ADAPTING LEAN CONSTRUCTION METHODS FOR DEVELOPING NATIONS

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Abstract

The Construction Industry has traditionally been one of the largest in many developing nations. While other industries have greatly increased their levels of quality and performance, the majority of construction work is based on antiquated techniques, attended by supply-chain deficiencies and high defect rates resulting in wasted labor and materials. Estimates indicate that up to 30% of construction costs is due to inefficiencies, mistakes, delays, and poor communications. As global competitiveness increases, so will the expectation of higher levels of quality and productivity in constructed facilities. Several researchers (Howell, Ballard, O’Brien et al.) have shown that lean construction techniques reduce supply chain losses, reduce construction costs and shorten project delivery schedules. Nevertheless, the research is based on the type of supply chain infrastructure most frequently found in fully industrialized nations. This paper describes the obstacles to high performance, productivity and quality initiatives that often beset developing countries and proposes a framework for providing technical support for lean methods application in those environments, and for continuous improvement in the associated activities.

Keywords
Lean Construction, Just-in-Time, Supply Chain Management, Quality, Value Stream

1. Introduction

In the past 20 years, manufacturing industries have greatly improved their competitiveness through the use of lean methods such as Supply Chain Management and Just-In-Time techniques. Nevertheless, the majority of construction work is still based on antiquated techniques, especially in developing nations. Research has pointed to a significantly high level of wasted resources in the construction industry – both human and material; up to 30% of construction costs is due to inefficiencies, mistakes, delays and poor communications. These problems can be especially costly in developing countries, where a significant percentage of the materials and equipment are imported; mistakes in equipment orders can have major
cost impacts. Time delays may render projects especially susceptible to currency risks and inflationary factors. To be competitive in the global economy, there is a clear need for industry-government cooperation to increase the focus on research and development, and to provide more training for practitioners so that a new culture can be promoted in the construction industry.

2. Lean Construction

Lean construction maximizes value and reduces waste and applies specific techniques in an innovative project delivery approach including supply chain management and Just-In-Time techniques as well as the open sharing of information between all the parties involved in the production process. Lean manufacturing is an outgrowth of the Toyota Production system that was developed by Taichi Ohno in Toyota in the 1950s. Ohno identified seven wastes in mass production systems – overproducing, waiting time, transporting, processing itself, having unnecessary stock on hand, using unnecessary motion and producing defective goods. Very importantly, Ohno visualized a failure to meet customers’ needs as waste. Ohno’s thinking was to develop a delivery process that met customers’ needs with very little inventory. However, working without inventory meant that the production line had to speed up, and every person involved in that process had to improve their skills in order to accomplish the production targets.

3. Construction supply-chain management

The term supply chain encompasses all the activities that lead to having an end user provided with a product or service – the chain is comparable to a network that provides a conduit for flows in both directions, such as materials, information, funds, paper, and people. Studies by Bertelsen, 1993, indicated project cost increases of up to ten percent because of poor supply-chain design. Supply Chain Management (SCM) analyzes the impact of facility design on the construction process and enables superior project planning and management, avoiding the fragmented approach of other methods. Through SCM, all parties are kept aware of commitments, schedules, and expedites – all work as a virtual corporation that can source, produce, and deliver products with minimal lead-time and expense. SCM application needs to be tailored to the conditions in the geographic area and environment in which projects are executed.

4. Obstacles To The Adoption Of Lean Construction Methods

Many similar obstacles face the construction industry in both the developed and developing nations. In both arenas the concept of construction performance does not emphasize productivity and quality initiatives. The industry measures performance in terms of the following: completion on time, completion within budget, meeting construction codes. Very little attention has been directed to owner satisfaction as a performance measure.

Contractors typically hire subcontractors, who do not have contracts with the owner - even if the owner pays a high price, the subcontractor may still have to work with inadequate budgets, often compromising quality as a result.

Communication tends to be via the contract, and is limited. The designer is paid to produce a design expressed in the form of specifications and drawings. The contractor is expected to use these as a means of communication, and produce the completed facility. This communication often does not work as well as it should.

Innovation moves slowly; contractors in developing countries often lack the expertise or financial resources to adopt technological advances - adoption is inhibited further by fear and uncertainty. Roofing
contractors, for example, tend to use the same time-honored methods to ensure that supplies and equipment are on site each day. Expediters, at additional cost, deliver items that are frequently forgotten.

Owners have not specifically demanded productivity and quality. There is lower emphasis on productivity/quality awareness in developing countries among all parties, including owners. Owners have come to accept industry pricing

Few large companies, and virtually no small companies have implemented the concept of a quality or productivity manager – the traditional approach is to depend on the experienced staff to run projects efficiently; such staff are rarely if ever trained in optimization techniques.

There is little, if any, benchmarking - many manufacturers and service organizations have become pre-eminent by adopting the best practices of benchmarked organizations. Construction has done very little of this; construction professionals guard their trade secrets very closely, due to distrust, fear of losing competitive advantage, but more likely, simply by being anachronistic.

5. Implementation Issues

It is important to carry out extensive planning at the very beginning of any project in order to accomplish lean construction. The design process should include not just the facility design but also the design of the construction process itself. The project is subdivided into activities as in a manufacturing process, potential conflicts are identified during the design stage, and solutions are considered that will avoid wasting resources in the future. This planning function is markedly different the traditional planning related to budgets and schedules.

For effective deployment of corrective measures, the following inhibitors need to be borne in mind: Many projects have waste and problems in the supply chain. However, this is often invisible as separate parties focus on their immediate responsibility and act in their own self-interest. Problems tend to arise in early phases of supply chain, and waste is caused mostly by parties to construction that often are not alerted to the consequences of their actions.

Comparisons with previous research (Jarnbring (1994) on supply chain management of construction projects in Sweden indicated a potential for cost savings of 10% to 17% - due to inefficiencies caused by lack of coordination between contractors and suppliers. Koskela and Leikas 1997, observed a typical shortcoming in the industry resulting in excessive variation – construction components often ordered with incomplete or missing information.

6. STRUCTURE OF THE PROPOSED FRAMEWORK FOR LEAN METHODS IMPLEMENTATION AND MANAGEMENT

Figure 1 illustrates the proposed framework. The parties to construction projects, i.e., owners, designers, and contractors (as well as their suppliers) are illustrated in four rectangles at the top of the page. The success of lean methods approaches is highly dependent on having a cohesive team working toward congruent goals and objectives. To accomplish this, a partnership relationship would be needed; it could be formalized with a binding legal agreement, or at least, the parties could informally resolve to maintain an amicable relationship. Both information and transactions would flow between the parties, as represented by the arrows. A web-based or web-enabled information system would provide far more rapid information flow than is available with paper-based construction management systems. In the model, Government agencies, depending on the region and on applicable policies could provide critical support to make lean methods feasible. Monitoring of inflation risks and pricing levels could provide the stability that organizations need in order to make lean methods feasible. Uncertainty and fear
cause organizations to conceal information instead of sharing it, as is required to make lean methods feasible.
The vertical block at left illustrates a number of support mechanisms. This support system must include professionals who have a thorough understanding such techniques as supply chain management, Just-In-Time principles, value stream mapping, quality-based continuous improvement, and Post Occupancy Evaluation. Most of these techniques lie within the skill set of industrial engineers. It is therefore proposed that one or more industrial engineer(s) or related professionals be appointed to the position of Lean Methods Expert (LME). They could be hired on a project basis, or in the case of large contractors or developers, shared between several projects.

7. CONCLUSIONS AND RECOMMENDATIONS

Lean construction may require more time in the design and planning phases, but this attention eliminates or minimizes conflicts that can dramatically change budgets and schedules. The concept of design for production should be implemented, using design consultants with relevant expertise.

Partnering should be promoted to maximize team building and development of trust.
Members should be empowered in decision-making to make these partnerships meaningful.

A positive aspect of developing nations that promotes lean construction is that they have a less litigious environment than does the USA, and disputes tend to be resolved by negotiation processes. On the other hand a survey of cost inflation in the Caribbean Basin pointed to a monthly inflation rate of as much as 2 – 3%, and in some cases 5% and over.

Each member of the construction supply chain should be made aware of its influence on the overall project. Efforts should be made to gradually change the cultural approach to projects to improve effectiveness. For example, Mario Fiallo and Victor Revelo (2002) observed that in Ecuador it is difficult to introduce new construction planning and control systems. Contractors have a tendency to focus on finishing tasks as opposed to devoting more time to planning that would avoid the waste and misuse of resources in the overall project. This is probably true of some professionals in other regions as well.

Information systems should be upgraded to make maximum use of Just in Time techniques by providing instantaneous information to all involved parties. Internet-based technology should be used to provide seamless communication regardless of differences in hardware and location.

Total Quality Management approaches should be introduced in the design process to improve design accuracy and contract document information to contribute more effectively to the value adding process in the construction supply chain.

Facility design should be performed with supply chain performance in mind as design factors drive performance. Design choices should favor appropriate technologies. Materials and components should be selected that best meet the needs of the supply chain discipline.
FIGURE 1 LEAN CONSTRUCTION INFRASTRUCTURE

- Lean Methods Support
- Supply chain management
- Electronic Commerce
- Post Occupancy Evaluation
- Safety Management

Authorized Architect
- Program management
- Selection of design methodology
- Selection of constructive method
- Selection of project delivery method

Owners

Contractors
- Sub-contractors

Suppliers
- Equipment
- Materials

Worldwide web-based information management system

Information Flows

- Government Agencies
  - Monitoring of inflation risk
  - Price controls
  - Code enforcement

- Banks
  - Funding sources

Owners
Based on the experience of the authors, project managers in the developing countries could benefit significantly from formalized training in project management skills. This is especially true for engineers, architects and other professionals working in governmental organizations. Most mega projects in developing countries are conceived, planned and funded by public sector agencies, which are manned by staff that are critically unfamiliar with the tools, techniques and methodologies of modern project management systems. It is therefore suggested that proper education and training models be first developed. Developing nations countries have special needs and specific challenges. The implementation model must be robust enough to take into account the cultural, political, social, environmental and economic attributes of the particular developing nation.

REFERENCES


