Evaluating Productivity in Reinforced Cast-in-Place Concrete Construction Projects in Puerto Rico: From Case Study to Framework

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Abstract

This research project focuses on the evaluation of the production of reinforced Cast in Place (CIP) Concrete building in a project located in the southern region of Puerto Rico. The projects analyzed consist of several similar buildings constructed within identical site limits, safety requirements and federal specifications. While the construction processes were nearly identical, the two buildings studied were built by different workforces and managed under different leadership. This documentation serves as a benchmark for small construction firms in Puerto Rico. By comparing self-performed work against subcontracted specialized labor, firms can better decide whether to build internal capacity or leverage external expertise to balance between cost efficiency and schedule performance.

Introduction

Since the 1960s, reinforced cast-in-place (CIP) concrete has dominated Puerto Rico's infrastructure due to its seismic and hurricane resistance. Despite recent challenges like inflation and labor shortages, the industry is evolving through sustainable materials and advanced technologies like FRC and UHPC. Today, CIP remains the preferred method for complex, large-scale projects and high-rise construction due to its durability and structural versatility.

Background

This research evaluates reinforced cast-in-place concrete productivity in Puerto Rico by comparing self-performed and subcontracted work within the same project. It analyzes how leadership, specialized labor, and regional constraints—like six-month submittal cycles and hurricane-related delays—impact efficiency. The findings provide a strategic benchmark for small firms to optimize cost, schedule performance, and technical execution in infrastructure projects.

Problem

The core problem is that small construction firms in Puerto Rico lack structured data to decide between self-performing or subcontracting concrete work. This leads to operational inefficiencies, as seen when self-performance (B304) resulted in 8.33% higher labor costs and a 16.03% slower schedule compared to subcontracting, exacerbated by six-month submittal delays and unpredictable tropical weather.

Methodology

This article compared two (2) reinforced CIP construction processes of the buildings. However, the two analyzed buildings were within the same construction limits, safety requirements and federal construction specifications but were built by different manpower and different leadership.

Step I. Establish a baseline & Scope definition

Define the scope of work for both buildings, ensuring a common basis for comparison. Detail the critical path and task sequencing to obtain a better understanding of the scope of work and identify specific improvement areas.

Step II. Production data collection (Time study)

Perform a study and collect actual data. The information will gather three important groups: the initial estimated cost and the initial estimated PoP, the actual costs and actual time of performance for B470 and B304. Develop a new independent estimate and independent schedule for the construction of a similar building.

Step III. Cost and time comparative analysis

Utilize the data obtained from B470 and B304 and compare it with the initial estimate. This information will provide a comparative of the costs that were to be incurred prior work and what were the actual costs for the construction of each building. This result can lead us to determine if the resources that were originally intended for the project were sufficient or not.

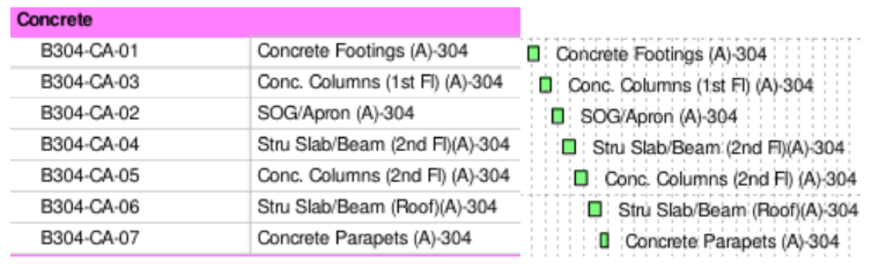
Step IV. Document results for future reference

The final phase of the methodology focuses on the Root Cause Analysis and the formal documentation of lessons learned. Compared to information already gathered from the initial estimate, actual building construction information and the independent estimate to find document the efficiencies during the process. Calculate and compare total costs and duration for similar tasks to pinpoint variance. Identify patterns and performance drivers, then document findings in a final report highlighting differences in productivity.

Results and Discussion

Step I. Establish a baseline & Scope definition

The scheduling department provided the Baseline Schedule where the initial construction approach was defined and the Scheduler provided the schedule fragnet for each structure isolating the reinforced CIP concrete activity.



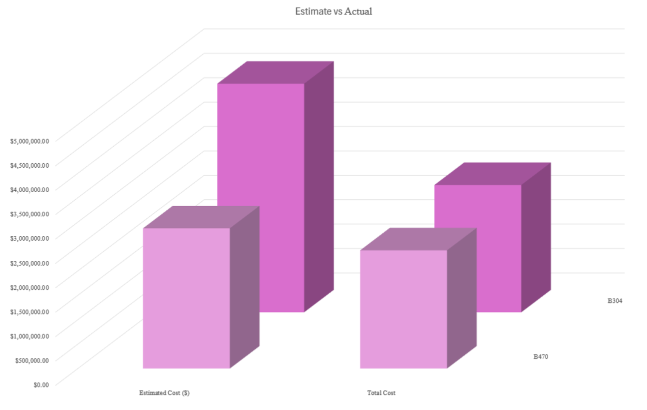
Step II. Production data collection

The data was collected from the initial breakdown for payment. This will provide the initial estimated costs with their respective profit for the buildings in discussion. The Period of Performance (PoP) described on the Base Line schedule for B470 and the PoP for B304.

	B470	B304
Actual Payroll Costs	$1,247,232.00	$1,351,168.00
Actual Equipment Costs	$395,200.00	$412,773.70
Actual Material Costs	$559,000.00	$607,500.00
Miscelaneous Costs	$220,143.20	$237,144.17
Total Cost	$2,421,575.20	$2,608,585.87
PoP	287	333

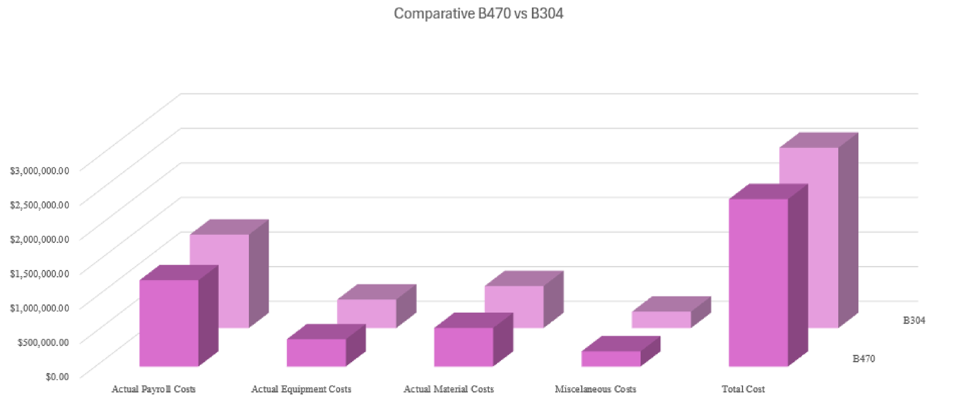
Step III. Cost and time comparative analysis

Figure # 2 shows a comparative between the original intended effort and the actual work for the buildings B470 and B304.



Step IV. Document results for future reference

The final stage of this research involves a Root Cause Analysis (RCA) and the formal documentation of performance drivers to bridge the gap between theoretical estimates and field reality.



Conclusions

Subcontracting proved more efficient than self-performing, completing work 16.03% faster with 8.33% less labor. Productivity was primarily hindered by "soft" delays, such as six-month submittal cycles and regional weather. Small firms should utilize a data-driven framework to assess technical proficiency, analyze cost-benefit trade-offs, and improve pre-construction synergy. This documentation is a strategic necessity for Puerto Rico's infrastructure performance.

Ultimately, this research serves as a vital benchmark for small and medium-sized construction firms in Puerto Rico. It proves that documenting and comparing productivity data is not merely an administrative exercise but a strategic necessity to find efficiencies, manage labor shortages, and ensure the long-term performance of the island's critical infrastructure.

Future Work

For future studies, the others disciplines under the vertical coinstruction should be added. There are Mechanical Electrical and Plumbing disciplines that the small companies should be familiarized and determined if some of this disciplines should be performed with directly with the construction company or should be subcontracted.

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