. Furthermore, industry will adopt higher technologies such as Virtual Reality (VR) devices, Artificial Intelligence (AI), monitoring and signal systems for preventative maintenance, and drones for monitoring jobsites. These changes should be incorporated into the curriculum development of construction management and engineering programs to proactively prepare young professionals for more advanced construction practices.
There are several lessons learned from the pandemic. Based on the problem presented earlier, new solutions have emerged from the pandemic such as pre-ordering farther in advance than normal, considering alternative suppliers, requiring owners to pay faster, lengthening project schedule to accommodate smaller crew sizes and less productivity, videoconferencing, and utilizing drones and webcams to offset the effects of any pandemics that may happen in the future.

This paper identified the main impacts of the COVID-19 pandemic on the construction industry and revealed how these effects will change trends and the direction of the industry in upcoming years. These results can be used as a guide to get ahead of forthcoming changes and take advantage of new opportunities created by the pandemic. Industry can catch up the lost productivity due to obsolete technology by the application of new technologies in a post-pandemic era. The construction industry should proactively consider the aforementioned solutions to mitigate the effects of unprecedented pandemics on construction projects.
References


