

Lessons Learned from the COVID-19 Pandemic in Construction Projects in Chile

Lecciones Aprendidas de la Pandemia por COVID-19 en Proyectos de Construcción en Chile

Araya, Felipe^{*1}; Ogalde, Katia¹; Olivari, Katherine¹; Olivari, Valeria¹; Salazar, Luis¹; Sanchez, Omar²; Sierra-Varela, Leonardo³; Filun, Álvaro⁴

¹ Departamento de Obras Civiles, Universidad Técnica Federico Santa María, Valparaíso, Chile.

² Civil Engineering Department, Pontificia Universidad Javeriana, Bogotá D.C., Colombia.

³ Departamento de Ingeniería de Obras Civiles, Universidad de La Frontera, Temuco, Chile.

⁴ Magister en Ciencias de la Ingeniería, Universidad de La Frontera, Temuco, Chile.

Fecha de Recepción: 23/09/2024

Fecha de Aceptación: 27/06/2025

PAG: 1-16

Abstract

The construction industry faced significant challenges due to the COVID-19 pandemic. This study examines the lessons learned from construction projects in Chile after the pandemic, through semi-structured interviews with project management professionals. The method used is a qualitative analysis of interview transcripts to identify both positive and negative impacts, as well as lessons learned. The results show that the adoption of technologies and digitalization had positive effects on projects. However, negative effects were identified, such as increased execution times, concerns about workers' mental health, and issues in the supply chain. Regarding lessons learned, the need to maintain improvements achieved during the pandemic is emphasized, with digitalization and new technologies being key elements. This study helps understand how the pandemic changed construction projects in Chile, providing a comprehensive view of the effects of COVID-19 on the sector and offering valuable information to companies and organizations to adapt to future post-pandemic contexts.

Keywords: Lessons learned; Construction industry; COVID-19; Chilean construction; Qualitative analysis.

Resumen

La industria de la construcción enfrentó grandes desafíos debido a la pandemia de COVID-19. Este estudio analiza las lecciones aprendidas en proyectos de construcción en Chile tras la pandemia, a través de entrevistas semiestructuradas con profesionales de la gestión de proyectos. El método utilizado es un análisis cualitativo de las transcripciones de las entrevistas para identificar los impactos positivos y negativos, así como las lecciones aprendidas. Los resultados muestran que la adopción de tecnologías y la digitalización tuvieron efectos positivos en los proyectos. Sin embargo, se identificaron efectos negativos como el aumento de los tiempos de ejecución, preocupaciones sobre la salud mental de los trabajadores y problemas en la cadena de suministro. En cuanto a las lecciones aprendidas, se destaca la necesidad de mantener las mejoras logradas durante la pandemia, con la digitalización y las nuevas tecnologías como elementos clave. Este estudio contribuye a comprender cómo la pandemia cambió los proyectos de construcción en Chile, ofreciendo una visión integral de los efectos del COVID-19 en el sector y proporcionando a empresas y organizaciones información valiosa para adaptarse a futuros contextos post-pandemia.

Keywords: Lecciones aprendidas; Industria de la construcción; COVID-19, Construcción chilena; Análisis cualitativo.

Corresponding author: felipe.araya@usm.cl

Departamento de Obras Civiles, Universidad Técnica Federico Santa María, Valparaíso, Chile

1. Introduction

The world was hit by an unprecedented crisis when the COVID-19 pandemic was declared an international public health emergency by the World Health Organization on March 11, 2020. To curb the spread of the virus, strict lockdowns were imposed, significantly limiting mobility and public gatherings (Sierra, 2022). The COVID-19 pandemic had a significant impact on various industries, and the construction industry is no exception (Gumusburun Ayalp and Çivici, 2023); (Mahasuar, 2023). This industry relies heavily on manual labor and in-person interaction, which poses unique challenges (Karimi et al., 2022); (Ogunnusi et al., 2020). There were disruptions in the supply chain and the need to adapt construction processes to biosecurity protocols to protect workers (Farooq et al., 2023); (Onubi et al., 2023). In Chile, where the construction sector is crucial and was growing, the impacts of the pandemic were particularly significant (Araya et al., 2023). The challenges ranged from adapting artisanal processes to reconfiguring previous stages of construction, which affected various stages of the construction project lifecycle (Raoufi y Fayek, 2022). This, in turn, had consequences for projects, organizations, professionals, and workers (King et al., 2022); (Maqbool and Patil, 2023).

The COVID-19 pandemic had a significant impact on the construction industry worldwide (Al-Mhdawi et al., 2022); (Gumusburun Ayalp and Çivici, 2023). At first, it was unclear how the pandemic would affect the industry. However, as the virus spread globally, researchers began to study the impact it had on the industry. Some studies, such as Alsharef et al., (2021), Araya, (2021), and Pamidimukkala and Kermanshachi, (2021), identified initial challenges faced by the sector, including changes in productivity, workers' mental health, and employment dynamics. Additional research, such as Radzi et al., (2022), showed a decline in the start of new construction projects, a drop in foreign investment, and a decline in labor demand. Araya et al., (2023) conducted a study on the impacts of the pandemic on the construction industry in Chile. They discovered that the pandemic had mainly impacted the industry in terms of economics, productivity, and project delays. Nevertheless, some studies, such as Assaad et al., (2022) and Leontie et al., (2022), discovered positive trends, such as significant advances in technology and digitization within the sector. These findings demonstrate the construction industry's capability to adapt and evolve in times of crisis, such as the pandemic Assaad et al., (2022).

Therefore, it is essential to analyze and synthesize the lessons learned from the pandemic's impact on the construction industry to plan actions and propose solutions that can mitigate the impact of future crises. The COVID-19 pandemic put the construction industry to the test, revealing areas that require learning and adaptation (Bakeri et al., 2023); (Jones et al., 2022). While previous studies have identified various impacts of the pandemic (Araya, 2022); (Araya and Sierra, 2021); (Assaad and El-adaway, 2021); (Elrefaey et al., 2022); (Kim et al., 2025), there is still a considerable gap in the synthesis and analysis of the pandemic's lessons for the construction industry, especially for construction industries in developing regions such as Latin America.

This study aims to summarize the primary lessons learned in Chilean construction projects due to the COVID-19 pandemic, and to develop a set of practical recommendations to apply these lessons effectively in future construction projects in Chile, thereby enhancing preparedness and responsiveness to future crises. The rest of the paper is structured as follows. Section 2 presents the main ideas in the existing literature about construction and COVID-19. Section 3 presents the methodology used to develop this study by discussing the data collected and how the data were analyzed. Section 4 presents the results from the qualitative analysis, whereas Section 5 discusses our results and contextualizes them with existing literature. Ultimately, Section 6 provides final remarks from the manuscript.

2. Literature review

2.1 Construction Worker Health in the COVID-19 Pandemic

The outbreak of the COVID-19 pandemic brought the safety and well-being of workers to the forefront of organizational concerns (Araya et al., 2024). This had a significant impact on the occupational safety approaches employed by companies (Karimi et al., 2022). The implementation of infection control measures and virus detection posed a considerable challenge in terms of time and resources for construction companies (Sierra, 2022). Projects had to adapt to new regulatory frameworks imposed by governments to address the crisis, which included implementing strict sanitary protocols at construction sites, such as temperature controls, mandatory use of masks, and capacity limitations (Esa et al., 2020); (Vílchez-Castillo et al., 2022).

Several studies showed that the COVID-19 pandemic had a significant impact on the mental health of construction workers (Dickson, 2023); (Gao et al., 2022). Employees in the sector reported increased levels of anxiety and depression, which are primarily associated with job uncertainty, intense workloads, and personal challenges that were exacerbated during the pandemic (Araya et al., 2023); (Nguyen et al., 2021);

(Pamidimukkala and Kermanshachi, 2021). Field workers on construction projects experienced particularly stressful work environments due to direct exposure to the virus and constant uncertainty about their health and the health of their families (Araya and Sierra, 2021); (Pamidimukkala and Kermanshachi, 2021). Those who switched to remote work also experienced distinct challenges, such as social isolation and difficulties in balancing work demands with home life (Mohamed et al., 2023).

2.2 Construction Resources in the COVID-19 Pandemic

The COVID-19 pandemic affected the supply and availability of various resources related to the construction industry. On the one hand, the availability of labor in construction projects was greatly affected. Several studies reported this decline in the labor force, with some estimating reductions ranging from 30% to 90%, depending on the level of risk of the activities performed (Esa et al., 2020); (Karimi et al., 2022); (Nweke and Nouban, 2022); (Rani et al., 2022); (Sierra, 2022). The decline in worker availability created additional pressures on the remaining workforce, leading to an increase in wages as a measure to attract and retain staff. However, the challenges associated with worker shortages also impacted project schedules, extending lead times and increasing operational costs (Kisi and Sulbaran, 2022); (Ling et al., 2022). On the other hand, the COVID-19 pandemic caused significant instability in the construction industry supply chain (King et al., 2022); (Rani et al., 2022); (Sierra, 2022). This instability was partly caused by blockades and movement restrictions (Esa et al., 2020); (Farooq et al., 2023), which created shortages of materials and inputs, increased prices, and difficulties in ensuring on-time delivery, resulting in notable project delays (Amoah et al., 2022); (Gammanage and Gunarathna, 2022); (Khalfan and Ismail, 2020).

2.3 Impacts of the COVID-19 Pandemic on Construction Budgets and Schedules

The COVID-19 pandemic significantly impacted the budgets and schedules of construction projects that were already underway. Kisi and Sulbaran, (2022) reported a 4%-5% increase in costs, mainly related to project implementation and health measures, such as hygiene kits, COVID-19 testing, and disinfection equipment (Esa et al., 2020); (Leontie et al., 2022); (Vílchez-Castillo et al., 2022). Project durations increased by up to 18.33% due to the temporary shutdown of projects, uncertainty about the pandemic's progression, difficulty in starting new projects (Araya et al., 2023); (Leontie et al., 2022), and material supply delays (Vílchez-Castillo et al., 2022). Labor shortages and stricter safety protocols further extended timelines. Additionally, communication challenges worsened, affecting coordination and project management (Karimi et al., 2022); (Subramaniam et al., 2022).

2.4 Negative Impacts of the COVID-19 Pandemic on the Construction Industry

The COVID-19 pandemic affected certain areas of the construction industry, both in the public and private sectors (Khalafallah et al., 2022); (Khalfan and Ismail, 2020); (King et al., 2022). Due to the uncertainty generated by the situation, there was a considerable reduction in government budgets and a widespread slowdown in the industry. Construction companies faced multiple financial challenges, including substantial losses, delays in project execution, and insufficient financial support, resulting in liquidity difficulties, loss of revenue, limited access to financing, and, in extreme cases, the bankruptcy of some companies (Araya and Sierra, 2021); (King et al., 2022); (Radzi et al., 2022). The pandemic also led to massive layoffs in the sector, exacerbating the negative impact on employment numbers and incomes of working families (Araya et al., 2023); (Assaad et al., 2022). (Table 1) includes a summary of the negative impacts identified in the relevant literature, providing a brief description of these impacts and the corresponding citations.

2.5 Positive Impacts of the COVID-19 Pandemic on the Construction Industry

Although the pandemic brought several challenges to the construction industry, it also had some positive impacts. Assaad et al., (2022) pointed out that the need to adapt to pandemic constraints led to an increase in the use of new technologies such as drones, virtual reality, and prefabrication (Araya et al., 2024). Similarly, Leontie et al., (2022), Ogunnusi et al., (2020), and Elrefaey et al., (2022) observed that the crisis acted as a catalyst for further digitization in the information and communication areas of the sector, particularly in meetings and administrative processes. Furthermore, the pandemic led to a heightened commitment to worker health and safety (Almohassen et al., 2023).

Jones et al., (2022) observed that the pandemic's resource constraints led to improvements and optimizations in project planning. Therefore, there was a need for efficiency, which accelerated the adoption of digital technologies like building information modeling (BIM) and software-based project management (Abanda, 2023); (Bouhmoud et al., 2023). (Table 2) includes a summary of the positive impacts identified in the relevant literature, providing a brief description of these impacts and the corresponding citations.

Table 1. Negative impacts of COVID-19 on the construction industry.

Id	Impact	Description	References
N ₁	Shortage of skilled labor	It is suggested that there is a reduction in the availability of labor in construction projects.	(Araya, 2021; Esa et al., 2020; Karimi et al., 2022; Kisi & Sulbaran, 2022; Ling et al., 2022; Nweke & Nouban, 2022; Sierra, 2022)
N ₂	Affections on workers' health and safety	It is suggested that the COVID-19 pandemic directly affects the health of workers and their safety perception.	(Araya, 2021; Araya et al., 2023; Araya & Sierra, 2021; Gammanage & Gunarathna, 2022; Karimi et al., 2022; Khalfan & Ismail, 2020; Sierra, 2022; Vilchez-Castillo et al., 2022)
N ₃	Affections to workers' mental health	It is suggested that there is a strain on mental health, with cases of anxiety and depression among workers, driven by certain measures taken during the pandemic, such as remote work, mobility restrictions, quarantines, and isolations.	(Araya et al., 2023; Araya & Sierra, 2021; Nguyen et al., 2021; Pamidinukkala & Kermanshachi, 2021)
N ₄	Supply chain disruptions	Due to COVID-19, the supply chain has been impacted by disruptions, material shortages, increased prices, delays in material delivery, and limited on-site resources.	(Alsharif et al., 2021; Araya et al., 2023; Araya & Sierra, 2021; Esa et al., 2020; Farooq et al., 2023; Gammanage & Gunarathna, 2022; Karimi et al., 2022; Khalfan & Ismail, 2020; King et al., 2022; Kisi & Sulbaran, 2022; Rani et al., 2022)
N ₅	Productivity decline	A decrease in worker productivity and, consequently, in construction overall is acknowledged.	(Araya et al., 2023; Araya & Sierra, 2021; Gammanage & Gunarathna, 2022; King et al., 2022; Radzi et al., 2022; Rani et al., 2022; Tekin, 2022; Vilchez-Castillo et al., 2022)
N ₆	Cost overrun	An increase in project costs is acknowledged due to rising material costs, higher wages in some cases due to labor shortages, fines for delays, and costs associated with complying with safety and health measures and supplies.	(Amoah et al., 2022; Araya & Sierra, 2021; Kisi & Sulbaran, 2022; Leontie et al., 2022; Nguyen et al., 2021; Nweke & Nouban, 2022; Vilchez-Castillo et al., 2022)
N ₇	Delays in construction processes	Acknowledging delays in construction projects due to lockdown measures and reduced mobility, as well as uncertainty, causing delays in project commencement.	(Alsharif et al., 2021; Amoah et al., 2022; Araya et al., 2023; Esa et al., 2020; Kisi & Sulbaran, 2022; Leontie et al., 2022; Nguyen et al., 2021; Nweke & Nouban, 2022; Vilchez-Castillo et al., 2022)
N ₈	Obstacles to effective communication	It is suggested that the COVID-19 pandemic posed an obstacle to communication management in construction projects.	(Karimi et al., 2022; Subramaniam et al., 2022)
N ₉	Economic impacts	The COVID-19 pandemic had a direct impact on the economy, affecting various levels of the construction industry. This impact has been caused by several factors, such as uncertainty, financial difficulties faced by companies, job suspensions leading to unemployment, project reductions and suspensions, and a decline in foreign investment.	(Amoah et al., 2022; Araya et al., 2023; Araya & Sierra, 2021; R. H. Assaad et al., 2022; Gammanage & Gunarathna, 2022; Karimi et al., 2022; Khalafallah et al., 2022; Khalfan & Ismail, 2020; King et al., 2022; Nguyen et al., 2021; Nweke & Nouban, 2022; Radzi et al., 2022; Rani et al., 2022; Sierra, 2022)

2.6 Chilean Construction Industry in the COVID-19 Pandemic

The COVID-19 pandemic had a major impact on the Chilean construction industry. The implementation of containment policies affected both the population and non-essential industries. In August 2020, the construction industry was classified as essential, allowing the resumption of projects. However, the previous stoppage, which lasted almost six months, had devastating consequences for the economy. According to Valladares and Barahona, (2021), the construction industry contributes approximately 6.6% of Chile's GDP. By 2020, reaching 5.7%, in addition to a 14% decrease in its sectoral GDP, it was recognized as one of the industries hardest hit by the pandemic. The impact of investment in construction recorded a 26.1% annual reduction in the third quarter of 2020, the largest drop recorded in recent decades, and largely attributed to the extent and severity of the quarantine restrictions (CChC, 2020). Employment in the sector was also drastically affected, with a reduction of 212,000 jobs in October

2020, representing a 26% drop in the sector (CChC, 2020). Faced with this crisis, the Chilean government adopted several measures to mitigate the economic and social impact. These included the Employment Protection Law, the FOGAPE COVID, and the MYPEs 2021 Bond, which is in line with the recommendations of the International Labor Organization (ILO) to stimulate the economy and protect employment.

Table 2. Positive impacts of COVID-19 on the construction industry.

Id	Impact	Description	References
P ₁	Adoption of new technologies	It is suggested that the COVID-19 pandemic spurred the use of new and innovative technologies in the construction industry, both in practical (construction methods) and administrative (BIM tools) aspects.	(R. H. Assaad et al., 2022; Karimi et al., 2022; Ogunnusi et al., 2020)
P ₂	Encouraging digitalization in construction	COVID-19 is proposed as a driver of digitalization in areas such as information technology and digital communication throughout various stages of construction projects.	(Elrefaey et al., 2022; Leontie et al., 2022; Ogunnusi et al., 2020)
P ₃	Improvements in safety protocols	There is a stronger commitment to workers' health and safety, and workers are complying with established protocols. The measures taken due to COVID-19 have resulted in an overall decrease in accidents.	(Almohassen et al., 2023; Alsharef et al., 2021)
P ₄	Improvements in planning processes	Optimization measures, such as rigorous planning and work sequencing, are suggested to manage time in response to contingencies.	(Jones et al., 2022)

3. Methodology

3.1 Sampling and data collection

The study began with a literature review of established databases such as Scopus and Web of Science. This review process involved analyzing 48 previous studies that focused on the negative and positive impacts of COVID-19 on the global construction industry. From this literature, nine positive impacts and four negative impacts caused by the pandemic on the construction industry were identified.

A semi-structured interview was developed with the aim of gathering the opinions of construction professionals on the impact of the pandemic on the industry and the lessons learned. A team of four researchers who were experienced in analyzing the impacts of COVID-19 on the construction industry created the questionnaire. To ensure the questionnaire's quality, the first version of the interview was evaluated by two professionals in the sector. They aimed to identify and modify any aspect that could create confusion or ambiguity during its application. Interview (see Appendix A). A combination of convenience sampling and chain or 'snowball' sampling was used to collect interviews, as it has been used by others in the existing literature (e.g., (Spearing et al., 2022); (Thelemaque et al., 2023)).

Data collection for this study was conducted through 20 interviews with selected professionals in engineering and construction management who were active during the COVID-19 pandemic in Chile (see (Table 3)). These interviews took place between January and March 2023 and were conducted until the point of saturation was reached, as they would not have provided any new relevant information (Hennink and Kaiser, 2022); (Saldaña, 2013). In this case, the number of interviews to reach the saturation point aligns with sample sizes reported in similar studies on the impact of COVID-19 in the construction sector, which also employed qualitative methodologies (see Asis, (2020) with n=10; Zamani et al., (2021) with n=20; Araya et al., (2024) with n=19; (Wang et al., 2021) with n=5). Each interview was conducted via video calls and lasted an average of 45 minutes. During these sessions, participants were provided with a brief description of the study's topic and objectives. Their anonymity and confidentiality were assured. The interviewees' years of experience ranged from 2 to 27 years, with an average of 13.5 years.

3.2 Qualitative analysis of Interviews

The research is based on the qualitative analysis of the results; the interviews were transcribed, reviewed, and coded for analysis in QDA Miner Lite. The coding process involves breaking down the interviews into excerpts that are then coded. In this study, excerpts were identified at the

sentence level. The NVivo coding method was then used, following Saldaña's, (2013) approach, to assign codes to the recurrent themes. This coding technique involved a detailed classification of response fragments based on the main ideas and themes identified from an inductive and data-driven approach (Namey et al., 2007). These fragments were then organized into broader categories and subcategories. In this study, the following three categories are identified: negative impacts, positive impacts, and lessons learned from the COVID-19 pandemic. The identification of the categories and subcategories followed an iterative process, culminating in the creation of three coding dictionaries (see Appendixes B, C, and D).

Table 3. Role and position of professionals consulted.

Id	Field of work / Profession	Current position	Experience (years)
I ₁	Buildings / Construction Engineer	Project Manager	7
I ₂	Industrial / Construction Engineer	Senior Field Engineer	5
I ₃	Buildings / Construction Engineer	Junior Field Engineer	2
I ₄	Buildings / Construction Engineer	Cost and Control Engineer	5
I ₅	Mining / Construction Engineer	Project manager	14
I ₆	Mining / Construction Engineer	Bidding Manager	13
I ₇	Roads / Construction Engineer	Project Manager	17
I ₈	Mining / Construction Engineer	Bidding Engineer	5
I ₉	Consulting / Construction Engineer	Consultant in Construction Management	21
I ₁₀	Buildings / Construction Engineer	Junior Field Engineer	2
I ₁₁	Buildings / Civil Engineer	Infrastructure Maintenance Manager	19
I ₁₂	Owner Inspector / Construction Engineer	Project Manager	27
I ₁₃	Buildings / Construction Engineer	Construction Manager	18
I ₁₄	Roads / Construction Engineer	Junior Field Engineer	4
I ₁₅	Buildings / Construction Engineer	Operations Manager	19
I ₁₆	Roads / Construction Engineer	Operations Manager	12
I ₁₇	Buildings / Architect	Owner Inspector	25
I ₁₈	Roads / Civil Engineer	Consultant in Construction Management	17
I ₁₉	Mining / Safety Engineer	General Manager	18
I ₂₀	Mining / Construction Engineer	Acquisition Manager	20

Once the coding was completed, the frequencies of each category and subcategory were obtained to facilitate their analysis. These frequencies were divided into two types: one indicating the number of times a topic was mentioned, and another revealing how many interviewees mentioned that the topic was important to note. These frequencies should not be interpreted in a statistical sense, as these were generated through a qualitative analysis.

4. Results

(Table 4) provides the frequencies of the categories and subcategories identified in the qualitative analysis of the interviewees. These categories and subcategories are classified into negative impacts, positive impacts, and lessons learned. The table presents both the frequencies, unique responses, and total responses. This information is essential to quantify and visualize the prevalence of each category and subcategory, providing a clear perspective on the most recurrent themes and their relevance to interviewees. Our results reflect the diversity of experiences and perceptions of professionals within the industry during the pandemic.

Table 4. Frequency of categories and subcategories from the qualitative analysis.

Type of impact	Category	Subcategory	Total responses (Unique responses)	Percentages
Negative	Project Management	Finance	21 (15)	13% (75%)
		Supply chain and materials	21 (17)	13% (85%)
		Workforce	16 (16)	10% (80%)
		Waste management	7 (7)	4% (35%)
		Communication	3 (2)	2% (10%)
	Construction Industry	Impact on the workforce and economy	11 (8)	7% (40%)
		Barriers to the development of new projects	8 (7)	5% (35%)
	Workforce Safety and Health	Mental health of workers	25 (16)	15% (80%)
		Physical health of workers	10 (9)	6% (45%)
		Job stability	4 (4)	2% (20%)
		Total	168 (19)	100% (100%)
Positive	Digitalization	Adoption of new technologies	32 (20)	39% (100%)
		Digitalization of information	13 (13)	16% (65%)
	Project Management	Planning	12 (12)	15% (60%)
		Finance	2 (2)	2% (10%)
	Workforce Safety and Health	Health and well-being of workers	12 (8)	15% (40%)
		Safety and self-care on the job	7 (7)	8% (35%)
	Protection of the environment	Reduction of waste	5 (5)	6% (25%)
			Total	83 (20)
Lessons Learned	Digitization	Digitalization and new technologies	17 (16)	68% (80%)
		Telework	8 (5)	32% (40%)
	Workforce health and safety	Rigorous health and safety	2 (2)	20% (10%)
		Work well-being and mental health	8 (6)	80% (30%)
	Project management	Work management	5 (4)	42% (20%)
		Strategic focus	4 (3)	33% (15%)
		Planning	3 (3)	25% (15%)
	Industry resilience and strategic responses	Health crisis management	4 (4)	40% (20%)
		Adaptation and prevention	6 (6)	60% (30%)
		Total	57 (20)	100% (100%)

5. Discussion

5.1 Negative Impacts of COVID-19 on the Chilean Construction

The COVID-19 pandemic negatively impacted construction project management, resulting in significant execution delays. Strict health and safety protocols, necessary to ensure worker protection, have decreased operational efficiency. Temporary shutdowns of construction sites and stalled projects due to the spread of the virus have also emerged as critical factors that have severely affected the industry. An illustrative case mentioned by one of the participants revealed that, within his company, a specific analysis was carried out to quantify the reduction in productivity. The results showed a 28% decrease in labor efficiency, a non-trivial impact that highlighted the magnitude of the operational disruptions. This situation reflects trends observed in other international markets and is in line with recent research findings. Studies such as those by Sierra, (2022) and Vélchez-Castillo et al., (2022) indicated that the percentage of productivity could be affected by extensions of up to 20% over the original project timelines.

(Table 3) identifies the mental health of workers as the second most common issue during the pandemic, which is in line with previous research studies (Jones et al., 2022); (Pamidimukkala and Kermanshachi, 2021); (Raoufi and Fayek, 2022). This study shows that employees' mental health challenges during the pandemic were directly linked to various factors, including uncertainty about job security, fear of contracting and transmitting the virus, heavy workloads, and adapting to new remote work arrangements. These findings highlight the need for specific and continuous psychological support strategies in times of crisis. Regarding the supply chain, the 85% of participants reported significant impacts on the price and availability of building materials especially at the start of the health crisis, which is consistent with the results reported by other researchers, such as King et al., (2022), Rani et al., (2022), Sierra, (2022), Tekin, (2022), and Amoah et al., (2022). These findings show the vulnerability of the global supply chain to external shocks.

As a result, it became difficult for companies to maintain normal operations and meet construction schedules. Furthermore, the study suggests that financial conditions in the construction industry deteriorated considerably due to the uncertainty generated by the pandemic. Limited investments led to reduced financial solvency for many construction companies, which, in several cases, resulted in bankruptcy filings. These results align with global observations on the financial consequences of the pandemic on the sector (Amoah et al., 2022); (Nguyen et al., 2021).

The construction processes were adversely affected by the COVID-19 pandemic, particularly when it comes to new project development. Our study participants and various literature sources (Araya, 2021); (Esa et al., 2020); (Karimi et al., 2022); (Kisi and Sulbaran, 2022); (Ling et al., 2022) have highlighted the low availability of labor as a significant obstacle. This shortage of workers is mainly due to two factors: first, unfounded fear of COVID-19 contagion, and second, government policies that incentivized many workers to leave the construction sector by providing bonuses. One interviewee noted that many workers migrated to other sectors or turned to self-employment, attracted by more secure and lucrative income opportunities that exceeded what they previously earned in construction. While this specific phenomenon of labor migration into self-employment is not widely reported in the international literature, it does illustrate a peculiarity of the Chilean labor market in the context of the pandemic, possibly due to variations in the social policies implemented by the Chilean government.

The results highlight the crucial importance of understanding how government policies during global health crises can have specific local impacts. The situation in Chile serves to illustrate how well-intentioned government interventions can have unintended consequences on labor dynamics in critical sectors like construction. These findings contribute to a growing body of evidence that suggests the need for more tailored policies that balance immediate economic relief with the long-term sustainability of key industries.

5.2 Positive Impacts of COVID-19 on the Chilean Construction

The COVID-19 pandemic brought several positive changes in the construction industry, with digitization being the most prominent and unanimously agreed-upon benefit among interviewees. Many companies have been driven to adopt new communication technologies and digitize information, resulting in advances such as the use of digital signatures, collaborative reporting, and the transformation of critical documents into a digital format. Virtual meetings via video calls were emphasized as a notable advantage, as they reduced travel times for participants and simplified project coordination. One interviewee mentioned that work was greatly simplified, allowing multiple meetings to be coordinated and managed more efficiently and eliminating the need for constant traveling. These findings are in sync with existing literature, which recognizes how the pandemic catalyzed digitization in the construction industry, streamlining processes and significantly reducing management times (Elrefaey et al., 2022); (Leontie et al., 2022); (Ogunnusi et al., 2020).

Within project management, planning emerged as the most influential subcategory, being mentioned 86% of the time by respondents. According to respondents, the pandemic drove the need for more meticulous and realistic planning, noting that there was a greater focus on developing detailed project plans, making them more functional and achievable. Similar results are found in the study by Jones et al., (2022), where it is noted that new work planning and sequencing strategies led to greater worker efficiency and contributed to a more organized and cleaner work environment. In the area of health and safety, the most prominent subcategory was the health and well-being of workers. Interviewees' testimonies revealed a significant increase in employers' concern for the health of their employees. These measures included restructuring work schedules to reduce the density of workers on site, increasing the frequency and thoroughness of cleaning practices, and, in some cases, providing private transportation to prevent employees from using public transportation, thus minimizing the risk of contagion during commutes.

5.3 Lessons Learned from COVID-19 in the Chilean Construction

One of the most important lessons learned was the significance of maintaining and strengthening the operational and technological improvements introduced in response to the crisis. These improvements included digitization and the adoption of new technologies, which helped companies cope with the pandemic and also led to more efficient and resilient operations, offering opportunities to improve project management, communication, and workplace safety. 80% of respondents acknowledge that the advances made in digitization due to the pandemic are beneficial and should continue in the future. The pandemic also highlighted the need to maintain rigorous measures for physical protection and the psychological well-being of employees.

In project management, the effective regulation of telecommuting and supply chain diversification is a key area that has received attention. It is important to reduce reliance on single or regional suppliers, which can mitigate risks in future crises. Prioritizing contracts by line item has also been noted to provide flexibility in financial and resource management in uncertain times, highlighting the need for robust and realistic planning that can adapt to rapid changes in the environment. Finally, the industry's resilience and ability to adapt to an unprecedented emergency have been remarkable. The key to effectively managing the crisis has been the ability to change work practices, adopt updated safety protocols, and adopt new technologies quickly. These adaptations have ensured worker safety and project continuity. This level of adaptability and the adoption of new methodologies should be seen as central pillars for the industry's future resilience.

6. Conclusions

This study sought to understand the lessons learned as a result of the COVID-19 pandemic and to present recommendations for their effective incorporation into construction projects in order to strengthen the industry's preparedness and response to future disruptions. Through a qualitative analysis performed on 20 interviews with construction industry professionals in Chile, the positive and negative impacts and lessons learned from the pandemic were identified.

It was observed that the impacts of the pandemic on construction project management were considerable, affecting labor dynamics, worker health, and safety. The most significant impacts were noted in time management, material availability, supply chain, and worker mental health. The results make it possible to recommend that construction companies adopt and reinforce the digitization practices that facilitated communication and project management during the pandemic. In addition, they must continue to develop robust mental health strategies for their workers, recognizing that emotional well-being is as fundamental as physical safety. Another point of improvement refers to diversifying the supply chain, and implementing more flexible contracts can help mitigate future disruptions.

The responses collected from the study demonstrate that both negative and positive impacts are intrinsically linked to the lessons learned. Thus, these practices should not only be seen as temporary solutions but as an integral part of a new operating standard in construction projects.

The results contribute to the theory by formulating a conceptual framework that can be used by researchers to analyze the impacts of comparable crises in different sectors of construction. In practice, this work facilitates the implementation of proactive measures based on lessons learned during the pandemic.

This study, by focusing specifically on the construction context in Chile, has limitations in terms of generalizing its results to other national contexts. Another significant limitation refers to the period in which the interviews were conducted, between January and March 2023. By then, Chile had made significant progress in its vaccination program and had overcome the most critical stages of the pandemic. This could have influenced the perceptions and attitudes of the interviewees, possibly leading to a more optimistic or less urgent view of the crisis compared to previous periods. While this may bias some of the results, conducting the interviews at this time also allowed for a more comprehensive retrospective analysis of the impacts of the pandemic, providing a richer and more mature perspective on how the sector has navigated and adapted throughout the crisis.

With the lifting of the international COVID-19 pandemic emergency, future studies must explore the post-pandemic reality in the construction industry. It is important to investigate whether the negative consequences continue to affect the industry, to assess how effectively lessons learned have been incorporated into project management, and to determine whether the lessons learned during the COVID-19 pandemic have produced real and lasting changes.

7. Acknowledgements

This study was partially funded by the internal funding from Universidad Técnica Federico Santa María, number PI LIR 23-17. Felipe Araya, Luis Salazar, Katia Ogalde, Katherine Olivari, and Valeria Olivari are greatly appreciated for the funding.

8. Notes on Contributors

Felipe Araya , Departamento de Obras Civiles, Universidad Técnica Federico Santa María, Valparaíso, Chile. ORCID https://orcid.org/0000-0001-9814-5184	Katia Ogalde , Departamento de Obras Civiles, Universidad Técnica Federico Santa María, Valparaíso, Chile. ORCID
Katherine Olivari , Departamento de Obras Civiles, Universidad Técnica Federico Santa María, Valparaíso, Chile. ORCID https://orcid.org/0009-0005-1354-3244	Valeria Olivari , Departamento de Obras Civiles, Universidad Técnica Federico Santa María, Valparaíso, Chile. ORCID https://orcid.org/0009-0003-3154-2312
Luis Salazar , Departamento de Obras Civiles, Universidad Técnica Federico Santa María, Valparaíso, Chile. ORCID https://orcid.org/0000-0001-7339-8935	Omar Sanchez , Civil Engineering Department, Pontificia Universidad Javeriana, Bogotá D.C., Colombia. ORCID https://orcid.org/0000-0001-6070-3910
Leonardo Sierra-Varela , Departamento de Ingeniería de Obras Civiles, Universidad de La Frontera, Temuco, Chile. ORCID https://orcid.org/0000-0001-9696-061X	Álvaro Filun , Magister en Ciencias de la Ingeniería, Universidad de La Frontera, Temuco, Chile. ORCID

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10. Appendix

Appendix A. Interview questions:

Do you agree to participate in this interview?

a) Yes.

b) No.

1. What positive impacts do you recognize on construction projects following the COVID-19 pandemic?

2. What negative impacts do you recognize on construction projects following the COVID-19 pandemic?

3. (Showing the table) Which of these benefits do you identify as living, and which of them have you not seen reflected in your workplace?

Which of these benefits have you not seen reflected in your workplace?

4. (Showing the table) Which of these benefits do you identify as living, and which have you not seen reflected in your workplace?

Which of these benefits have you not seen reflected in your workplace?

5. Based on your experience after COVID-19, what benefits do you recommend maintaining over time, and how would you propose to implement them?

6. According to your experience after COVID-19, what recommendations would you give to minimize or eliminate negative impacts?

Appendix B. Coding dictionary with definition of codes and sample responses of negative impacts.

Category	Subcategory	Definition	Example
Project Management	Finance	Statements related to the increase in the costs of projects that affected the liquidity of construction companies	"Due to the pandemic, we faced a financial restructuring of the company."
	Time	Statements related to project delays, halting, and closing of projects due to pandemic protocols	"During the pandemic, we had to close multiple projects."
	Workforce	Statements related to the limited availability of workforce and increased cost to hire construction workers	"The quantity of workforce in the field was severely reduced"
	Supply chain and materials	Statements related to the limited availability of materials and increased cost, and time in delivery to construction sites	"Fewer materials were available, and often at double or triple their expected cost."
	Waste management	Statements related to increased waste generated due to pandemic protocols, such as masks	"Multiple masks were distributed and then found in the garbage or on the floor."
	Communication	Statements related to the limited quality of communication when performed virtually	"Limited physical contact affected communication among team members."
Construction Industry	Barriers to the development of new projects	Statements related to reduced investments for the development of new construction projects	"Limited new investments were developed due to the pandemic."
	Impact on the workforce and economy	Statements related to government policies that difficult workforce hiring difficult, increased interest rates that affected the construction industry	"Limited projects and workforce were available due to social distancing and government policies."
	Job stability	Statements related to contract suspension, unemployment, and reduction of salaries due to the pandemic	"Workers' contracts were frozen, thus leaving workers without a salary."
Workforce Safety and Health	Physical health of workers	Statements related to the effects of workers getting sick with COVID-19 and the spread of the virus	"Workers were found breaking COVID-19 protocols during construction projects."
	Mental health of workers	Statements related to mental health issues faced by workers, such as stress, anxiety, and fear of getting infected	"Workers were afraid due to the lack of new projects, and getting infected and passing the virus to their families."

Appendix C. Coding dictionary with definition of codes and sample responses of positive impacts.

Category	Subcategory	Definition	Example
Digitalization	Digitalization of information	Statements related to the digitalization of construction documents, such as reports and drawings.	"We used to deal with a lot of paper, but now everything is digital."
	Adoption of new technologies	Statements related to the application of digital technologies	"It was demonstrated that construction management work can be done virtually."
Project Management	Planning	Statements related to a more detailed and realistic planning of projects	"Better planning was required for projects to be completed during the pandemic."
	Finance	Statements related to the financial savings due to working from home jobs	"Due to the virtual work, savings in transportation and food were possible."
Workforce Safety and Health	Safety and self-care on the job	Statements related to increased safety and self-care from workers at construction projects	"Synergies occurred between COVID and safety protocols."
	Health and well-being of workers	Statements related to increased concern about workers' health and well-being due to pandemic protocols	"Concerns about workers' safety and health improved due to the additional pandemic protocols."
Protection of the environment	Reduction of waste	Statements related to a reduction of waste generation due to digitalization	"All the paperwork that digital documents have saved helps the environment."

Appendix D. Coding dictionary with definition of codes and sample responses of lessons learned.

Category	Subcategory	Definition	Example
Digitalization	Digitalization and new technologies	Statements related to the potential of digitalization and new technologies in construction projects, and the importance of training workers, are important.	"It is essential for companies and professionals to digitize and use technology that improves work and results in projects."
	Telework	Statements related to the fact that it is possible that some positions within construction projects can be carried out through teleworking	"...we detected that several professionals can telework, performing office tasks through digitalization and online procedures, regardless of physical presence at the workplace"
Workforce health and safety	Rigorous health and safety	Statements related to maintaining rigorous health and safety issues in construction projects, even if pandemic measures are no longer required.	"They should be as rigorous with all situations or games regarding safety issues as they were with COVID."
	Work well-being and mental health	Statements related to the importance of mental health and the possibility of implementing measures to support workers in this regard.	"...a mental health service was implemented at work, a psychologist visits us periodically, and talks to interested employees"
Project management	Work management	Statements related to the need to regulate teleworking and enhance team communication in construction projects.	"...A detailed task list for those who telework, with daily goals, could level the workload and balance productivity among employees..."
	Strategic focus	Statements related to strategies learned from the pandemic, such as diversifying the supply chain, prioritizing contracts by item, and saving time when starting projects.	"...The issue of supply chain, for example, we used to buy locally, but the need to expand our sources due to low availability revealed economic benefits to us..."
	Planning	Statements related to the importance of maintaining improvements applied to the scheduling of construction projects.	"...a collateral benefit was the improvement in planning. It arose from health requirements, not from business interest, but it was positive, and it is important to maintain it."
Industry resilience and strategic responses	Health crisis management	Statements related to the generation of protocols and strategies to prevent and manage pandemics and other health risks.	"...no one taught us what to do in the event of a catastrophe like the pandemic. The lesson learned is that the experience prepared us to face similar situations in the future."
	Adaptation and prevention	Statements related to the industry's ability to adapt and the importance of long-term planning.	"The ability to adapt was remarkable, especially when working in such adverse conditions. Now, with resources and manpower available, your approach to programming and production could improve significantly..."