IMPORTANCE OF PARTNERS IN A CHALLENGING LEAN JOURNEY

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ABSTRACT

If a general contractor were to implement the Lean system on a construction project, the most important factor to the success of the project would the subcontractor's ability to implement Lean. The focus of this paper is team building in the project to improve Lean performance. This paper presents GS E&C's (Engineering and Construction, the general contractor) pilot projects for production control, where Lean construction was implemented in a construction project with its subcontractors. In Korea, GS E&C is one of the leading companies using Lean construction in the construction industry. The findings of GS E&C's pilot projects indicated that in a construction project, it had had trouble with production controls without subcontractor support. Another project showed that Lean was more successfully implemented when the subcontractor had strong Lean implementation experience and capability. This resulted in a new challenge for the general contractor – how to build relationships with subcontractors and improve their capabilities to implement Lean construction.

Active involvement in the entire construction process, enthusiasm for, commitment to, and motivation for implementation, and keeping an open mind about the changes, were all found to be very important when implementing Lean construction by both general contractor and subcontractor. This paper also discusses the prerequisites and barriers to the implementation of Lean with its subcontractor in Korean construction projects. These pilot projects investigate the possibilities of achieving closer alignment between GS E&C and its subcontractors. Such alignment may be achieved by implementing Lean production principles not only within, but across organizational boundaries.

KEY WORDS

Lean IT system, team building, subcontractor, and case study.

INTRODUCTION

Lean construction is an innovative way to manage construction projects (Kim, 2003). Most research tends to ignore the Lean capability of another stakeholder in the project. There are a lot of stakeholders in construction projects, and they all have their own interdependent roles. In Lean projects, it is more effective to have open minds and active

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participants. In order to maximize the value of the output, Lean construction emphasizes improvement of relationships among project stakeholders.

Lean construction will largely influence a lasting Lean change in the construction industry not from the top down, but from the bottom up (Miles, 1998). This paper describes organizational issues addressed by general contractors attempting to introduce Lean construction practices and techniques to subcontractor companies, some of which were Lean-ready[5], and others of which were not.

Implementation of Lean construction by a subcontractor is important for several reasons. The subcontractor has a different role in the production system than does a general contractor. The latter's role is primarily to coordinate production, but the production itself is done by the subcontractors, even if they are directly employed by the general contractor (Tommelein and Ballard, 1997). Lean can augment traditional methods to include what the owner wants while improving the bottom line for the stakeholders involved (Koskela, 1992; Howell and Ballard, 1994). A strong relationship and active communication among the stakeholders, especially between the general contractor and the subcontractor, are essential to achieving satisfactory results.

This paper provides an overview of the implementation activities and then focuses on organizational and management issues faced by the general contractor and subcontractors during the pilot projects. The organizational approach of each of the companies is described with their successes and failures. Clearly, each organization has had different levels of success in each pilot project. This paper discusses some of the main aspects of the organization that have impacted project activities. These findings are compared with others reported in the literature in an effort to identify the ingredients of the most successful strategies. Also, this paper will discuss some of the tools and methods or "Best Practices" that are shaping the Lean approach to reducing waste and adding value in the delivery of capital projects.

THE REQUIREMENTS OF SUCCESSFUL LEAN IMPLEMENTATION

COMMITMENTS

A greater degree of participation permits reaching higher levels of commitment (Alarcon and Seguel, 2002). It is worth noting that where general contractors (or customers) gave clear and positive directions about how Lean principles and tools should be implemented in the project, more successful implementation was achieved. Subcontractors that had been given a clear and concrete commitment from general contractors already obtained benefits from Lean implementation.

Also, the leadership of the general contractor has been critical for Lean implementation (Alarcon and Seguel, 2002). With solid leadership in the project, it has been possible to overcome various barriers to Lean implementation.

The GS E&C (general contractor) employed Lean implementation commitments. The CEO of GS E&C had a strong commitment to Lean. He led the daily Lean strategic meetings, provided continuous training sessions for all stakeholders, and sponsored seminars with lecturers experienced in the field. The equivalent of $50 million was invested the Lean system for GS E&C.

[5] Lean-Ready means; the company has the ability to production control directly, such as its own manual for Lean implementation, multiple experiences of Lean implementation, and its own Lean training team. Consequently, the company has enough Lean capability for the implementation of new theory.

INFORMATION TECHNOLOGY SYSTEM SUPPORTS

In construction research and practices, one important topic is information technology (IT), the operation of which may reduce the need for collecting some types of information about the market, or, more likely, may reduce the overall cost of gaining information (Porter, 1980). Construction practices have not been appreciably influenced by IT (Vaidyanathan and O'Brien, 2003). However, GS E&C has achieved a fine level of production control using Total Project Management System (TPMS).

Many companies have tried to develop project management systems. However, not many cases exist in which these systems have been implemented with subcontractors. The findings indicate that the cost reduction, task standardization, and real-time information-sharing using TPMS increase efficiency in working with the subcontractor. GS E&C is carrying out joint efforts to implement Lean practices that will lead it to gain improved competitiveness in the market.

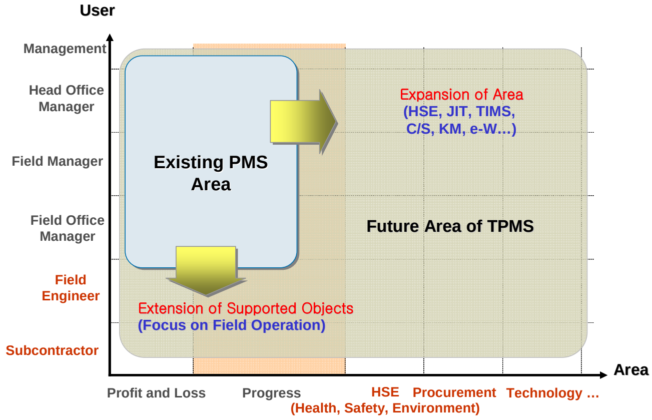

Figure 1. The aim of the Total Project Management System (TPMS) through Digitization of Project Information

The TPMS system supports field engineers and subcontractors who are managing work processes. Traditionally, work management systems have controlled profit and loss rather than work processing. Hence, it did not quite help a field engineer and subcontractor to perform field work.

TRAINING PROJECT PARTICIPANTS

The GS E&C has established training courses, and regularly trains and tests everyone including executives, on the basic concepts of their Lean implementation. The implementation of Lean is one of the criteria for the evaluation of the subcontractors of each project. The criteria of performance measurements are the level of Lean implementation, the level of application, the adaptation of the basic Lean concepts by the general contractor's Lean task force team (TFT). A TFT promoting Lean implementation is critical when efforts have been spread out over more than one project. Due to the hierarchical organization that characterizes the Korean construction industry, the Lean TFT is very important in the implementation process.

From the implementation of Lean until the present, GS E&C has provided Lean implementation training sessions. Sessions consisting of eight hours of training on Lean construction and its systems were given to 1,848 of their employees and over 3,800 employees of their subcontractors. This is an ongoing process.

SUBCONTRACTING

Cooperation with preferred subcontractors appears to be an advantageous way of encouraging Lean implementation in projects. Such projects, organized together, achieve cooperative, far-reaching, better results than they would obtain individually.

Subcontracting has been presented as an organizational alternative for some economic activities (Beardsworth, 1988; Shimizu and Cardoso, 2002). Firms are decentralizing their jobs more and more, allowing subcontracting to become a basic part of the work organization. In Korea, it is common for 80~90% of the construction work to be performed by subcontractors (Kim, 2002). In GS E&C construction has a preferred list of stakeholders; this is useful for establishing strong and ongoing relationships with them.

PERFORMANCE MEASUREMENT

In the past the general contractor has measured the subcontractor performance in the production system by result based Earned Value Method System (EVMS) (Kim and Ballard, 2001). This means they focused on the project cost of the subcontractor's work performance. However, under the Lean system the object of measurement shifted from the result to the project itself (workflow reliability). It is in line with Toyota's focus on metrics which is measure by means (MBM) rather than measure by results (MBR) (Kim and Ballard, 2005).

By measuring the subcontractor's performance based on their TPMS system, GS E&C emphasized the handoff of trade work to reliable subcontractors in order to increase workflow reliability.

INFORMATION SHARING

All activities require information to be processed. Information is required before activities can be started and each activity produces information once it is completed. Understanding the flow of information is therefore fundamental to planning and doing work. If we can track and control information rather than monitor activities, we can ensure that the right people have the right information at the right time. When this does not happen, we can pinpoint the source of the difficulty.

A systematic routine that was based on daily planning meetings held in order to coordinate with all of the project participants was a key ingredient. Another was well-defined IT support. Due to the high number of stakeholders involved, building a utilitarian IT system is very difficult. (Vaidyanathan and O'Brien, 2003). Thus, these activities should become part of the prerequisite steps for a successful Lean journey.

PILOT PROJECTS

Pilot projects were focused on the application of Lean construction production control practices to GS E&C (general contractor) with its first tier subcontractors. In this paper subcontractors with strong Lean experience were compared to those which do not and investigated the possibilities of achieving closer alignment between the general contractor and its subcontractors. Such alignments might be achieved by implementing Lean not only within but also across organizational boundaries.

The general contractor could provide a state-of-the-art Lean IT system but the result would not be valuable without the subcontractor's active participation, and full understanding of Lean. Also, the general contractor would need to provide continuous training and technical support.

Metrics

The general contractor announced to subcontractors that the Percent Planned Completion (PPC) and Reasons for Non-Completion[6] (RNC) would be the subcontractor performance measurements of commitment reliability during the pilot projects. Daily, PPC was checked in work meetings, and subcontractors were able to choose the RNC among the eight reasons in the system portal.

Cases

The pilot projects that were implemented by GS E&C were the Nam Chun highway project (Case A; with subcontractor's support) and the Seoul Ring-Road project (Case B; without subcontractor's support).

In Case A the company has had strong Lean implementation experience. The company had its own Lean implementation team in the head office which trained all members continuously. Also, the CEO of this company had a strong commitment to Lean implementation, thus most members visited the Toyota Motor Company in Japan to see its Lean activities. The company implemented the Last Planner System in 2005 and extended the LPS to all of the projects in 2006. The company also has its own standardized work process for all of its work series. In Case A the company used Lean to combine with its own Enterprise Resource Planning (ERP) system for managing costs and for production planning. Also, in this pilot project, the company trained its second tier subcontractors and induced them to participate in weekly planning meetings.

On the other hand, in Case B the company was experiencing Lean for the first time on this project, and was not actively involved in the meetings or training sessions during the pilot project. Furthermore, the company was inefficient because it was highly bureaucratic. Finally, the company was used to the traditional push system for production control.

[6] Reasons for Non-Completion of plan (RNC): Reasons that weekly assignments planned were not completed. The RNC of the PPC were: (1) poor planning (over-commitment), (2) failure of predecessors, (3) interference between subcontractors, (4) lack of workers, (5) weather, (6) changes order, (7) multi-usage/defects in equipment, and (8) materials

Table 1: General Description of Project and Lean Implementation Activities for Each Pilot Project

Activity	Case A	Case B
Pilot Project Period	Oct., 2006~Dec., 2007	April, 2005~ June, 2005
Project Type	Highway (4 Lanes)	Road (4 Lanes)
Data Collection	PPC, RNC, EVM	
Training (from GC)	Process Mapping workshop (5 days) Lean Implementation Workshop (1day)	
Training (from Sub itself)	Last Planner Workshop (1day, quarterly per year)	None
Planning Meeting (with GC)	Daily(20 minutes, in GC's office) after 4PM	
Participants in Daily Meeting (with GC)	Project Manger, Scheduler, Field Manager	Only the Project Manager
Planning Meeting (Sub itself)	Daily (20 minutes) at 8AM	Occasionally if needed
	Weekly (1~2 hour(s)) Fridays	None
Participants in Meeting (Sub itself)	All of Project Participants	Head Person in Department
Planning Process	SC does the weekly planning draft GC confirms	GC does the weekly plan
Lean Implementation Task Force Team	Exists in the Head Office (Training, Performance Measuring)	None
Implementing Lean Tools and Methods	Last Planner System, Standardized Work Procedure	None
Year in Lean Journey	2005	None

PILOT PROJECTS FINDINGS

The subcontractor in Case A performed well; all members from upper to lower management participated in training and organizational activities. Office and field managers and foremen participated together in implementation workshops. All project participants must identify attributes needed to implement Lean, in order to maximize fully the value of using the general contractor's state-of-the-art IT system. In Case A, there were 87 failures that occurred. The average PPC of Case A was 77.8%; weather was the major reason for non-completion of planned work. From day 14 to day 40 (week 2~week 6), the PPC was lower relatively than after day 40; possible reasons were that there were some change orders from the owner of the project. During the evaluation of the project, the importance of the subcontractor's (Case A's) Lean experience, and the support of the general contractor in the implementation became evident. The PPC and RNC rates showed the performance improvement. In Case A 5% of its budgeted cost was saved, and its schedule performance index improved 11% of during the period.

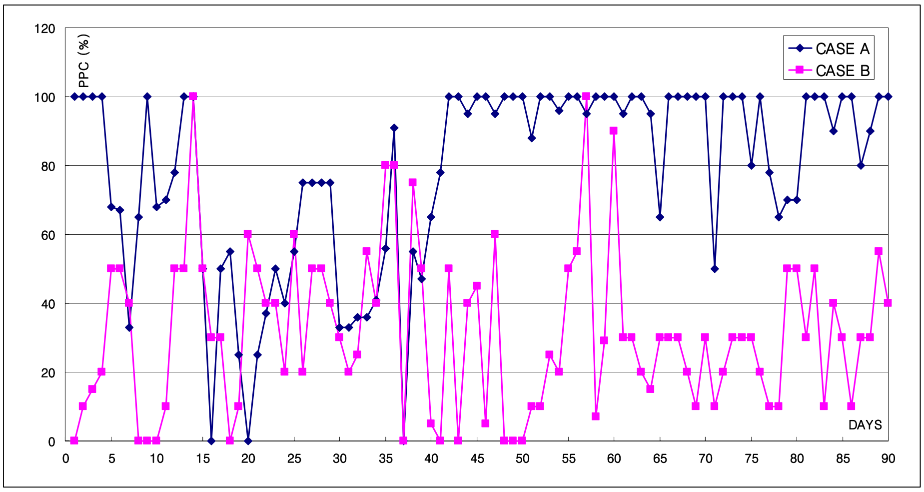

Figure 2. PPC Chart for Each Project for Pilot Project A and B

Table 2. Reasons for Non-Completion Planned Work Pilot Project A and B

	Planning		Failure of Predecessor		Interference between SCs		Workers		Weather		Change Order		Equipment		Material		Total	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
W1	1	7	1	3		1			1	3	1	2		1	1	4	5	21
W2		4	1	2		1		2	2	2		3	1	3		2	4	19
W3	2	7	2		1		2	1		1	3	4	1	1	2	3	13	17
W4		5	1	2	1	3	2		4		1	1	2	2		3	11	16
W5		4	2	3			2	3	1	2	3	3	2	1	2	1	12	17
W6		6		2	1	3	1	2	1	1	1	3	1	4	2	4	7	25
W7		8		2		1	1	3		2	1	1	1	3	1	4	4	24
W8		7	1	4		4		3	1	1	1	3		5	1	5	4	32
W9		3		7	1	5	1			3	2	5	1	5		5	5	33
W10		7		5		4		3	2	6		5	1	7	2	8	5	45
W11	1	9	1	8	1	7	1	6	3	2	1	2	1	1		7	9	42
W12		11	1	7		2			2	1		5	3	4	2	5	8	35
Total	4	78	10	45	5	31	10	23	17	24	14	37	14	37	13	51	87	326

The subcontractor in Case B did not meet expectations. In Case B, 326 failures occurred. The average PPC of Case B was 31.5%; poor planning (over-commitments) was the major reason for non-completion of planned work. These results show that to achieve a good Lean implementation, the project needed adequate subcontractor Lean implementation capability and continuous support by the general contractor. The reasons for unsatisfactory results in Case B are as follows:

- The reasons for lower PPC
  - Over-commitments: the planner over-scheduled habitually on the weekly work plan
  - Constrained work: the make-ready and shielding processes were incomplete, work was pushed downstream
  - A lack of resource management: the level of inventory fluctuated inconsistently
- Planning performance
  - Daily PPC was checked, but there was little or no follow through on the plan
  - When behind schedule, fire fighting activities continued

  - There was a lack of responsibility toward executing the Lookahead Plan
  - There was a lack of standardization of work processes
- Unwillingness to shift the paradigm
  - Not understanding that downstream trades are the customer (too narrowly focused on current work)
  - There was a lack of analysis of uncompleted work, constrained tasks, and reasons for failure (lack of continuous improvement)
  - There was a lack informational transparency: attempted to solve constraints without sharing information

DISCUSSION

SUPPORT FROM SUBCONTRACTORS

The pilot projects showed that there is an increased need for subcontractors' actively to support Lean. The collaborative approach to the project seeks to guarantee learning among the participants in the project and to facilitate the transfer of research and implementation results to the participating firms. Active involvement in the entire construction process, enthusiasm for, commitment to, and motivation about implementation, and keeping an open mind about the changes, were all found to be very important when implementing Lean construction.

A greater degree of participation permits reaching higher levels of commitment. A commitment with upper management can be observed both cases. However, in Case B, the leader did not clearly understand the implementation of Lean in the project, just followed the general contractor's implementation, and was not actively involved.

SUPPORT FROM THE GENERAL CONTRACTOR

Strong Lean commitment from the general contractor is necessary for successful implementations. Communication with, and support and training of, the subcontractors are important factors in the environment. The general contractor provides training and guidance for the implementation of the Lean methodologies to its preferred contractors. By giving these types of support, the general contractor can reverse the subcontractors' reluctance to implement Lean. Training improves inside an organization and generates greater participation in and commitment to Lean implementation. In Case A, the training workshops were conducted by the subcontractor who was given training materials and an IT system by the general contractor. This working relationship has really been a contribution and has facilitated the implementation of improvements.

BUILDING CAPABILITY OF SUBCONTRACTOR

In order to have a high quality Lean implementation, the subcontractor's lean knowledge and capability must be high. To build the subcontractor's capability, the general contractor needs to invest both effort and capital.

The purpose of production control is to make a reliable workflow, which is a basic lean principle (Liker, 2004). The case study results suggest that the performance of the production control system depends on the capability of the subcontractors because the subcontractors directly control project production. The higher the PPC, the easier it becomes to implement other lean practices, as PPC is the measure of workflow reliability.

The subcontractors' lean capability in Case A has shown how effective production controls are.

THE NEED TO IMPROVE THE BIDDING PROCESS

Under the current bidding system in the Korean construction industry, the lowest bidder is at an advantage. So when implementing Lean, the lowest bid system needs to be taken into consideration. However, the general contractors need to adapt the bidding system to account for workflow reliability because this is a value-added activity.

PROJECT ALLIANCE

A strategic project alliance with its subcontractors is a factor in increasing competitive advantages in the construction industry (Shimizu and Cardoso, 2002). A cooperative network among companies operating within the same production chain can create a synergy of positive impacts, or the so-called collective efficiency (Amato and Neto, 1999).

Lean implementation contracts are set up before the start of projects and are a very important factor in Lean compliance by all the stakeholders. The contractual relationship helps to clarify each stakeholder's obligations.

CONCLUSIONS

The successful implementation of new practices in construction companies requires the rigor and discipline of a well-established organization.

Lean construction implementation holds great promise for the further development of construction as an industry by increasing efficiency and streamlining processes. As construction processes rely heavily on cooperation and coordination, examining new ways that project participants could communicate and form relationships is vital to the advancement of the construction industry. The lessons learned so far have been very useful to help some of the companies improve their ability to learn from one another, and the way in which they approach implementation.

Some of the conclusions of the pilot project can be summarized as follows:

- The higher the subcontractor's Lean capability, the better the production control.
- The leadership and commitment of upper management are important to ensuring successful implementation.
- The general contractor's continuous support of the subcontractor is necessary.

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REFERENCES

Alarcon, L., and Seguel, L. (2002). "Developing Incentive Strategies for Implementation of Lean Construction." *Proceedings of the 10th annual conference, International Group for Lean Construction,* Gramado, Brazil.

Amato N. (1999). “Productive Cooperation Networks as a Competitive Advantage for Small and Medium Size Firms in the State of Sao Paulo (Brazil).” *44th International Conference of Small Business,* Naples, Italy.

Beardsworth, D. (1988). “Management, Transience and Subcontracting: the Cases of the Construction Site”. *Journal of Management Studies*, ASCE, 25(6), 603-625.

Howell, G., and Ballard, G. (1994). “Lean production theory: Moving beyond ‘Can-Do’”. *Proceedings of the 2nd Annual Conference of International Group of Lean Construction*, Santiago, Chile.

Kim, D. (2003). “Guidelines for Implementing Lean Construction”, *J. of the Architectural Institute of Korea*., AIK, Seoul, Korea, v.19 n.9(2003-09)

Kim, Y. and Ballard, G. (2001). “Activity-Based Costing and Its Application to Lean Construction”. *Proceedings of the 9th annual conference, International Group for Lean Construction*, Singapore, Singapore.

Kim, Y. and Ballard, G. (2005). “Management Thinking Behind Performance Measures”. *Proceedings of the 1st International Conference on Construction Engineering and Management*, Seoul, Korea.

Koskela, L. (1992). “Application of the New Production Philosophy to Construction”. *Technical Report # 72*, Centre for Integrated Facility Engineering, Department of Civil Engineering, Stanford University, CA.

Liker, J. (2004). “The Toyota Way.” *Mcgraw-Hill*. New York, NY.

Miles, R. (1998). “Alliance Lean Design/Construction on a Small High Tech Project”. *Proceedings of the 6th annual conference, International Group for Lean Construction,*Guaruja, Brazil.

Porter, M. (1980). “Competitive Strategy: Techniques for Analyzing Industries and Competitors.” *The Free Press,* NY. Reprinted in 1998

Shimizu, J. and Cardoso, F. (2002). “Subcontracting and Cooperation Network in Building Construction: A Literature Review.” *Proceedings of the 10th annual conference, International Group for Lean Construction,* Gramado, Brazil.

Tommelein, I.D., and Ballard, G. (1997). “Coordinating Specialists”. *Technical Report No.97-98*, Construction Engineering and Management Program, Civil and Environmental Engineering Department, University of California, Berkeley, CA

Vaidyanathan, K., and O’Brien, W. (2003). “Opportunities for IT to Support the Construction Supply Chain” *Proceeding of Towards a Vision for Information Technology in Civil Engineering 2004, ASCE, P1~19.*