

Prefabrication and the Labor Shortage on the Central Coast

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The labor shortage has affected every aspect of construction all over California, however the central coast has been hit especially hard. The central coast's location between the two major developmental hubs presents challenges such as relocating employees and finding skilled craftsman. One potential method that has been shown to increase productivity and cut costs is to prefabricate. Prefabrication can improve working conditions and increase worker safety while streamlining schedule and reducing environmental impact. While these benefits are certainly possible in larger cities that have the manufacturing grunt, this paper aims to understand if prefabrication is a viable way to alleviate the labor shortage in small communities. Research shows that there are a number of problems that present themselves to contractors located on the central coast, such as longer lead times on prefabricated items, a shortage of manufacturing plants, a shortage of labor, and a technology delay. Some contractors are combatting these issues with increased housing stipends for workers as well as varying levels of off-site prefabrication. Their success tends to be limited by trade coordination with architects as well as the size of the market.

Key Words: Pre-fabrication, Central Coast, Labor Shortage, Technology

Introduction

Research Goals and Objectives

This paper aims to answer one a research question: Is prefabrication viable for central coast contractors? If it isn't, it's important to analyze why it isn't and what changes would make it viable on the central coast. Since the research will be qualitative in nature, a definition of goals would be meaningful. One goal is to gather a broad enough sample from the construction industry on the central coast to make the conclusion meaningful. If it is viable, this research aims to further understand which types of trades find the most use out of prefabricating components and systems.

One objective measure of the achievement of this goal is to acquire five substantial interviews with local contractors. Five will be a broad enough number to be meaningful but still be practical, as contractors are very busy and difficult to get a hold of. In order to keep the interviews consistent, there will be a set interview questionnaire with six questions. If the research meets these objectives, this constitutes successful achievement of my research goals.

Background on the Labor Shortage

The construction industry is used to facing project delays such as bad weather, material shortages, and union strikes, for example. A relatively new speed bump in the industry is a shortage of skilled labor that is affecting the industry on a national level. In 2018, the USG + U.S. Chamber of Commerce Commercial Construction Index said that 65 percent of small contractors reported difficulties finding skilled workers (Emerson 2018). The hiring ratio has improved in recent years which indicates that there are more job openings per applicant and a shortage of qualified workers. As written, in February of 2018 the nationwide employment opportunity index for construction jobs was at a meager 0.16, which means that for every job opening there were 6 applicants. This is up from the previous year, which would see double the amount of applicants (Emerson 2018). Some smaller metropolitan areas like Hot Springs, Arizona are seeing even worse of a shortage, where there are four job openings for every qualified applicant (Emerson 2018).

The industry has no problem finding people, but most of those people don't have construction experience. As written, this forces companies to spend much more on training, which adds to construction costs (Emerson 2018). When a company faces increased construction costs and a decrease in skilled labor supply, they are forced to come up with alternate solutions to boost productivity. Some solutions that contractors have come up with include stepping up recruiting efforts as well as investing in technology. Innovations in technology like laser and GPS-Guided road graders are aimed at decreasing on-site labor and using prefabricated and modular building materials is another way to boost productivity. Prefabrication increases productivity, but it's still difficult to get enough volume of business in a given location to warrant a component factory being economically viable . . . as written (Emerson 2018).

Prefabrication Defined

Traditionally, construction work has been based around on-site work characterized by cast-in-place technology, formwork and falsework, wet trades, and excessive amounts of material waste. Boiled down, the basic idea of prefabrication is to transfer a certain portion of on-site construction work from the traditional project site to a controlled environment like a factory or other manufacturing site. A project is considered prefabrication if it either uses individual prefabricated building components or is entirely based on the assembly of prefabricated building modules to later be transported on-site. (Lu, Chen, Xue, Pan 2018) "Prefabrication is widely considered as a way of cleaner production, which is a concept that aims at preventing the production of waste, while increasing efficiencies in the use of energy, water, resources and human capital." (Lu, Chen, Xue, Pan 2018) Much research has unanimously discovered that prefabrication is a 'cleaner' strategy with the following benefits:

1. *Working Conditions* – Factories allow controlled conditions for the weather, quality control, improved supervision of labor, easier access to tools, and fewer material deliveries. (Lu, Chen, Xue, Pan 2018)
2. *Reduced Environmental Impact* – Reduced amounts of material waste, air and water pollution, dust and noise, and overall energy costs allows for fewer job-site environmental impacts. (Lu, Chen, Xue, Pan 2018)
3. *Safety* – Controlled work environments reduce worker risk because they are not exposed to inclement weather, extreme temperatures, and hazardous operations like building at heights. (Lu, Chen, Xue, Pan 2018)
4. *Streamlined Schedule* – Changing the sequencing of work flow compresses the project schedule because components can be assembled off-site while a preceding activity is being performed on-site. (Lu, Chen, Xue, Pan 2018)
5. *Storage* – Off-site production means that there are reduced requirements for on-site storage and fewer losses or misplacements of construction materials. (Lu, Chen, Xue, Pan 2018)

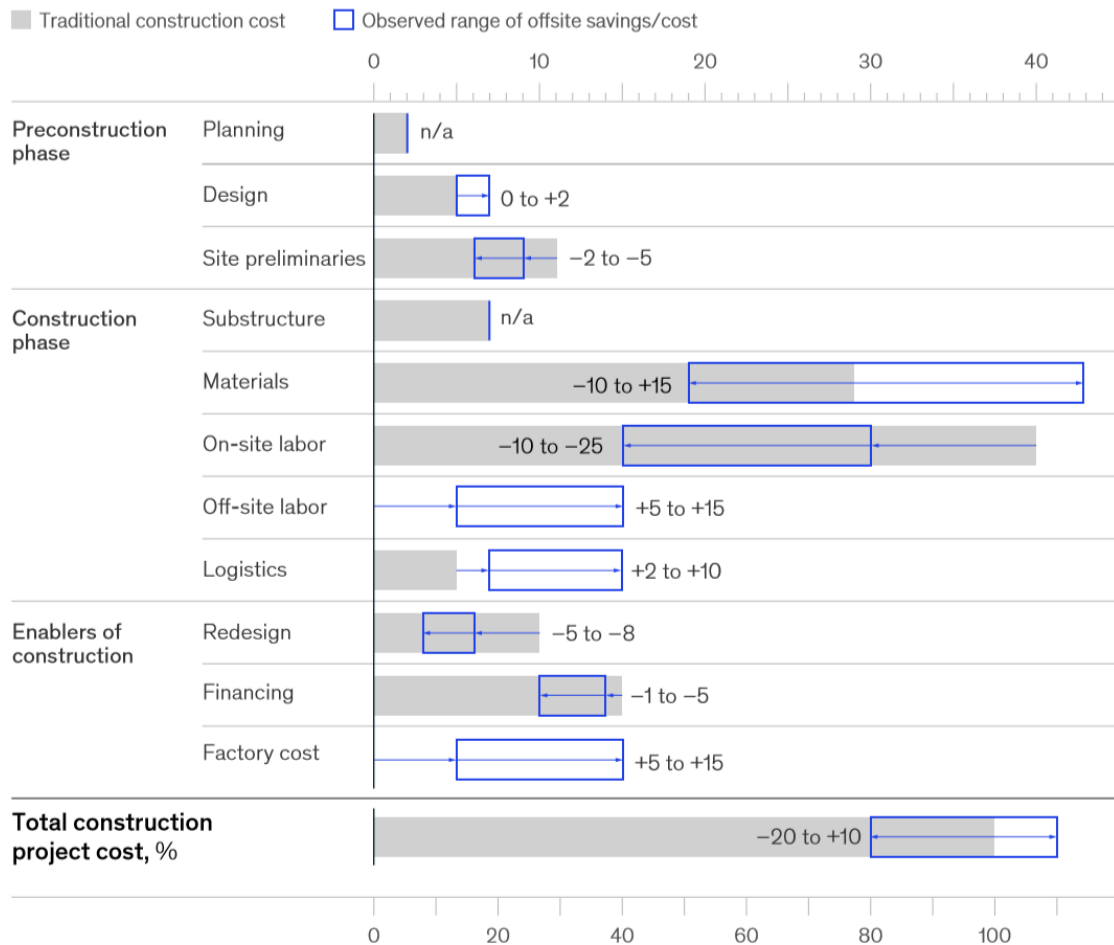
Measuring Prefabrication

Moving forward, it's important to understand how to measure the effects of prefabrication, or 'pre-assembly' in a qualitative way to align with this paper's research methodology. Qualitative measurements have the possibility to offer an index-style understanding of the different types of prefabrication found in the construction industry. "Qualitative measurements cannot represent the amount of prefabrication used, but they can tell what kind of prefabrication is adopted. Hence, qualitative measurements are more suitable than their quantitative counterparts to describe which type of prefabrication is fitting into a certain [Political, Economic, Social and Technological] Background. (Lu, Chen, Xue, Pan 2018) One proposed breakdown of these specific types of prefabrication is as follows: Component and sub assembly, Non-Volumetric (dimensional pre-cast concrete walls), Volumetric assembly (kitchens with usable space enclosed), and Modular building (structural modules that form the fabric of a building's structure). (Gibb 2001) These sub-categories have different applications for the many different trades, with varying on-site and off-site labor levels.

Although this paper's research methodology is strictly qualitative, it's important to understand the quantitative methods of measuring prefabrication as well. Quantitatively, modular construction can cut a project's schedule by 20-50 percent while cutting construction costs by as much as 20 percent. (Bertram, Fuchs, Mischke, Palter, Strube, Woetzel, 2019) Schedules acceleration can be achieved through the following:

1. *Design* – "Design firms are looking to develop libraries of modules for the manufacturing process, potentially accelerated and simplified through automated design, which will shorten the design period." (Bertram, Fuchs, Mischke, Palter, Strube, Woetzel, 2019)
2. *Foundations* – Foundations are unaffected, but modules are designed to be lightweight for transport, so they are far less complex to install which could reduce the size and complexity of foundations. (Bertram, Fuchs, Mischke, Palter, Strube, Woetzel, 2019)
3. *Offsite manufacturing* – Enclosed and controlled factory environments facilitate quicker production times. Manufacturing can also take place parallel to foundation work, unlike traditional projects. (Bertram, Fuchs, Mischke, Palter, Strube, Woetzel, 2019)
4. *Onsite Construction* – "Typically, one team of five workers can assemble up to six 3D models, or 270 square meters of finished floor area, per day. This is significantly faster, and therefore cheaper, than traditional construction." (Bertram, Fuchs, Mischke, Palter, Strube, Woetzel, 2019)
5. *Rework* – A factory environment makes quality control much easier and reducing or eliminating rework altogether improves construction schedules. (Bertram, Fuchs, Mischke, Palter, Strube, Woetzel, 2019)

The cost savings are quantitatively determined by breaking down the project costs into the preconstruction phase, construction phase, and enablers of construction. Within each of these categories, there are metrics that contribute to project savings and costs. The potential savings of 20 percent will primarily be seen during the construction phase through materials and on-site labor. The 10 percent cost risk will be seen in off-site labor, factory cost, and logistics like site transport. (Bertram, Fuchs, Mischke, Palter, Strube, Woetzel, 2019)



¹Indicative breakdown; varies by project.
 Source: US Federal Highway Administration; McKinsey Capital Projects & Infrastructure

Figure 1 – “There is an opportunity for 20 percent savings – but at a risk of up to 10 percent cost increases if labor savings are outweighed by logistics or material costs.” (Bertram, Fuchs, Mischke, Palter, Strube, Woetzel, 2019)

Methodology

Research Methodology

In order to gather a broad sample of qualitative data, this research will consist of a series of interviews with a number of central coast contractors. These interviews will be conducted with pre-determined questions to focus conversation and keep the interview process consistent. Subcontractors who self-perform their own work will be a knowledgeable source of first-hand experience with fabrication as well as installation. General contractors are another source that will be useful in gathering broader observations about many sub-contractors as well as their own firm’s self-performed experiences, if applicable. Once gathered, this data will be analyzed using some of the qualitative metrics that have already been created by industry leaders to determine if prefabrication is a viable solution to increase productivity and alleviate the labor shortage on the central coast.

Research began with an in-person attempt at an interview, with only one of those being successful on the first attempt. In many cases, a visit to a contractor's office resulted in receiving a business card of the most qualified employee at the company to speak on the matter of prefabrication. At that point, the research became email and phone-call based once in-person interviews were exhausted. Three interviews were conducted via an email questionnaire and one was conducted over the phone.

Interview questions:

1. To what extent do you use prefabrication in your trade (Component and sub assembly, Non-Volumetric (dimensional pre-cast concrete walls), Volumetric assembly (kitchens with usable space enclosed), and Modular building (structural modules that form the fabric of a building's structure))?
2. How has the labor shortage affected your operations?
3. Does being located on the central coast away from the two major hubs of construction affect ability to use prefab materials?
4. Do you have your own production shop or factory?
5. What other challenges does being located in the central coast in a relatively small community cause?
6. What plans have you put in place to improve any of the above?

Results

Extent of Current Prefabrication Use

The two general contractors interviewed noted that they used little to no prefabrication on their projects. The extent of their prefabrication use was limited to trusses, precast veneer, and structural steel. The electrical contractor has their own fabrication shop and responded that they are in the early stages of prefabrication, within the past 2 years. They primarily prefabricate assemblies consisting of pre-bent conduit, panel boards with stub outs, underground racks for conduit support, and hangar systems. Similarly, the fire protection specialist responded that they are also in the early stages of prefabrication and that most of the central coast still relies on traditional coordination. If prefabrication is effective, it will take the thinking out of the field and can result in 200% labor efficiency. This would require much more front-end coordination which is limited by the lack of effective BIM coordination on the central coast.

Central Coast Labor Shortage Effects

Unanimously, every contractor reported having extreme difficulty in finding skilled labor on the central coast, partly due to the cost of living driving the skilled labor out of the area. This leads to increased cost in skilled labor or a less experienced labor force filling the void, which extends a project's schedule and cuts into profitability. One trade contractor even reported that this leads to an environment where the need to out-perform others diminishes and creates complacency in the labor force.

Central Coast Location in Relation to Prefabriation

In addition to increased shipping costs, all contractors noted that the main problem in being located on the central coast was the general lack of knowledge of how to utilize the benefits of prefabrication. The technological advancement that is occurring in the main hubs of California such as San Francisco and Los Angeles has not made its way to the central coast, which makes it difficult for contractors to evolve and adapt prefabrication. In addition, most of the fabrication shops are in these two hubs which adds to the difficulty. Most contractors reported that they do not have their own shop, while a few have small ones or import from northern or southern California.

Other Challenges Central Coast Location Poses

Some other problems that location poses are that there are limited innovative solutions other than prefabrication due to location and technological advancement as previously discovered. The electrical contractor reported that they have no room to grow into being what one might consider a larger company. They mentioned that they have great relationships with both the community and the local contractors, however the amount of large projects is limited. A few smaller problems that a contractor reported were high gas prices on the central coast that add up quickly, high housing costs, as well as difficulty in obtaining equipment.

Conclusion

Through extensive interviews with central coast contractors, this research has revealed that prefabrication is in its early stages of development on the central coast. The negative labor shortage effects are intensified due to location as housing prices drive skilled labor out of the area, making the labor pool less competitive and forcing contractors to hire less skilled labor or pay a premium for skilled labor. As the central coast construction industry sits, prefabrication alone has not been shown to be a viable enough solution to alleviate the labor shortage on the central coast. In part, this is due to the lack of technological advancement on the central coast as well as the size of the market, which is too small to make prefabrication efficient. In order to make it effective, contractors may need to start building their own prefabrication shops and bridge the technological gap that limits their productivity.

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