LEAN CONSTRUCTION IN PORTUGAL: A LAST PLANNER SYSTEM IMPLEMENTATION CASE STUDY

Nelson Sampaio Peneirol

M.Sc. Candidate, Instituto Superior Técnico, DECivil, Av. Rovisco Pais, 1049-001 Lisboa, Portugal, Phone: +351 91454646, Email: nelson@peneirol.net

ABSTRACT

The construction industry all over the world is being challenged by high cost pressure, shortened project cycles and increasing competitiveness. Construction projects are becoming more and more dynamic, through greater complexity, uncertainty and quicker production. The lean thinking revolution, which was born in the Toyota Production System, spread to industries outside manufacturing. Its great results were also appealing to construction thinkers and researchers. Lean Construction has developed a path of its own in the last 15 years and is breaking through as a new paradigm for managing construction projects. During this time an increasing number of companies have implemented Lean Construction practices in an attempt to improve performance of construction projects. The most popular and successful technique is the Last Planner System[1]. In Portugal the construction sector is becoming aware of the accomplishments due to the lean changes. Thus, this paper looks at the possibility of introducing Lean Construction and Last Planner tools to a Portuguese site. It reports on the experience and the lessons learnt during the implementation of this innovating system of planning and production control. Performance measurement is defined and made, Percentage Planned Completed (PPC) is collected and causes for non-completion are analysed. Further exploration on the company Lean Construction implementation is made, contrasting the outcomes with those presented in prior literature.

Keywords: Lean Construction, Last Planner, implementation, production control, planning

INTRODUCTION

The construction industry has a major importance in the worldwide economies. It represents itself alone 10.4% of the European Union Gross Domestic Product (GDP) and 11.6% of the Portuguese one (BP, 2007; FIEC, 2007). On the other hand, it is very sensitive to domestic economical variables. More and more the construction is defied to deal with lower profit margins, augmenting competition and greater concern about the quality delivered to costumers. Despite that the sector has not been able to develop major technologies concerning performance improvements, especially in terms of production. It looks as though there is an established lack of will inside the industry to make decisions to improve the construction environment and attract intelligent and creative people able to innovate the processes (Fiallo and Revelo, 2002).

Nowadays most of the projects are complex, quick and uncertain, in one word, dynamic. It is imperative to improve coordination and production control. Lean Construction is breaking through as a new paradigm for managing construction projects, developing beyond the initial lean principles from manufacture (Howell 1999; Abdelhamid and Salem 2005).

[1] Last Planner is a trademark of Lean Construction Institute

Very often the implementation of Lean Construction emphasizes the Last Planner. This is a production planning and control tool to improve work flow reliability. Many pilot projects have been adopted by companies worldwide that in most cases reported successful betterments in the production process, mainly on the issues of productivity, duration and safety. These benefits ultimately returned in reduced costs and durations (Fiallo and Revelo, 2002; Alarcón *et al.*, 2005; Kim and Jang, 2004). Regardless the encouraging results, it is also observed that the introduction of the Last Planner method to a site, a company or into a country is not an easy and uncomplicated task (Koskenvesa and Koskela, 2005).

A reduced number of construction companies are undertaking the first efforts to implement and disseminate Lean Construction in Portugal. The purpose of this paper is to present a study conducted in a Portuguese site where a Last Planner model was applied. It also discusses the implementation advantages and barriers. Some issues for future research and replication are pointed out. The data presented and the lessons learnt can be used as reference to improve the work flow reliability in future projects.

LEAN CONSTRUCTION

Lean Construction begun as a management approach based on Lean Production concepts. Because of construction production peculiarities it evolved as a philosophy beyond the original one from the manufacturing industry. It lays for the foundation of a new theoretical view of constructions and project management. Lean Construction pretends to deliver a new understanding of construction and defies the traditional view. It is becoming a new paradigm of construction projects management, researching different issues such as product and process design, production planning and control, supply chain management, performance measurement, IT support, people and culture, safety, quality and environment (Koskela, 2000; Bertelsen and Koskela, 2004).

This philosophy is about managing and improving the construction process to deliver what the customer needs. Lean Construction is concerned in maximizing the value delivered whilst minimizing waste. The goals are to design and operate the right process and to have the right systems, resources and measures to produce things right on the first time. It focuses more on quality, rather than costs, and seeks to remove all non-value adding components and processes whilst improving those that add value (Howell, 1999).

RESEARCH METHODOLOGY

As described above, the goal of this research is to investigate the perspective of introducing Lean Construction concepts on Portuguese sites and construction companies. The theoretical knowledge on the subject is examined and a strategy is established to proceed with the implementation of a Last Planner model. In order to collect data in this study an empirical investigation was carried out based on surveys and interviews to the implementation participants. The case study model supplements information with Percentage Plan Complete (PPC) measurements and failure causes analysis. Finally the outcomes are examined and the case study findings and the lessons learnt are described, deriving into conclusions and present recommendations.

LAST PLANNER

One of the methods developed under the Lean Construction concepts is the Last Planner System for production control. Due to its successful results this method became popular and some people have wrongly considered it as a synonym of Lean Construction. Last Planner addresses short term planning and control of operations. This system pretends to build integrated processes where products are pulled by the customer. The production is conceptualized as flow which leads to an emphasis on production shielding from uncertainty to increase reliability. The objective is to ensure, through diverse methodologies and tools,

that the pre-requisites of a task are sounded before it is assigned, enabling its execution without disturbances and that it is completed according to plan (Ballard and Howell, 1998; Ballard, 2000)

The planning progresses on different project time levels. Weekly plans are sought to increase the degree of realization and lookahead planning is rolled to ensure that assignments for the next 3 to 6 weeks have their preconditions made ready. The goal is to maintain a sufficient backlog of ready tasks. The weekly planning also takes into account the milestones of higher-level plans. Measurements to the work flow reliability are made through Percentage Planned Complete (PPC); the number of activities completed divided by the total number of planned activities. The causes of lack of completion are also investigated. This way, control is positioned to engender continuous improvements (Ballard, 1999). Underneath the development of a near production planning is conversation, where the responsible commits himself to accomplish what is put into schedule. This way, it is intended to attain a trustworthy environment between the different parts involved (Macomber e Howell, 2003).

CASE STUDY

This paper examines the implementation of Last Planner within a construction site. Thus, it was made a partnership with the company OPCA, SA, one of the leading Portuguese contractors that appointed an already ongoing project for the pilot application. The job site was located in Estoril, outside Lisbon, and the contract stipulates the construction of a thermal and spa building, for tourism purposes. The study was carried out during the technical installations phase, which includes HVAC, pipe installation for public and thermal water, sanitary installation, electrical and communication networks. The implementation focused mainly on the work of these subcontractors, which alone represent more than 60% of the execution global costs.

MODEL DEVELOPMENT AND IMPLEMENTATION

The goals of the Last Planner model applied in this case study are divided into three core issues. Firstly, develop a system of production planning and control for the contractor management team that also involves the subcontractors responsible. Secondly, put into operation the model applying initial training and creating gradual conditions for a consistent and reliable work flow to increase productivity. Finally, making a weekly control of the implementation through measurement and starting programmatic evaluation of the results to progressively improve the production system and the company's knowledge.

The Last Planner model was implemented in this case study with the following expectations:

- Increase the efficiency of the construction process.
- Identification and reduction of the waste sources.
- Make the project delivery happen smoothly and with better coordination between partners.
- Maintain or even reduce the construction time whilst quality is preserved.
- Induce a new culture based on cooperation and share of the global project goals.
- Create a cleaner and safer work environment.

The development process of the model was open to critics and suggestions from the participants whose feedback allowed upgrading and adjusting of some procedures to the people and companies involved.

The model presents planning and control methodologies. The first ones intend to align in the best sequence and capacity the work to the site units. The second ones return information

about the schedules made which helps to estimate the current project status. With this data corrective and preventive actions are taken to make things happen. This way, a continuous improvement process based on learning is carried out. The people involved adopt a proactive posture towards the production process.

Planning presents a three level hierarchy with appropriate plans for each one. Detail increases in lower stage plans. The planning schedules occur as follows:

- phase schedule: plan based on the master plan that focuses in a phase or to certain activities, that is prepared by the management team. It describes the sequence and duration of the activities by the Critical Path Method (CPM) but with more detail than the master plan and underlining the related project milestones put up in a pull system.
- Lookahead Plan: production shielding schedule with a 3 week outlook that receives inputs from the phase schedule but only permits activities whose prerequisites are made ready and those responsible are committed to accomplish.
- Weekly Work Plan (WWP): weekly reading of the Lookahead Plan that identifies make-ready-actions and the teams in charge of the assignments.

The activities assigned in the WWP are sounded and their prerequisites are made ready. The constrains analysis of the tasks are classified in seven different categories, namely the subflows introduced in the Lean Construction theory (Koskela, 2000): 1) previous activity(ies), 2) materials, 3) labour, 4) equipment, 5) information, drawing and plans, 6) space, and 7) external conditions. A quality assignment is one whose all constrains are worked out. If any of the prerequisites are signed the task will probably have problems during execution.

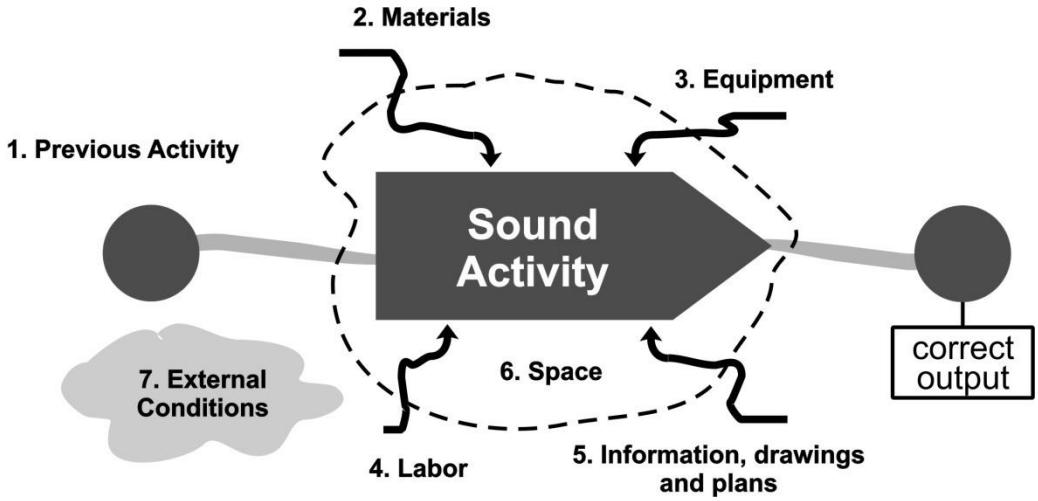

Figure 1: Sound Activity prerequisites.

In order to assess the quality assignments made the PPC metric is used which is the ratio between the number of completed assignments and the total number of assignments planned for each week. “Nearly” or “90%” is not acceptable to classify an assignment as complete. For example a WWP with 10 tasks of which 8 were completed has a PPC equal to 80%. For the assignments not completed the causes are explored.

The site testing process progressively became a routine that concentrated in:

- Updating master plan progress.
- Involving participants in the system and starting systematic lookahead planning with pre-requisites analysis.
- Making WWP with tasks free of constrains.

- Making participants commit in the weekly plan.
- Checking PPC every week.
- Finding the causes of weekly plans failures and trying to learn with them in order to avoid them to recur.

The plans made were documented in simple and visual maps easy to read. Every week they were distributed to ensure that everyone had the same information at the same time about the whole production process. A weekly cycle to enable the systematic planning and control process was established.

DISCUSSION

IMPLEMENTATION PROGRESS

The results obtained in this Last Planner site implementation were similar to those in other projects abroad. As shown in Figure 2, there is a clear increase of the PPC during the study period, rising from values under 50% to over 80% in final weeks. On week 27 there was an increase in the number of tasks and a decrease in the PPC results. Probably at this early stage of the implementation there were more difficulties in making realistic planning in a more complex production scenario. After this week the lookahead plan was reworked. Comparing values before and after week 27, there was an increase from an average 52% PPC to 70%. During the period comprehending week 28 to 33 there is a middle value of 25 tasks assigned each week.

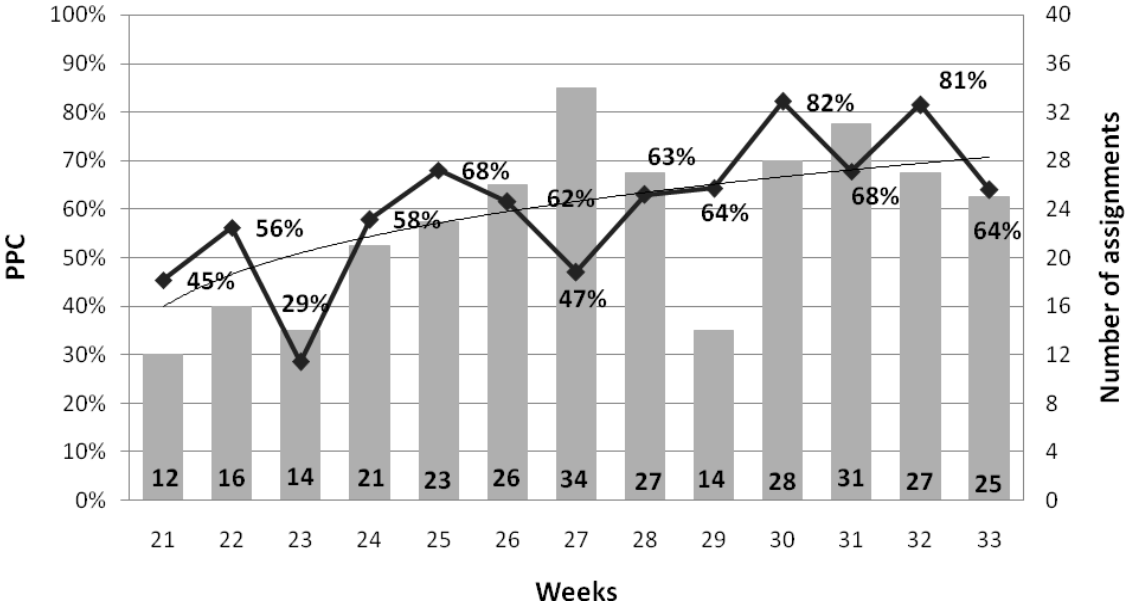

Figure 2: Progress of PPC and number of assignments on every week.

Most of the causes of non-completion of the WWP assignments fit on the prerequisites of work category, with 41% of the total of failures recorded during the study. Afterwards comes labour counting 27% and in third place the drawings and plans issues, specifically lack of definitions and modifications to the design (see Figure 3). Even though in the field drawings and plans were often appointed as the reason for delays, in the investigation they were not proved to be the main one. Much more failures were due to poor planning, constrains resolution and deficient coordination and use of human resources. People probably easily try to blame a third party when problems appear, before even considering their own failures.

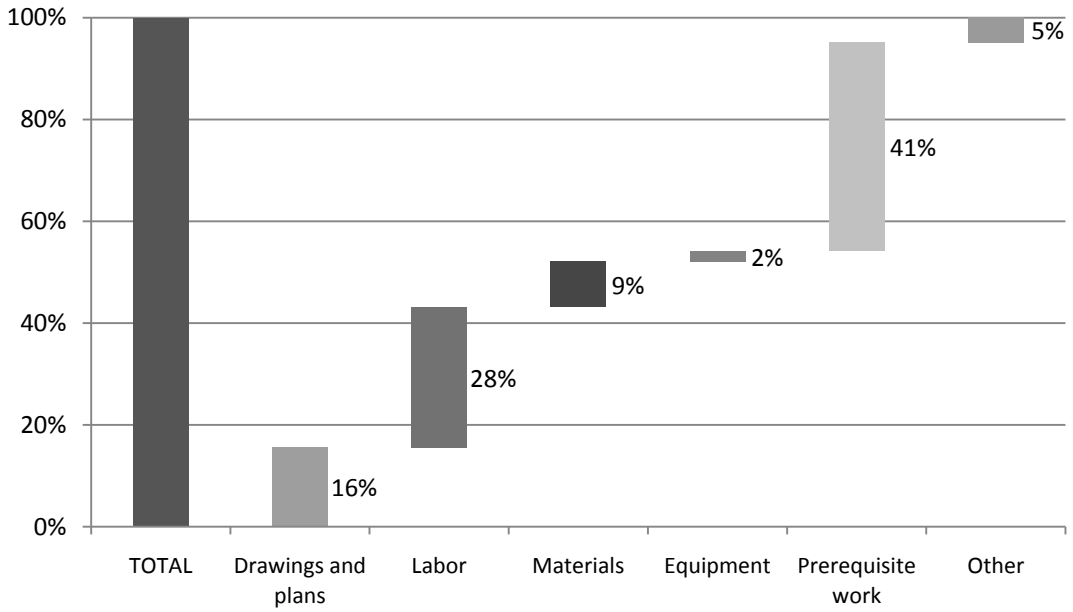

Figure 3: Reasons for non-completion of WWP assignments.

CASE STUDY FINDINGS

The interviews carried out in the final stage of the study looked for approaching the key issues on the implementation process, however they were conducted in a way that allowed an open discussion.

Weekly planning meetings were considered essential and were widely supported. Participants appreciated the fact that the planning system improved the communication and the information. That helped in avoiding misunderstandings, controlling the work and clarifying responsibilities. In the meetings participants got to know each other better and the work environment improved. It was also seen as a key step up the involvement of the foremen in planning.

The WWP is seen as an important tool to coordinate the site tasks and the teams. These schedules make everybody understand the overall production and not just their own work. Throughout the test the author realized that there was a growing perception of the WWP importance in making the work flow more reliable. Small achievements with impact made people see that lean change was good for them. They mainly felt that a more reliable planning was causing less frustration owing to not knowing what and when it was going to happen.

Albeit the author noticed an improvement in the planning process during the test time, it was said that meetings should improve its duration. People interviewed also pointed out that problems should be surveyed more constantly throughout the week. It was felt that this would help to solve many issues that would not be necessary to introduce in the meetings, decentralizing the decision and easing the production rhythm.

The lookahead plan was found very useful in the weekly meetings because it helped to not lose track of the project milestones and to prospect the long term activity prerequisites. Nevertheless, it is seen as important to make the lookahead planning with more of the project participants, particularly suppliers and design responsible.

IMPLEMENTATION BARRIERS

The difficulties founded in the implementation process were analyzed and compared with the ones pointed out in prior literature (Alarcón *et al.,* 2002). We can summarize them as it follows:

a) Time

The testing had a short length in terms of time. To extend the investigation would be helpful to understand the impact of the Last Planner in the time and cost of the project. There was often little time available from the management team to concentrate in planning and preparing the weekly meetings. That affected the rigor and extent of the lean change, resulting in lower improvement efficiency.

b) Training

It is necessary to introduce more effectively the Lean Construction and Last Planner concepts to facilitate the understanding of the system and its goals. In the beginning, while planning people focused more on the schedules rather than activities soundness. Besides, some foremen who participated in short term scheduling initially were not comfortable with the planning methodologies.

c) Organization

This is a key issue for a successful implementation. Company top management involvement is essential to define strategies and to consolidate practices. At the project level the commitment and leadership from the management team defines the extent of the improvements.

d) People and culture

Construction project are human endeavours thus a Last Planner implementation is influenced by behaviours that function as barriers. The most significant are:

i) Resistance to change, which is revealed in low improvement expectations and poor commitment.

ii) Lack of self-criticism, which restrains continuous improvement.

iii) Absence of long run views, due to limited scope on short term objectives and disregard for the project big picture.

iv) Difficulty in saying “no”, many times the responsible receive orders that they are not possible to be accomplished and accepted them without dissenting.

v) Misinterpretation of PPC, which is productivity metric in terms of work flow and seems to be confused with project tasks progress measurement.

CONCLUSION AND MOVING FORWARD

Through this pilot implementation this paper is meant to initiate a discussion about the potentials and barriers in implementing Lean Construction and more specifically Last Planner in the construction industry in Portugal.

From this implementation it was also learnt that it is important to have an implementation team to facilitate the commitment scheduling and that this must belong to the project management staff. PPC showed an increasing tendency in the course of the study time. That shows that the Last Planner improves the work flow reliability. That may mean better time and cost results for the project; however the duration of the study was not long enough to analyze such impacts.

In this way, further implementation studies should be carried out, preferably in simultaneous. That would make it possible for a competing scenario where experiences and good results could be shared and compared. It is also very important to take into account the barriers described and create solutions for them.

Aftermost, the lean change in construction companies is cross-functional to the project. It progressively tends to spread to new areas beyond the Last Planner system of production control. Synergies with partners and suppliers must be reinforced to help the lean change. Collective efforts enable partnership improvements within the industry that are essential in a value-driven world.

The author expects that other researchers and practitioners conduct more Lean Construction projects in Portugal, disseminate their findings and comment on the ones presented in this paper.

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