

CASE STUDY: LEAN SUPPLY CHAIN MANAGEMENT IN CONSTRUCTION PROJECTS

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ABSTRACT

Researchers and construction professionals have adopted lean manufacturing concepts and strategies in the development of lean construction principles. Much of these efforts have centered on the field construction activities themselves. However, the ideology of lean focuses on the entire value stream of an operation from raw material to final product delivery. Waste and inefficiency is still evident throughout construction supply chains. The goal of this paper is to investigate improvement opportunities in the construction industry, utilizing the practice of lean supply chain management. A case study was conducted to achieve this goal and investigate applicability in the field. An assessment was done with a local contractor already familiar with lean. From this study came a number of findings and observations: differences between lean and non-lean fabricators and effects on construction, effective staging of materials. From these findings, improvement recommendations are prepared for future projects.

KEY WORDS

lean construction, supply chain management, just-in-time, collaboration

INTRODUCTION

It has been established that lean practice holds potential for improving construction. Since the early 1990s, lean principles and techniques adopted from the manufacturing industry have been examined for applicability in construction. The purpose behind this is to bring improvements to the construction process, similar to those seen in the manufacturing industry. Manufacturers have shown significant increases in productivity and quality, while reducing lead times. The

construction industry has not shown these improvements and lags behind others in technology developments. Researchers and those practicing lean construction in the field have made significant progress up to this point. However, much of the effort in developing and implementing lean construction has focused on field operations whereas lean focuses on the entire value stream of a construction operation. One area of this value stream where waste is still evident is with the supply chain. Members of this chain include manufacturers, suppliers, distributors and transporters. Often

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times these different business units work to satisfy their own objectives without considering effects of their actions downstream in the process. Dollars are wasted through ineffective supplier relations and transactions. Cox and Ireland (2002) quote, "construction supply chains have remained contested, fragmented and highly adversarial because of the conflicting nature of demand and supply." These inefficient supply chains, along with incorrect design information, are bottlenecks which are inhibiting flow in the construction process, causing a "road block" for further value generation. The strategy involving the integration and coordination among these different members of the supply chain is called supply chain management. The term lean supply chain management then arises when fundamental concepts of lean are included. According to the Diekmann report, "there is clearly a coupled opportunity to apply lean thinking to the supply chain and design and contracting processes to create what the Lean Construction Institute calls the Lean Project Delivery Process" (Diekmann, 2004). This is where more research is needed, in lean supply chain design and management.

The goal of this project is to investigate improvement opportunities in the construction industry, utilizing the practice of lean supply chain management. Expected benefits from such improvements include reducing project lead times, decreasing costs, improving quality, and decreasing variability.

CASE STUDY

PROJECT DESCRIPTION

In support of this paper, a lean study was conducted with an established

Cincinnati contractor, a regional medium size company focused on building construction. The group had been incorporating lean tools into their field operations and has successfully implemented Last Planner. The other tools they had been working to implement were Visual Workplace, Increased Visualization, Daily Huddle Meetings, Fail Safe for Quality, and First Run Studies/System Improvement Events. The company organized what they called an advanced lean team to facilitate the use of these tools. Along with continued development of these tools, their goal was in becoming a "lean enterprise" by incorporating improvement efforts into all other areas of their business. Field study was conducted on the construction site of a 12 story 410,000 sq. feet hospital research building and the time frame for involvement with this group was approximately five months. The general contractor (ContA) averaged about 10 staff and 25 labors on the project. Some of the other participating trades were the formwork subcontractor, rebar subcontractor, masonry subcontractor, miscellaneous metals fabricator and installer, exterior framing subcontractor, and exterior specialty/window/curtainwall fabricator and installer.

RESEARCH QUESTIONS:

- What could be pursued within the supply aspect of lean construction?
- How may these initiatives tie in with other tools currently in use?

ASSESSMENT

Fabrication:

The central focus of this part of the assessment was the application of lean manufacturing techniques in

fabrication shops. Two off-site fabrication shops supplying the job were chosen for the study, namely SubA and SubB. SubA utilized lean principles and SubB did not. SubA supplied the exterior cladding systems (windows, curtainwall, etc.) and SubB supplied all miscellaneous metals (ledge angle, beams, etc.). Both fabricators also handled field erection. Walkthroughs were taken of each fabrication shop. Business processes were discussed. Activities on site were then monitored to investigate material flow into the field and to see how lean and non-lean supply chains can have differing effects on field activity.

Logistics management of deliveries and inventories:

The central focus of this part of the assessment was JIT delivery and materials management on site. Materials for the building enclosure were looked at in detail. Quantities being delivered were determined. Times, schedules, and methods for these deliveries were monitored. The idea here was to find where JIT delivery of materials applies and where it does not.

OBSERVATIONS

Fabrication:

After visiting the shops, many differences were noticed between the two subcontractors. The first difference noted with SubB was the larger amount of product sitting in queues between processes. SubA implemented a quality control program which not only empowered employees to identify defects at their stations but also consisted of a formal procedure for improving quality through a measuring system. A quality tracking form for each job is kept with scoring

and employee sign offs. The only means of quality control seen with SubB was through daily inspection by the shop foreman.

SubA produced only to site demand in the quantity needed and at the time they needed it. For example, a production run would consist of all the punched opening windows for level one of the building. The next week, these windows would all be installed on the job site. On the contrary, SubB would produce in mass quantities. For example, a production run would consist of all brick ledge angle for the whole building, when all that is really needed for that next week is that for the first floor. Plant management did agree with the site installers that only portions would be brought to the site at a time, which was appropriate. However, all the rest of the ready angle has to be staged in the plant and sits until needed. This takes up space and results in carrying costs. The fabrication process maps for SubA and SubB are shown on Figures 1 and 2. In addition, SubA used lean thinking to utilize downtime. Any extra time was filled with assigned side work, such as hardware or mounts needed for installation. This work was not critical and could be done at anytime. Traditional means would show jumping ahead of schedule and moving ahead to the next job. This goes against lean principle.

More clutter was seen in the SubB shop as compared to that of SubA. SubA uses the lean philosophy of 5S, which focuses on organizing shops, eliminating unneeded items, dedicating a place for everything, and sustaining any improvements made. This was evident in the walkthrough.

SubA did have a relatively small number of suppliers and had one

primary for metal, glass, and rubber. With these few suppliers, they also had pull systems in place for how much and when they received materials. Inventory tracking forms were then maintained to compare ordered versus

received. SubB had a very large number of suppliers, whom delivered in bulk amounts. The fabrication comparison of the two subcontractors is given in Table 1.

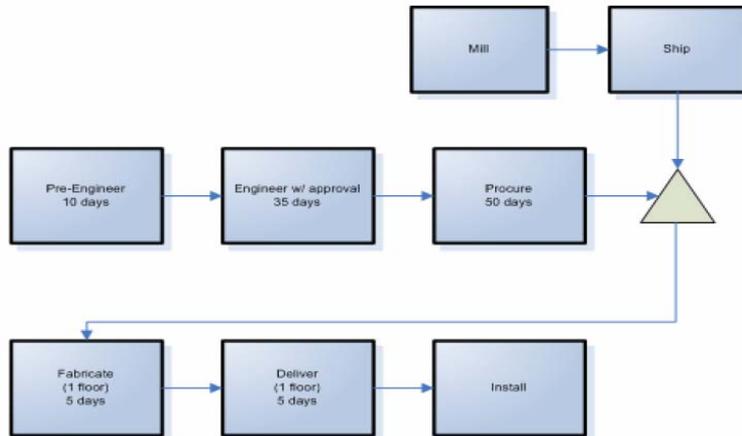


Figure 1: Fabrication Process Map for SubA- Punched Opening Windows

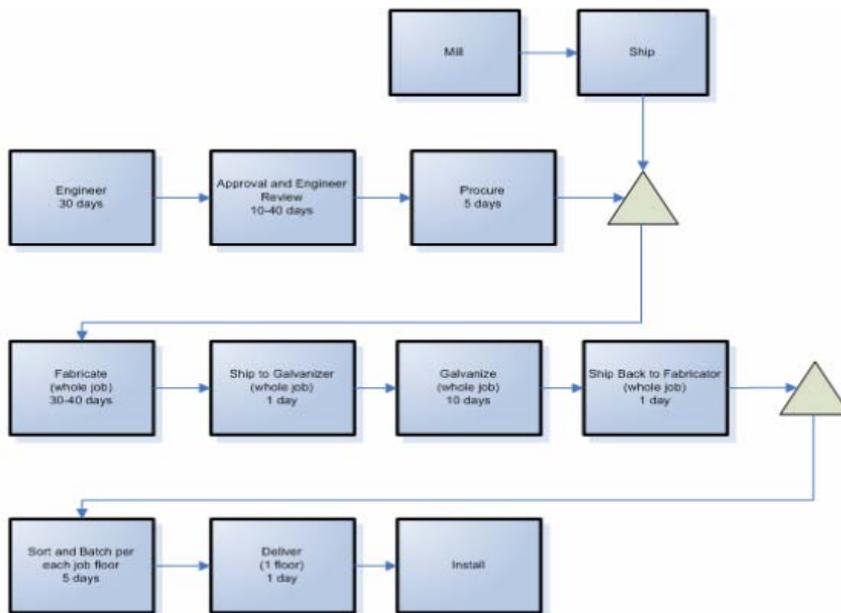


Figure 2: Fabrication Process Map for SubB - Brick Ledge Angle

Site activities with regards to these suppliers were also monitored and

observations were made. During the study one problem that arose was

delays from SubB in supplying the brick ledge angle. The hold up seemed to be at the galvanizer, which was the final step before shipment to the site. This lack of control in the supply chain is a common problem in the construction industry. On the other

hand, lean can offer improvements. SubA was just starting field installation at the conclusion of the study. No delays were seen with them and they seemed to be able to react relatively quickly to changes.

Table 1. Fabrication Shop Lean Comparison

	SubA	SubB
Lead Times	Shorter	Longer
Queues	Small if any between processes	Larger between processes
Quality Control	Formal program, Improvement	Final inspection by shop foreman
# Suppliers	Few	Many
Batch Sizes	Small, In job phases	Large, Whole job quantities
Inventory Control	Regularly, Tracking Forms	None noted
Visual Management	Obvious	None noted
5S/Workplace Organization	Effective	Lacking
Standardization	Computer shop drawings	Computer and hand shop drawings
Quick Changeover	Available	Lacking
Capacity	More flexible with demand	Less flexible with demand

Logistics management of deliveries and inventories:

The site used in this study was very organized and staging areas were very efficient. Three gates to the site were accessible. Deliveries were scheduled and routed to the tower crane, buckhoist (elevator near the tower crane), north staging area, or loading dock. A delivery board in the office was used to schedule deliveries. This situation gave everyone a visual of what areas and times were open for deliveries. Most material was brought into the north staging area. In many instances, materials being delivered were taken straight to the area of use versus just dropping them in the yard and letting them sit. This was accomplished by effectively coordinating delivery times, ensuring that pre-requisite work was completed, creating any space needed, and making needed lifts or machines available for moving materials.

Last Planner:

One goal of the study was to see how the initiatives of lean SCM could tie into the existing lean tools, technologies, or current practices utilized by ContA. The first tie noticed was through the Last Planner process. Material issues need to be drawn out more during the lookahead. Lead times and procurement dates must go into the phase schedules. ContA was seen pushing subcontractors to do this during the scheduling meetings. Just as the Last Planner process utilizes the theory of a pull system, materials need to be pulled from the suppliers (not pushed) to meet site demand. Material control must go hand in hand with the Last Planner meetings. This includes weekly communication between suppliers or fabricators and the site regarding material status. It is common knowledge that one of the biggest causes of construction delays is lack of material. These reasons for

variance from plan are tracked through the Last Planner weekly foreman meetings. By focusing more on inventory control and material lookaheads, and by trying to incorporate lean thinking into supply, improvements could be made and monitored through these variance charts.

RECOMMENDATIONS

Based on the observations from the case study following list of recommendations is prepared:

Fabricators and suppliers:

- For each job, a brief value stream assessment of each supply chain should be performed.
- Higher consideration should be given to fabricators that practice lean manufacturing in their shops during job bidding and
- Strategies incorporating lean principles with preferred and common fabricators, suppliers, or subcontractors in each market should be developed.
- New options for pre-assembly or pre-fabrication should be discussed with suppliers and fabricators.

Site activity:

- Lean supply concepts and inventory control should be incorporated into site planning by Organized and efficient usage of staging and lowering inventory levels and delivery quantities to an acceptable minimum.

- More real time feedback should be provided to the fabricators regarding status of the project on site.

Last Planner and Production

Control:

- Subcontractors' involvement with identifying material constraints and issues ahead of time should be increased during the lookahead process.
- Material variance tracked in Last Planner should be decreased.
- Items regarding procurement and material lead times should be included into the Last Planner reverse phase schedule (RPS).

CONCLUSIONS

This paper focuses on investigating improvement opportunities in the construction industry by utilizing the practice of lean supply chain management. This topic is an extension of lean construction theory and techniques. As a part of this study a field case study is performed with a local contractor. An assessment was done with the lean supply initiatives in mind; specifically fabrication, and logistics management of deliveries and inventories. Observations were collected from informational interviews, supplier shop visits, and construction site activity. A listing of recommendations was prepared. These recommendations consisted of improvement ideas in this arena and discussed how supply chain management concepts tie in with lean methods and other technology applications currently practiced and used by the contractor.

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