A CASE STUDY ON REBAR SUPPLY CHAIN MANAGEMENT BY GS E&C

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ABSTRACT

In the past it has been difficult to implement lean supply chain management in construction because one entity does not have control over an entire supply chain. This research investigates supply chain practices at GS Engineering & Construction in Korea.

The purpose of this case study is to explore the lean application on rebar supply chain management practice at GS. The paper discusses vertical integration in the supply system to reduce lead time and to improve a supplier's reliability. It also discusses production control system and task standardization for a contractor's planning reliability.

KEY WORDS

Supply chain management, rebar supply chain, lean construction, case study, vertical integration, task standardization

INTRODUCTION

Lean transformation is not a set of tools or methods but a continual process toward lean objective, which is to maximize value and minimize waste (Diekman et al. 2004). The paper introduces a story of lean transformation that one general contractor experienced. This research investigates supply chain practices at GS Engineering & Construction in Korea. GS has its own engineering sector, design sector, and construction sector. GS E&C in Seoul, Korea, was established in 1969 and has grown remarkably as a world-wide general contractor ever since. The range of construction activities has expanded into large-scale development and public projects, laying the groundwork for growth. Sales were robust in all five sectors, boosting total sales 39.1% from just under $4.05 billion in 2004 to more than $5.63 billion in 2005. GS has a diverse business portfolio that includes civil engineering ($0.73 billion, 13%), industrial ($1.037 billion, 18%), environment ($ 0.312 billion, 6%), commercial building ($ 2.203 billion, 39%) and housing ($1.349 billion, 24%).

GS started its lean journey with a focus on the rebar supply chain. Their started by applying JIT (Just-In-Time) to rebar supply, but found that sites were too unpredictable in their readiness for deliveries. As lessons were learned from pilot projects, GS finally implemented vertical integration in rebar supply and the Last Planner System on site production system to improve supply chain performance.

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The purpose of this case study is to explore the application of lean principles and methods to rebar supply chain management at GS. The study focuses on vertical integration of the supply system and the use of production control to improve site demand reliability.

LITERATURE REVIEW

In the construction industry, increasing numbers of construction organizations have started showing a realization towards the importance of supply chain management concept (Akintoye et al, 2000; Vrijhoef and Koskela, 2000; Dainty et al 2001a). However, unlike retail and manufacturing sectors, the construction industry has been slow and reluctant in employing the concept of supply chain management (Love, 2000).

Vrihoefi and Koskela (1999) showed that waste and problems in construction supply chains are extensively present and persistent, and most problems are due to interdependency largely interrelated with causes in other stages of the supply chain.

Polat and Ballard (2003) presented supply chain configurations for rebar and detailed the causes of problems throughout the supply chain. They (2003) asserted that the problems are caused by fragmentation in the construction industry as well as lack of awareness of the supply chain management concept.

BACKGROUND ON LEAN IMPLEMENTATION: LESSONS LEARNED FROM PILOT PROJECTS

The lean journey began when the management of GS recognized the enormous waste of materials on construction sites. For instance, GS usually had a rebar inventory of three to four weeks on construction sites, which increased holding costs and exposed the material to corrosion and theft. In response, the company began development of an advanced inventory management system.

In the beginning stages of system development the only concern was effective inventory management, and Just-In-Time (JIT) was introduced to inventory management system as the part of the solution. The JIT implementation task force team was organized to adapt JIT to GS, followed by pilot projects where JIT delivery of rebar was tested. However, the test revealed that JIT should be preceded by alignment between supply and demand systems to assure on-time delivery of information and materials to project sites at the least cost and maximum value.

Suppliers who provided prefabricated rebar usually had three weeks lead time and the delivery time was only 65%. In the new supply system, GS needed to reduce lead time and make delivery predictable. In the supply chain system, the buyer is a construction production task which creates demand. The order should be placed based on production demands. However, demands were not predictable enough that the order could be placed based on daily or weekly schedules. Rather orders were placed for 3-4 weeks of material at least a month ahead.

APPROACH TO IMPROVE SUPPLIER'S RELIABILITY

GS vertically integrated with a rebar fabricator and established the GS-BAS system for reducing lead time and improving reliability.

GS-BAS (BAR BENDING AUTOMATION SYSTEM)

GS-BAS systematizes all processes related to reinforced concrete work, which represents 20~30 percent of the cost for most construction projects. This integrated CAD system lowers cost by minimizing rebar consumption and raises work precision. GS E&C developed an automated program for calculating material quantities and preparing detailed shop drawings. This system automates shop drawing preparation, material quantity calculation, procurement, and on-site project management. The GS-BAS has raised both the quality and productivity of on-site rebar work. The system is linked with the production control system and managers on project sites can access the system through intranet. The process of review and approval can be done quickly in the same system. The study found that the time for engineering design, review, and approval was reduced from two or three weeks to two days (Figure 1).

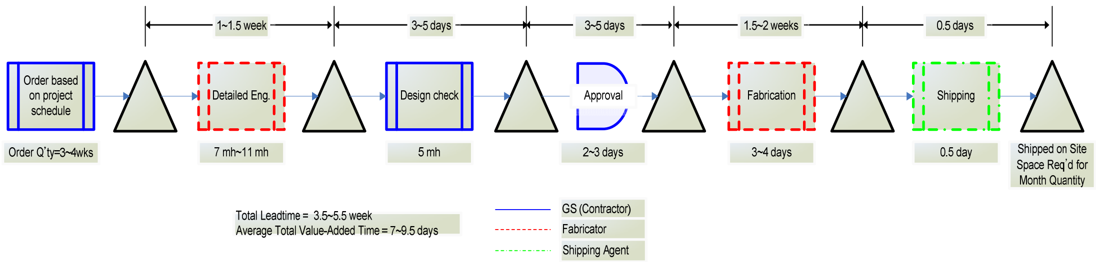
REBAR PROCESSING PLANTS FOR VERTICAL INTEGRATION

The goal of the rebar processing plants is to reduce supply lead time, meet the exact specifications of the reinforcing process, eliminate the space for inventory loading and field working, and manage the material effectively. There are suppliers who provide pre-fabricated rebar. GS had worked with some of their suppliers. However, JIT delivery requires tight coordination between suppliers and buyers. Collaboration between production control and rebar supply was not achieved until GS established its own rebar processing plants.

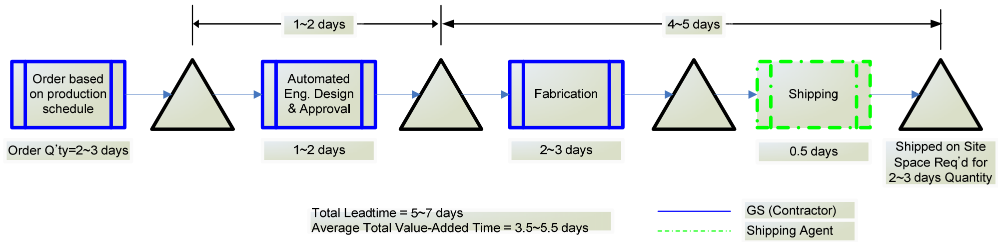
In 2005, GS established rebar processing plants in both the Seoul and Pusan areas and they have supplied rebar to 15 GS construction sites. The plant is equipped with fully automated machines. The rebar was distributed through a JIT process and the plan is to expand this operation for all construction projects company-wide. The construction sites and the rebar processing plants cooperate through the rebar processing plant operating system. Figure 1 shows previous and current value stream mapping for rebar fabrication. The total average lead time was reduced by 3.5 weeks after a new approach was adopted. The total lead time is a time that includes processing time, waiting time and set-up time.

Total Lead Time = Processing Time + Waiting Time + Setup Time

As seen in Figure 1 the value adding ratio was calculated as Total value adding time / Total lead time, and was only 25 % before a new approach was implemented. The waiting time and set up time was reduced mainly because (1) they merged the processes regarding engineering (i.e., detail engineering, review, and approval) into one process through the automated GS-BAS system and transparent information sharing and (2) the fabrication process is dedicated to only one contractor. The quantity of the order is reduced from 3-4 weeks quantity to 3-5 days quantity.



(a) Value Stream Mapping for Rebar Fabrication Before a New Approach was Implemented



(b) Value Stream Mapping for Rebar Fabrication After a New Approach was Implemented

Figure 1. Value Stream Mapping for Rebar Fabrication

DISCUSSION OF GS REBAR SUPPLY SYSTEM

A firm can be described as vertically integrated if it encompasses two single-output production processes in which either (1) the entire output of the "upstream" process is employed as part or all of the quantity of one intermediate input into the "downstream" process, or (2) the entire quantity of one intermediate input into the "downstream" process is obtained from part or all of the output of the "upstream" process (Perry 1985). The case of GS rebar supply system is an example of vertical upstream integration through ownership.

The GS-BAS system which facilitates engineering processes including shop drawing combined with in-house rebar fabrication shop has reduced lead time of rebar supply from 3 weeks to 5 days and reduced variability of delivery time.

Such improvement in lead time and delivery reliability enabled GS to perform JIT delivery when GS achieved reliability of the production system. The rebar processing plants an annual production capacity of 280 thousand tons of rebar. Through the implementation of the JIT material delivery system, GS expects the annual cost saving amounts up to USD 30 to 50 million.

In addition, vertical integration gave GS other benefits as followings:

- Improved supply chain coordination with buyer (i.e., construction sites)
- Reduced transportation costs
- Capture fabricator's profit margins

It is noted that vertical integration requires enormous financial investment. Therefore, vertical integration is not suitable for all companies. GS justified its financial investment because GS has more than 200 construction projects.

APPROACH TO IMPROVE BUYER'S RELIABILITY

GS has implemented the Last Planner System (LPS)[4] as their Daily Work Management for improving demand predictability (i.e., work flow reliability) (Ballard 1994). GS had used the earned value method for their production control before adopting lean construction until pilot projects revealed low demand predictability.

The subcontractors are required to input activities and tasks into the TPMS directly, through the use of mobiles and screen boards in field offices. Then the field managers of GS have the opportunity to confirm the action. Whenever any conflicts occur among subcontractors, personnel of GS act as a mediator to help settle the disputes. TPMS helps

[4] GS had a consulting service on LPS from SPS (Strategic Project Solution)

subcontractors understand the importance of work reliability through the PPC analysis of daily work management and provide the criteria for evaluation of subcontractors. The concepts of "Shielding" and the "Make Ready Process" in the Last Planner System were introduced into the daily work plan system in order to increase PPC. The transparency of payment may be secured through daily work meetings discussing the completion of daily work and payment, which is updated automatically according to completion of work.

TASK STANDARDIZATION

One of the problems revealed during the pilot project is that the level of detail in defining tasks depends on managers' preferences. For example, one task that manager A on a project X used can be broken into five different smaller tasks if manager B manages on project Y does things differently. Therefore, performance data such as PPC (percent plan completion) is hard to be used for organizational performance indicators because performance data on a project is too gross.

Detailed activities and tasks were standardized based on data from nineteen projects in order to set up a standard for work processes and to give reference for defining level of tasks assigned for production control. 8,700 detailed activities and 46,000 tasks were standardized and registered in the system. The number of detail activities and tasks in each business division is in Table 1.

Table 1. Activity and Task Numbers

	Architecture	Heavy Civil	Housing	Plant
Number of Detailed Activity	2,600	2,300	800	2,000
Number of Task	11,600	13,500	6,000	12,700

DISCUSSION OF PRODUCTION CONTROL

GS adopted the Last Planner System for their production control because they learned that stabilizing work flow (i.e., predictable handoffs) is the prerequisite to JIT delivery method. GS measured PPC (percent plan completion) for this purpose. Average PPC on the sixteen projects where the system was experimentally implemented rose around 25 % to 86% over a three month period.

The participants in the experiments also pointed out that the LPS facilitates identifying schedule conflicts and coordinating each subcontractor's production schedule which otherwise is locally optimized.

Since the production control system uses distributed planning in which subcontractors make their own production planning, the ability of subcontractors is critical to the success of the production control system. GS also had experiences with difficulty in working with inexperienced subcontractors.

CONCLUSIONS

The paper reviewed a supply system and production system of one general contractor who had a lean journey.

The company used vertical integration with a rebar fabricator to improve reliability in supply system and the Last Planner System to improve reliability in production system. The paper also revealed an important lesson learned from a pilot study that JIT delivery system without reliable production system aggravates the production system. It is noted that a company's supply and production system is integrated into a company's ERP (enterprise resource planning) system called TPMS (Total Project Management System). It allows a company to coordinate production and supply system more efficiently.

REFERENCES

Akintoye, A., McIntosh, G. and Fitzgerald, E. (2000), A survey of supply chain collaboration and management in the UK construction industry, *European Journal of Purchasing and Supply Management*, Vol. **6**, 2000, pp. 159–168.

Ballard, G. (1994). "The Last Planner", *Northern California Construction Institute*, Monterey, California.

Dainty, A. R. J.; Briscoe, G. H. and Millett, S. (2001b), New perspectives on construction supply chain integration, *Supply Chain Management: An International Journal*, **6**(4), 163–173.

Diekman, J., Krewedl, M, Balonick, J., Stewart, T., and Won, S. (2004). *Application of Lean Manufacturing Principles to Construction*, Research Team 191, Construction Industry Institute, Austin, TX.

Love, P.E.D. (2000), Construction supply chains, *European Journal of Purchasing and Supply Management*, 6(3–4),145–7

Vrihoefi, R and Koskela, L. (1999). "Roles of Supply Chain Management in Construction", *Proceedings IGLC-7*, Aug.1999, Berkeley, CA.

Perry, M. (1985). "*Vertical Integration: Determinants and Effects*", Handbook of Industrial Organization, Vol 1, Chapter 4, Elsevier, United Kingdom.

Polat, G. and Ballard, G. (2003). "Construction Supply Chains: Turkish Supply Chain Configurations for Cut and Bent Rebar", *Proceedings IGLC-11*, Aug.2003, Blacksburg, VA.