Reduction of Extensive Construction Costs & Lead Times of Single-Family Homes in Florida due to Covid-19

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Abstract *— The timely completion of single-family homes in Florida was significantly affected by the outbreak of COVID-19 due to increased prices of materials, services, and lead time. Supply chain disruption and inefficient project management processes emerged as the main causes for increased costs and delays, leading to low profitability projects and businesses bankruptcies. In this study, data was collected from vendors and builders in Orlando, FL before and after the pandemic in an effort to optimize the project management process and consequently reduce the long lead-times and cost of construction. It was found that by creating a comprehensive construction schedule, using project management software to streamline their supply chain, embracing strategic procurement techniques, and value-adding supply chain management, an effective and profitable deliver of single-family homes is possible.*

Key Terms *— construction materials and services, construction costs, Covid-19, lead time*

INTRODUCTION

The Coronavirus, which broke out in 2019, has adversely affected the construction industry in the United States by interrupting operations, resulting in increased costs of building materials and delivery of projects. Additionally, the lead time, which is the duration taken to order and deliver construction materials and services for building single-family homes, has significantly increased in Florida due to the pandemic. Most property developers and contractors across the U.S. experienced delays in material delivery in the early years of COVID-19 [1]. The hold-ups affected project progress, causing substantial schedule disruptions.

The increase in lead time was primarily relevant when the affected supply chain entailed raw materials or items from overseas. Most projects rely on supplies from Europe, Canada, Mexico, and China.

Therefore, exploring an appropriate technique that minimizes lead times and optimizes construction schedules using project management software can help address the problem of increased construction costs and delivery time. Such a tool enables contractors to schedule the project phases and create memos for ordering the necessary materials ahead of time, tracking price increases, executing material take-offs and determining which supplies to purchase in large quantities. Consequently, the builders can deliver quality single-family homes on time and within budget.

LITERATURE REVIEW

The impact of COVID-19 on construction supplies' cost and lead time has generated significant interest among scholars and practitioners. Research shows that the pandemic resulted in a shortage of construction materials and delays in supplies [1]. In addition, prices of goods and services escalated, resulting in additional construction costs, loss of revenue, and the inability of managers to pay staff on time or deliver projects per schedule.

The coronavirus also impacted labor supply in the sector as most workers could not report on duty due to lockdown and social distancing [2]. Thus, the absenteeism of team members affected contract performance, scheduling, and timely completion of projects.

Labor scarcity, minimized construction productivity, supply chain disruption, and increased construction costs have been identified as the

pandemic's critical impacts on the construction sector [3]. Effective supply chain management and project support are essential for managing the material-related effects of COVID-19 [4]. However, market stability and financial assistance are critical for solving project-related consequences. Therefore, this paper pursues the management aspect of addressing the material-related implications of the coronavirus.

Research has shown that different project management software can help improve cost and lead time. For instance, the potential of the building information model (BIM) in reducing construction costs and enhancing time control has been studied [5]. The results indicate that BIM significantly impacts project cost and time. Furthermore, the tool helps address delays and cost overrun issues by creating and executing computer-generated models that integrate designs, planning, building, and operation of the project. Additionally, MS Project software helps managers optimize the project period by developing a comprehensive schedule and minimizing workforce and equipment to reduce project costs [6]. Overall, various project management software can help contractors reduce project costs and lead time.

ANALYSIS APPROACH

The approach adopted for this study entails generating a list of materials and services required for constructing a single-family home during COVID-19 and then contacting vendors and builders to collect data on the supplies' prices before and after the pandemic and their associated lead times. The data is then analyzed for a construction schedule with reminders for ordering the materials and scheduling services with extensive lead times. The adopted methodology also strives to comprehend the relationship between higher bidders vs. lead times and the availability of the necessary goods and services for delivering the homes. Finally, the MS Project 2019 software creates the construction schedule.

RESULTS

The analysis presented in Table 1 reveals that construction materials prices increased significantly between October 2019 and September 2022. In addition, the supplies associated lead times rose during COVID-19 as seen in Tables 2 and 3. For instance, the slab price, which stood at $12,000 in 2019, increased to $13,800 during the pandemic. Likewise, the block wall cost changed from $11,000 in the pre-COVID-19 period to $13,530 during the pandemic, representing a 23% change. The price of lumber increased by 88% from $14,385 in 2019 to $27,043.80 in 2022. Similarly, the data indicates that the necessary labor for framing a house increased by 60%.

Table 1
Price Increases 2019 x 2022

Cost Code	Description	Oct 2019	Sep 2022	Price Increase	
28000	FOUND./SLAB/BL. WALLS - Slab-Turnkey	$ 12,000.00	$ 13,800.00	$ 1,800.00	15%
29150	Block Walls - Turnkey	$ 11,000.00	$ 13,530.00	$ 2,530.00	23%
35100	Floor Trusses	$ 14,385.00	$ 27,043.80	$ 12,658.80	88%
40000	Framing - Labor	$ 14,925.00	$ 23,880.00	$ 8,955.00	60%
46000	ROOFING - Turnkey	$ 6,060.00	$ 6,666.00	$ 606.00	10%
38000	WINDOWS - Turnkey	$ 8,471.00	$ 9,318.10	$ 847.10	10%
54000	GARAGE DOORS - Turnkey	$ 2,175.00	$ 2,610.00	$ 435.00	20%
54021	PLUMBING	$ 10,740.00	$ 12,028.80	$ 1,288.80	12%
54026	ELECTRICAL	$ 9,640.00	$ 12,050.00	$ 2,410.00	25%
54037	HVAC	$ 8,175.00	$ 9,810.00	$ 1,635.00	20%
61450	Stucco - Turnkey	$ 9,784.00	$ 11,740.80	$ 1,956.80	20%
49000	INSULATION - Turnkey	$ 2,530.00	$ 2,783.00	$ 253.00	10%
51100	Drywall - Materials	$ 4,101.61	$ 4,511.77	$ 410.16	10%
67500	Flooring - Wood / Laminate - Turnkey	$ 905.00	$ 959.30	$ 54.30	6%
68500	Flooring - Tile Turnkey	$ 8,349.00	$ 8,849.94	$ 500.94	6%
65200	Wall Tile - Wet Areas (i.e. Shower Walls)	$ 2,704.00	$ 2,866.24	$ 162.24	6%

As illustrated in Tables 2 and 3, the pandemic also affected the lead times of the materials and services required to deliver single-family homes. For instance, the time taken to assemble, and erect trusses increased by 9 weeks, from 3 weeks in 2019 to 12 weeks in 2022. Slabs that were poured within 2 days before, changed to 28 days post-COVID-19. Additionally, roofing tiles, which took seven days to deliver before the calamity, rose to six months after the outbreak. The analysis further establishes that HVAC equipment use to take seven days to be delivered and between four and five weeks during and after the pandemic. The delivery time for windows increased from 28 days in 2019 to 18-25 weeks post-pandemic. Overall, the results suggest that the changes in lead time correlate with the increase in the prices of the supplies and the total project cost.

Table 2
Materials Lead-Time

Item	Before Covid-19	After Covid-19	Sources
Trusses	3 weeks	12 weeks	BFS, Trusswood
Slab	2 days	2 weeks	MT, MJS, CKS
Block	2 days	2 weeks	MT, MJS, CKS
Framing Material	3 days	2 weeks	BFS, 84 Lumber, Romac
Roofing (tile)	1 week	6 months	Collis Roofing, Noland's Roofing
Plumbing	3 days	2-3 weeks	RJ Kielty, Ferran
HVAC	1 week	4-5 weeks	Mills Air, Energy Air
Windows	3 weeks	18-26 weeks	MI, PGT, CGI
Drywall Material	2 days	3-4 weeks	Rosen, Marjam

Table 3
Construction Lead-Time

Type of Construction	Before Covid-19	After Covid-19	Sources
Spec Single-Family Homes	7 month	12 month	Davila Homes, J Drews, Meridian Homes
Custom Single-Family Homes	10 month	16-20 month	Davila Homes, J Drews, Meridian Homes
Multi-Family Homes	8 month	12 weeks	Davila Homes, J Drews, Meridian Homes
Construction Documents	2-3 weeks	8 weeks	ArciDynamics, MJS, Phil Kean
Building Permits - Orange County	2 weeks	4-6 weeks	Orange County Building Dpt.

These results demonstrate that the costs of materials and services required for constructing a single-family home unit increased substantially during the COVID-19 pandemic. Building a house during or after the pandemic became more challenging and new strategies have to be implemented in order to optimize the construction process and consequently mitigating those issues.

Project Scheduling

Project management software with scheduling tools can help contractors avert these challenges by controlling the budget and supply chain from the initial phase to the final delivery. Furthermore, the forecast created by technologies, such as MS Project, Buildertrend and BIM gives the builders a comprehensive perspective of the project's financial and resource landscape across critical metrics. Consequently, they can effectively track planned budgets against actual spending and identify the valuable and valueless aspects of the project. For instance, as illustrated in Figure 1, the MS Project tool enables contractors to create project schedules and flow charts.

In addition, the builders using this software can analyze project costs, assign tasks and activities, determine cost overran, and ascertain the overall cash flow and resource overview. Overall, project management software can help constructors optimize project costs and reduce long lead times occasioned by crises like COVID-19 by scheduling, budgeting, and tracking resources throughout the project process.

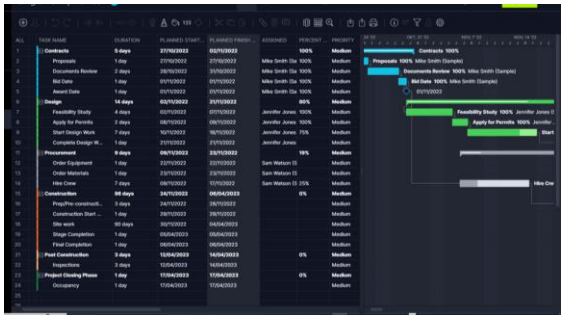

Figure 1.
Project Management Schedule for Single-Family Home

Logistics Management

A local builder, Davila Homes, also mentioned that most construction managers emphasize day-to-day management and technical aspects with little focus on logistics and that efficient onsite logistics enhance project performance and outcomes. Though some cost effects and delays are beyond the managers' control, streamlining logistics can significantly reduce construction costs and lead-times during and after the pandemic. Good logistics results in lower costs due to reduced breakages, thefts, and delays. Moreover, logistic management also reduces labor costs because materials are readily available. Technology provides an optimal mechanism for planning, coordination, quality control, supply, and purchase.

Building Information Modeling (BIM) is another revolutionary technology that was adopted by several builders, including Davila Homes during and after Covid-19 since it applies digital technology to streamline construction logistics and make design changes. The technology combines big data and modern logistic practices to deliver construction materials at the lowest cost-efficiently. This study also identified BIM as a possible solution to the supply chain mess. The software can increase material delivery, manage suppliers and employees, and assist construction managers in identifying designs improvement areas.

RECOMMENDATIONS

These findings call for project managers to develop comprehensive construction schedules that provide an overview of the entire phases of the construction process, including the development of contracts, design, procurement, construction, post-construction, and project closing phase. The approach enables contractors to figure out the duration that the various project tasks are expected to take, the resources required for executing the activities, and the team responsible for each phase in the building process. In addition, the project managers should anticipate supply price changes as the construction process progresses. Moreover, the procurement process should be timely with effective supply chain management mechanisms, such as the just-in-time method. Thus, adopting these measures helps contractors ensure that the necessary materials are available on-site when needed, reducing wastages and optimizing lead times. Using tools such as Buildertrend, MS Project and BIM, contractors should create the necessary memos to order material ahead of time and track price changes using the software's enabling feature. In addition, they conduct material take-offs, determine which supplies to purchase in large quantities, and get substantial discounts.

The project leaders should also send more bids to potential suppliers and get several quotes for the same item before settling on a provider. Setting up blanket orders also helps optimize project costs and reduce delays. Hence, contractors can establish long-term contracts with vendors to lock in low pricing and ensure a continued supply of ordered materials and services. Thus, long-term relationships with the suppliers entail purchasing specific quantities over time at a consented fixed price, helping resolve the challenge of fluctuating prices.

CONCLUSIONS

The results of this analysis indicate that COVID-19 resulted in increased construction materials and service prices. In addition, the pandemic also affected the supplies and lead time. Overall, the increased construction cost made it difficult for builders to deliver single-family home projects per the client's schedules. Therefore, A comprehensive construction schedule can help the managers with an overview of the entire phases of the construction process, the specific timelines, and the necessary resources for executing each stage. In addition, strategic procurement, logistics and value-adding supply chain management techniques are essential for the timely completion of single-family homes during and after the pandemic crises.

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