Implementing Lean construction in a traditional project management culture: Challenges and roadblocks

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Abstract

Lean Construction, and more specifically, the Last Planner System, challenges the foundation of traditional project and construction management practices and their influence in the construction process. This paper describes the problems a client organization faced regarding its request to use Lean construction in a pilot project. It explores the issues raised during the implementation of Lean principles in a project driven by traditional project and construction practices and culture and illustrates the use of constructive research for influencing construction processes. The conclusions are that the move from traditional to lean construction management is a paradigm shift and that the socio-cognitive aspects of changing mental models have been neglected in this process.

Keywords: Lean Construction, Last Planner System, Case study
1. Introduction

Koskela’s (2000) theory describes production in construction as a balance of transformation, flow and value generation. However, construction management practices are only built around the Transformation view: a project is broken down into work packages and related sequences of activities. Dupagne (1991) identifies three problems with this linear division of work: the lack of iterations in the design process; the lack of consideration of constraints within subsequent phases or the unnecessary constraints set in the design of these phases; and the lack of leadership and responsibilities, leading to suboptimal solutions, poor constructability and operability, rework in design and construction and lack of innovation. This could explain why construction is seriously lagging behind other industries in terms of productivity and quality of the end product.

Lean construction is an approach to address these problems that was derived from best practices in the automotive industry. However, it requires drastic changes in practices and culture, which could be a serious challenge in a fragmented industry. This research explores the challenges and roadblocks that a large industrial client organization faced when he decided to apply lean principles in a construction project in the Quebec province. The client, a large international firm, has successfully implanted lean processes in most of its plants and was keen to apply Lean Construction principles to pilot projects in Quebec in an effort to improve project performance. Since the projects were delivered by a large engineering firm through an Engineering Procurement & Construction Management (EPCM) contract, the client organization requested that the project be delivered using the Last Planner System (LPS), a well recognized Lean project delivery tool. The paper describes a constructive research project that analyses the supply chain performance in implementing LPS and provides recommendations for accelerating the adoption of LPS, based on previous research and LPS implementation in Peru (Flores, Salizar and Torres 2000, Bonelli and Carrasco 2000 and Ghio 2001). It outlines the issues encountered in applying these recommendations and the lessons learned from this project.

2. Lean Construction

In recent years, manufacturing has made great improvements in performance, the most notable in the automobile industry where much smaller amounts of resources are used for product development. These improvements are not the result of technological improvements but correspond to the application of a new production theory, "Lean Production", which has its roots in various management principles, including Just In Time (JIT), Total Quality Management (TQM), Time-based Competition, and Benchmarking and Concurrent Engineering.

This new production philosophy is based on the existence of two aspects present in all production system: transformations and flows (Koskela, 1992). While all activities demand cost and time, only the transformation activities add value to the resources (materials and instructions) that are being transformed into a product. Thus, any improvement of the flow activities that do not add any value (inspections, holds, movements) through which the transformation activities are connected, focus on the reduction or elimination of the same, while the transformation activities must execute more efficiently. In the design, control and improvement of construction activities, both aspects must be
considered. Howell & Matthews (2005) also describes the inter-relationship between the contractor management of the flow and the successful transformation of materials to the desired end product.

The principles of traditional management, from where the actual project and construction practices and culture are inspired, had considered only the transformations of each of the activities. The transformations desired had been treated as activities that generate value; as a result of these management principles, process flow have not been controlled or improved by means of changes in the management practices of construction activity management. This has led to complex, uncertain and confused flow processes, an increase in non-value added activities and the reduction of the end-product value. The material and information flows are thus the basic unit of analysis of the new production philosophy, which combines three different views (Koskela 2000): production is a transformation of inputs to outputs (traditional approach), production is a logistics flow (the focus of Just in Time), and production is a generation of value through customer requirements (Quality Focus). Thus, time, cost and value are the measure of traditional managements’ main characteristics.

Since 1993, a growing number of researchers have joined forces to study and evaluate the results of the implementation of Lean Production in construction, calling it Lean Construction, and sharing their experiences in formal conferences organized by The International Group of Lean Construction (IGLC). Lean Construction is considered as a new paradigm for project management. Its principles and tools were embraced many years ago by companies in several countries including: the USA, the UK, Denmark, Finland, Germany, Australia, Brazil, Chile, and Peru and more recently in companies located in countries such Colombia, China, India, Sri Lanka and Saudi Arabia.

3. The Last Planner System (LPS)

Traditional construction management practices are built around the critical path method (CPM), whose cycle could be described as “Will-Resources-Did”. The core principle is that a sequence of activities and tasks are first planned (Will), then resources are assigned to execute these activities (resources) and the control of the execution is done by comparing the planned with the actual activities (Did). This cycle, similar to the transformation view described by Koskela (2000), simply tries to apply the appropriate means to a given resource to produce goods, with no means to learn and improve during the process. There is also no commitment from the resources to meet the time constraints defined in the plan. The result is that an average of about half of the planned activities are delivered according to schedule (Ballard 2000).

To address this issue, Ballard developed the Last Planner System (LPS) a tool designed to enable the practical application of the concepts of Lean Construction. In particular, it proposes a close collaboration between project stakeholders, encouraging the sharing of information among various trades using a resource management pull system. This collaboration is encouraged in part because there is no triggering for when the activities will become necessary for future activities. It is a technique of continuous improvement, with a system of performance measurement and failure analysis.
To facilitate the analysis of each of these aspects, Ballard (2009) proposes a development of means to achieve the two goals of Lean: minimize waste and maximize value. The use of Last Planner occurs at different levels. One level searches to minimize waste-reducing downtime, checking the workflow and reducing the duration of non-value added steps. The other level looks to maximize the value in delivering a product for the customer to achieve its objective better, increasing system control (ability to achieve the objective), delivering the product on time, minimizing disruption of production and responding quickly to disturbances in production.

The vision "Should-Can-Will" is the heart of the Last Planner flow principle. This reflects the determination to make a commitment (Will) to perform an activity (Should) only if it is possible (Can). The verification of constraints release is part of the Last Planner core process. Verification ensures firstly, that the activity is released from any constraint in order to make a reliable commitment, and then that the resources are available as agreed for the activity. The cycle Will-Resources-Did only allows a comparison between what was planned and what was achieved in practice (Mossman, 2008, Ballard et al 2002, Ballard 2009).

The PPC (percentage of planned activities completed) is an indicator to measure the planning and the performance of the production unit. It represents the ratio of completed assignments divided by the number of planned assignments. Studies consider a PPC value above 80% as a good performance, while a PPC value below 60% is considered to be a poor performance. Howell & Macomber (2002) conclude that teams with experience in implementing the system are able to maintain PPC values above 85%.

Finally, there is a noticeable difference between the initial planning done by the Last Planner System (LPS) and the CPM method used in traditional construction practice. In both cases, a maximum compression of the calendar is expected, but once this is obtained, the methods are different. The CPM method will use the compressed calendar as its planning base, not considering contingencies and as a result, project schedules are extended. Instead, LPS divides the initial margin between all activities in order to accommodate variations throughout the project, and to not have to change the sequence along the way. Thus, at the end of the project, LPS will improve the likelihood that each activity’s duration will be reduced, compared to using the estimated CPM with a buffer, and so the project time will also be reduced.

4. Research method

Constructive research is a well-known approach in information technology and in management, a response to the growing concern that academic research had become less and less useful for solving practical problems (Kasanen, Lukka and Siitonen 1993, Lukka 2000). It is a goal-directed problem-solving activity which aims at producing an innovative, theoretically grounded solution for a relevant problem: developing a construct demonstrating its usefulness and usability and determining the scope of applicability of the solution. The case study here is based on an observation of the LPS implementation in a project for which the owner, as part of a business improvement program, wanted
to test its use on pilot projects. The project consists of the optimization of a hydro-electrical plant located in the north of Quebec in Canada.

Data collection consisted of triangulation of three methods: interviews, observations (through site visits) and review of project documents. The interviewees included the EPCM Project Control Director, the personnel responsible for the implementation (on the owner’s and the EPCM contractor’s sides) and the supervisors (EPCM contractor and subcontractors). Observations were focused on planning meetings on the construction site. Schedule and PPC data were provided by the EPCM.

Interventions consisted of reports to the EPCM identifying gaps between the LPS framework and practices observed on site. On-site visits were made, on a weekly basis for the month of March 2011, to participate in the designed “lean meetings”. The principal focus was to observe how these meetings were held and their outputs in order to make improvements in the construction process (coordination reports). Observations were made during the Lean and the daily meetings, and interviews were conducted with the site planning team (both the owner and the contractor sides), project manager and field supervisors (contractor and subcontractors) to obtain feedback about their response to the LPS implementation. The final analysis and discussion covers the performance and the issues that arose from the use of LPS in this project, utilizing Ballard’s (2000) LPS framework and Hamzeh and Bergstrom’s (2010) implementation steps.

5. Description of the Last Planner implementation

The client, a large firm devoted to mining and transformation, is seeking major improvements in the planning and delivery of its power plants and factories. Quebec is quite rich in minerals and provides easy access to hydroelectricity. However, the construction industry has proved to be unreliable in terms of meeting project targets and delivering a quality product. This client organization successfully introduced benchmarking to track and improve construction project performance. This project is one of the first in the province to experiment with LPS.

The justification for implementing the LPS on this project was to address a specific problem: a lack of physical space to carry out the work where the five main subcontractors of the project had to work to carry out the type of activities involved, especially given their importance to the project. Prior to LPS implementation, weekly meetings were held in what they called the “conflict zone”. However, the only available tool was the CPM, which does not take these sorts of issues into account. In other words, the LPS was chosen as a tool that could address the problems that the CPM could not. It was expected that LPS would help to avoid delays and improve communication, and therefore the flow of activities between the subcontractors who worked on site.

The LPS is a paradigm shift from traditional construction management practices. In Quebec, the industry is highly fragmented and projects go to the lowest bidders. Introducing the LPS in such an environment is a challenge, since the supply chain changes from project to project. This may explain why this project is the first in Quebec to introduce a lean philosophy in this industry. This client
organization benefits from a peculiar context that made this possible: the client, the EPCM and the main contractor company are accustomed to working together in this area. Furthermore, the local main contractor works with the same local subcontractors on other projects. The EPCM is one of the largest engineering firms in Canada. It has developed a rigorous project delivery method based on CPM.

5.1 Phase 1: Planning the implementation of the LPS

The client organization dedicated two people for the planning and supervision of LPS on the project: a six sigma black belt responsible for quality systems in the client’s support group for major projects, and an LPS coordinator. The EPCM has no trained resource in LPSs for this project. As a first step, the six sigma black belt prepared an introductory presentation about the LPS to the staff and the LPS Coordinator on the construction site. It included steps for its implementation in a project, and explanations of how the LPS tools work using examples taken from two previous Lean implementations realized for the client organization in the US. In addition, a form of partnering contract was introduced to promote good lean management practices (early warnings, weekly activity updates and planning, the weekly LPS meetings) within the team.

Documents were also distributed to the team explaining the roles and responsibilities of the LPS coordinator, the LPS core principles and methods, how the LPS weekly meetings should be structured, how to make these meetings successful, and how to use the PPC. The client organization’s six sigma black belt also held discussion meetings with the LPS coordinator and the EPCM site manager to understand the site process, identify issues and propose solutions on how to reorganize the work according to the LPS.

5.2 Phase 2: Application on the field and PPC calculation

The LPS principal activity was the on-site, weekly “Lean meetings” specific to this conflict area. They were conducted in a room equipped with an electronic white board to coordinate tasks by projecting the plan of that area (Figure 1). The LPS coordinator, the EPCM project manager, the superintendent, the Health & Safety coordinator, and the supervisors for each trade participated in these meetings.

The meetings usually began with a review of the previous week’s coordination report to verify the tasks accomplished. The contractor’s planner reviewed the previous week’s activities with the aim of calculating the PPC, based upon the reports provided as to the completion of the assigned activities from each of the responsible contractors’ personnel. Following this, the contractor’s planner proceeded to complete the coordination report for with next week’s activities. In order to do that, subcontractors had to explain the exact area they were going to occupy over a plan projected using the electronic board (Figure 1). Each subcontractor’s responsible supervisor, in turn, marked their job areas and explained their activity plan and the duration of each allotted task (the time measurement was days, detailed to AM or PM). For purposes of clarity, each of the five subcontractors was
assigned a different colour. Discussion between the parties was open and everyone contributed to clarifying how a job was going to be done and compromises were planned and negotiated. Early warnings appeared from this open discussion and were considered for the final report version. The resulting weekly plan was immediately printed from the electronic board and distributed at the end of the meeting to each of the participants. At a later stage, the final version was sent by email.

![Plan of the conflict area projected on the white board](image)

Figure 1: Plan of the conflict area projected on the white board

At these meetings, the planners requested that the subcontractors present a 3 week-Look Ahead Plan (3w-LAP) every 15 days. Once these were received and discussed on site, they were sent to the contractor project control manager in the Montreal office. The only visual information sent from on-site as a result of the LPS implementation were the resulting weekly plans, the coordination reports and the 3w-LAPs and they were solely posted in the room where the “Lean meetings” were held.

### 5.3 Interventions from the researcher

Following these observations and an analysis of the relevant documents, issues were identified and recommendations made to improve the implementation of LPS and increase the on-site productivity. Suggestions were made during the “Lean meetings”. An LPS theoretical review (Howell, Ballard and others), a study about a successful implementation of LPS by Hamzed and Bergston (2010) and the results obtained in previous studies and LPS implementations realized in Peru (Flores, Salizar, Torres, 2000; Bonelli and Carrasco 2000) provided the theoretical and empirical background for these recommendations.

One of the core issues was the fact that LPS was not used for the whole project but for a specific area. Processes based on two different paradigms (Lean Construction and CPM-based construction management) were used – which led to misunderstandings, overlapping of management tasks and conflicts. For example, daily meetings were held to gain awareness of the progress and the planned activity to consider issues than can arise from a planned activity. Other peripheral activities were also considered in the daily meetings. The information from these daily meetings was not available at Lean
meetings and vice-versa. Even during Lean meetings, a traditional WBS structure of activities was the one considered to produce the weekly plan.

The use of PPC was also misunderstood (Figures 2 and 3). Subcontractors considered that the purpose of measuring the PPC was to achieve a global value of 80%. According to Figure 2, this goal was achieved in average. However, the measurement of PPC was inconsistent. For example, even if the activities were achieved on the day they were supposed to, the calculation did not consider if was done at the expected time (AM/PM) and so the causes for its non-completion were not considered. An important dimension of LPS is on-the-site learning: an identification and analysis of the reasons that cause an interruption in each week’s the work flow contributes, with time, to a process of continuous learning on the job site, which was not the case.

Figure 2: Evolution of PPC

Figure 3: relationships between PPC and number of planned activities
Another important dimension is the quality of the data. An activity cannot be included in the weekly plan if it has not met the 7 conditions for an activity to be started: the input activity has been completed, complete drawings and specs for the activity are available to the workers, all the workers planned for the task are present, they have the equipment and material required to do the job, and external conditions that could impact the work have been identified and taken care. From our interviews, this validation of the activities has not been conducted.

Discussions of our observations and recommendations were held with those responsible for the on-site implementation (the owner-planner and the EPCM-planner) and with the person in charge at the owner’s Montreal office. The same points were presented in written reports prepared after each of the visits, in which the same suggestions were made in order to see some changes. These suggestions were not, however, taken in account by the EPCM.

6. Discussion

When the subcontractors of this project collaborated in the implementation, it was observed that the manager responsible for the on-site implementation considered LPS as a methodology more appropriate for the construction-building type of a project with repetitive elements than for this industrial-construction type of project. He considered this project as one of a kind, which is a typical idiosyncrasy founded in other studies.

Excuses such as “the subcontractor will not be able to do more than what we are asking to do because then it will take them lots of time to prepare” or “we have to consider the location of the project” were given when asked why the suggested remedial actions were not applied. If they had been applied, they may have made more improvements possible and/or be make more detail available for the planning process. The simple act of compiling a list of the principal causes of no-completion of a planned activity was considered as akin to “looking for the guilty party”. A change of paradigm requires discarding obsolete practices when adopting new ones. The LPS challenges common construction management practices, and so professionals such as planners, construction managers and superintendents will resist the changes. The right conditions have to be put in place for this shift to be successful. Hamzeh and Bergstrom (2010) recommend adopting a series of steps when implementing the LPS, based on the analysis of success factors for LPS implementation: harness the support of the project’s owner and the organization’s top management, establish a cross-functional nucleus team and develop goals to accomplish, evaluate and map the current planning process, customize LPS to the current project/organization, identify challenges and opportunities, develop and perform a train-the-trainer program, create a positive team experience, and identify and manage recurring issues.

There was strong support from the client organization top management. The implementation of the LPS in the project was discussed at a management level between the client organization and the contractor, and so there was commitment from the head representative of each organization. The problem was with the EPCM who considered this as an additional requirement, and maintained its traditional construction management process. An aggravating factor was that the LPS was adopted to solve a specific problem of communication in a conflict area, not as a new paradigm to improve the
performance of project delivery. The evaluation and mapping of the current planning process was made to highlight the gaps between the actual planning process and the LPS. The LPS implementation plan was customized to the project and to its organization, with consideration of the possible challenges of its application by the six-sigma expert. However, there was no core of LPS cross-functional champions to drive the changes, implement the train-the-trainer program, create a positive team experience, or identify and manage recurring issues. Therefore, the conditions were not present for a successful LPS implementation.

Other factors have also played a role in this partial failure. Agreeing with Hamzed (2009), some of the reasons for the partial results of LPS implementation in this project are local and others are more general. At the local level, we can take into consideration that it was the first approach for the on-site team in the use of lean methods, that the project had a traditional management organization and that planning was made following the CPM method. On the general level we can consider the lack of human skills and experience in the utilization of new philosophies or tools and the organizational inertia.

It should be noted that implementing LPS should not be regarded as a simple application of a new tool to a project, as it requires that the people who use it change the way they view and execute their work. The LPS is a lean construction method that requires teamwork and continuous improvement. This implies a real change in the status-quo, which generally intimidates people who have been working “successfully” for years using a traditional management framework without making any changes. Taking them out of their “comfort zone” becomes the primary challenge when implementing the LPS, because the method itself is not very complicated in and of itself. This is symptomatic of the fear of change, something very familiar to those who deal with change management systems, which is why a nucleus of champions is essential to break the socio-cognitive barrier associated with discarding familiar and well-mastered practices.

7. Conclusion

The case study presents the issues facing the implementation of the LPS in a project conducted by traditional, centralized CPM-based planning. The main difficulties perceived for a complete implementation were: lack of training, resistance to change, the contractual structure and the partial and late implementation of LPS. This case also demonstrated the challenges of conducting constructive research in this context.

A key factor in this partial failure is the lack of understanding of the socio-cognitive aspects related to a paradigm shift in construction management practices. It was the client organization’s middle management who indicated their commitment to Lean: their goal was to convince the top management of the value of Lean Construction to improve the delivery of projects. The fact that the EPCM top and middle management were not committed is confirmed by their lip service (indicated by adding PPC updates to traditional project management reports, for example) to LPS: PPC graphs were inserted into their standard project management reports, but little effort was made to systematically apply the LPS. It must be considered that the LPS is not a method that can be merely chosen and implemented
as needed and that it will work effectively ‘off-the-shelf’. The implementation of LPSs requires deeper organizational changes in ways of thinking, cultural change and the will to move away from the status quo. The same could be said about constructive research. While the EPCM agreed to have the researcher spend 50% of his time at their company to conduct the research and provide recommendations, interventions and access to information for the researcher were not supported.

It is clear that additional, more thorough studies of this method are needed in order to make improvements to the construction culture in Quebec. To support the transition and changes to the complex construction industry and to improve this industry’s efficiency and performance, studies to identify and measure wasteful practices, to measure the common causes of non-completion of activities, and an in-depth study of planning methodologies and construction management are also needed. The results of these studies then need to be shared, rapidly and with a focus on their practical application. To help facilitate this process, educational training is required, including on-site workshops and discussions with management teams, all geared to promote general familiarization with the processes involved and the results that can be achieved. Private and public companies are directly responsible to help achieve these objectives by working hand in hand with educational institutions to publicize and share the results of these studies. The positive results of LPS construction projects in other countries speak for themselves.

8. Acknowledgements

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