Hamzeh, F.R, Kallassy, J., Lahoud, M., and Azar, R. (2016). "The First Extensive Implementation of Lean and LPS in Lebanon: Results and Reflections." In: *Proc. 24th Ann. Conf. of the Int'l. Group for Lean Construction*, Boston, MA, USA, sect.6 pp. 33–42. Available at: <www.iglc.net>.

THE FIRST EXTENSIVE IMPLEMENTATION OF LEAN AND LPS IN LEBANON: RESULTS AND REFLECTIONS

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ABSTRACT

Lean construction as a philosophy and set of tools has been successfully implemented in construction to reduce waste and improve customer value. The Last Planner System (LPS) has enriched the construction industry with a production and planning system that aims at improving the reliability of construction planning and workflow. However, several developing countries have not started implementing lean construction or LPS. This paper presents a reflection on the first implementation of lean principles in general and the LPS in particular on a large scale project in Lebanon. The study employs case-study analysis to investigate the implementation process by the General Contractor's team as well as the various subcontractors. Results highlight the team's satisfaction despite the several challenges faced. Improvements to the reliability of planning and project's progress are clearly presented through a longitudinal cross section of the main key performance indicators measured on the project. The paper also highlights the major barriers faced during implementation. This study serves as a reflection process for the general contracting company implementing lean and LPS while forming a basis for future implementations in Lebanon and the Middle East.

KEYWORDS

Lean Construction, implementation, Last Planner System, production planning and control.

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INTRODUCTION AND LITERATURE REVIEW

Lean construction (LC) as a philosophy and a set of principles was introduced in construction to maximize customers' value through waste reduction and continuous improvement (Koskela, 1992). The literature is rich in case studies describing the successful implementation of LC on real projects. Garnett et al. (1998) reported a 25% reduction in construction time, an increase in client satisfaction, and a decrease in the overall project cost. Conte (2001) showed that the project construction time was reduced by 20% to 30% and cost was reduced by 5% to 12%.

The Last Planner System (LPS) is one of the tools used in LC to increase reliability of planning and workflow (Ballard & Howell, 2004). It is a production planning and control system used to reduce variability and uncertainty in construction. (Ballard & Howell, 1994). The LPS includes four levels of planning steps: master scheduling, phase scheduling, lookahead planning, and commitment planning. The main goals of LPS are: (1) planning the tasks in detail as soon as they near execution, (2) involving the people who are going to perform the work in the planning, (3) identifying and removing constraints ahead of time in order to clear the path for the execution team, (4) coordinating between team parties and trade partners in order to make reliable promises to execute the planned work, and (5) identifying the root causes of the problems and learning from failures to continuously improve (Ballard et al., 2007, Hamzeh et al. 2015)

Despite the benefits displayed, several companies struggle to successfully implement LC and face a number of barriers during implementation (Wandahl, 2014). Organizations need to address several change management issues related to their current processes as well as their cultural realities when implementing LC. Starting the shift towards lean thinking, the organization must first create a sense of urgency (Hamzeh, 2011). An urgency to change, whether through continuous improvement or a sense of competition. People, in general, do not like to change and prefer to stick to old habits by maintaining routine and stability (Zammuto & Krackower, 1991).

A successful implementation requires lean champions who understand lean principles and the philosophy behind them. Those leaders need to motivate people to adopt lean principles, to redirect them from the safety of traditional methods, and to resist any attempts to dilute lean principles (Raghvan et. al, 2014; Howell and Ballard, 1998). On top of that, the champions themselves need to be fully engaged with the system and taking part in implementation for the system to succeed. (Garnett et al., 1998)

Wandahl (2014) studied the major barriers behind implementing LC by surveying several papers published in the IGLC conference and found out that the major barriers are: lack of communication, lack of top management commitment, lack of knowledge, lack of leadership, lack of training, and most importantly cultural resistance to change. Kenny and Florida (1993) confirm that lean success is heavily reliant on culture

An important cultural change is having a 'no blame' environment. This is crucial when teams start learning from failures to continuously improve. Moreover, people must trust each other to start exercising reliable promises (Seymour, 1998). Therefore, companies must focus on changing the behaviors of people rather than just focusing on implementing the tools (Liker, 2004; Kalsaas et al., 2009).

There has been a slow adoption of LC in the Middle East (ME). AlSehaimi et al. (2009) present an LPS implementation in the ME and Rached et al. (2014) discuss barriers for implementing integrated project delivery in the ME. Both studies report a variety of barriers related to culture, lack of teamwork, short term vision, and lack of knowledge in LC as implementation barriers. Some aspects of lean and LPS were investigated in Lebanon where Jazzar & Hamzeh (2015) present LPS metrics in shelter rehabilitation projects, Hamzeh et al. (2012) study improvisation in planning, and Yassine et al. (2014) tackle takt-time planning in construction to improve work flow. However, none of these studies address a formal implementation of lean and LPS. In this context, this paper presents a reflection on the first implementation of lean principles and LPS in Lebanon. The paper describes the journey towards the first LC implementation, research methods used, results from case study research, discussion of the results, and conclusions.

THE JOURNEY TOWARDS LEAN

This paper describes the journey of a leading construction company in Lebanon and the Middle East region as it is implementing, for the first time, LC and the Last Planner System on a large and prestigious construction project in Lebanon.

Since its founding date in 1971, the company delivered a wide variety of projects in the residential, commercial, educational, and industrial sectors in Lebanon and around the Middle East region. Prior to implementing LC and LPS in the company, projects' planning was handled by the planning department as a silo cell and was considered a specialty that doesn't concern much other departments. Planners would send out emails or print out schedules on a weekly or fortnightly basis indicating the dates that they want other departments or projects to adhere to. The planning process was not collaborative.

The planning cycle in the construction company would start by performing work on site for a given week based on what each team believes they can do, given the available resources and the cleared activities at that point in time. A schedule update is performed by the planning department after incorporating the actual progress. The updated results and floats are then sent back to the site and to the client as an after-the fact reporting. For a number of employees, scheduling had only one purpose, which is to satisfy the contract requirements. To most, it wasn't essential to plan the work on site; doing the best they can do considering the current constraints seemed like the wisest course of action to them.

Realizing the shortcomings of this planning method and recognizing that no project was delivered as promised in the past 10 years, the company established a team of operation engineers to map the current processes, critique them and identify adequate operational improvements to implement on construction sites. Before researching any new system, the newly-founded team agreed that the desired system needs to meet two main goals: 1) involve every employee in active planning, and 2) create a culture of making and meeting promises. Once the company's planning goals were defined, the team came across LPS in their research and realized that this new system will meet their requirements and reach the desired goals if implemented correctly.

The project in which the implementation took place is a shopping mall located in Beirut, Lebanon, with a total built up area of 150,000 square meters. The project began in 2015 and is expected to finish in 2017. Results of this study will highlight the improvements seen on site as well as the major barriers faced during implementation.

METHODOLOGY

The paper employs case-study analysis as it allows strong evidence collection, description and observation. It also answers questions related to "how" and "why" where no control for behavioral events is required (Yin, 2003).

The lean champions were recording on a weekly basis the outputs of safety, time, cost, productivity, and quality. The causes of delays were monitored as well. Several key performance indicators related to LPS were recorded as a longitudinal section (through time) including: Percent Plan Complete (PPC), target productivity attainment, target quality attainment, and safety adherence score. Other indicators were also tabulated such as: PPC by each Last Planner, root cause of delays, constraint identification, and constraint resolution. Results are presented in the next section along with a discussion of the improvements seen, the challenges faced, as well as suggestions for further improvements.

RESULTS AND DISCUSSIONS

Implementation started with communicating a new philosophy; creating a sense of urgency, presenting a viable solution, and inspiring a buy-in into the local team. The lean champions introduced LPS concepts as well as the key performance indicators that will be measured on site. The lean principles were printed and posted in the meeting room, relabeled as "the war room", for the teams to get familiar with the new system. Although teams were hesitant and resisting the change at first, they started to see improvements after several meetings and got more motivated to implement the LPS. This is confirmed by the feedback of the implementing team. A section engineer comments: "This system is very useful … I believe that the most important part is how we are dealing with constraints, planning their resolution and learning from the historical records". The project director said: "This new system ensures proper and continual communication between all project team members and therefore improves teamwork, which represents the biggest challenge on large construction projects; it also increases transparency."

Starting from a master schedule, the company developed an internal excel program that enabled every employee to develop their own lookahead (LA) plans. Weekly work plans are based on LA schedules and daily huddles are conducted to review, plan and adjust the plan for the day. During the weekly meetings held on site, key performance indicators related to LPS were measured and posted on a dashboard accessible to all. These include: Percent Plan Complete (PPC), individual Last Planner's PPC, productivity, quality, safety, root cause of delays, and constraint resolution. Figure 1 shows a photo of a weekly meeting held on site and the "War Room" setup. Figure 2 shows some of the indicators mentioned. Although the LPS was introduced one year into the construction phase, several improvements ensued soon after introducing the new system.

First, visualization has increased since the key performance indicators were posted on the dashboard. The site team was glad to see their weekly updated results and liked the transparency of the system. Second, all the engineers and foremen agreed that the communication has enhanced. In a typical weekly meeting, the team members review last week's performance, discuss the constraints faced, plan work for the coming week, and collaboratively work on eliminating constraints beforehand. Hence, they are able to visualize where they stand and what they are willing to achieve in the coming week. Moreover, the last planners were heavily involved in the planning process by collaborating with the responsible engineers for each zone to agree on the tasks they are willing to achieve for the coming week

Figure 1: Onsite weekly meeting and the "War Room" Setup

Figure 2: Weekly key performance indicators posted on dashboard

A site foreman said: "This new system created in us a sense of empowerment and accountability which significantly boosted our motivation". PPC for each last planner was recorded to track reliable promising. Figure 3 shows the weekly PPC for the whole project and Figure 4 shows the last planners' PPC for a specific week. Third, the team aimed to relate safety, quality, time and cost similar to the objectives of the Toyota Production System (TPS). Quality management indicators were measured to track quality related results. Figure 5 shows the quality inspection approval rate on the project, as one of the quality management indicators employed.

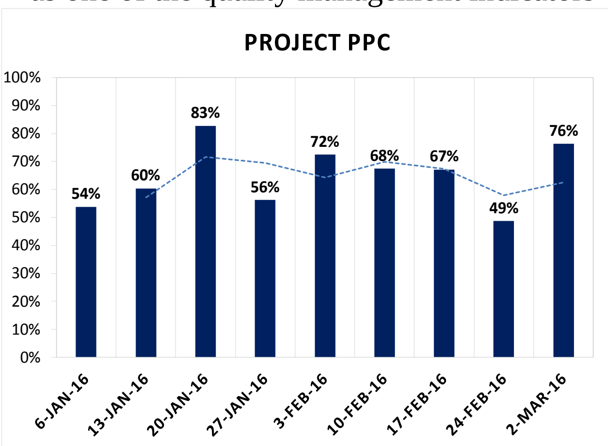

Figure 3: PPC calculations for the project as a whole

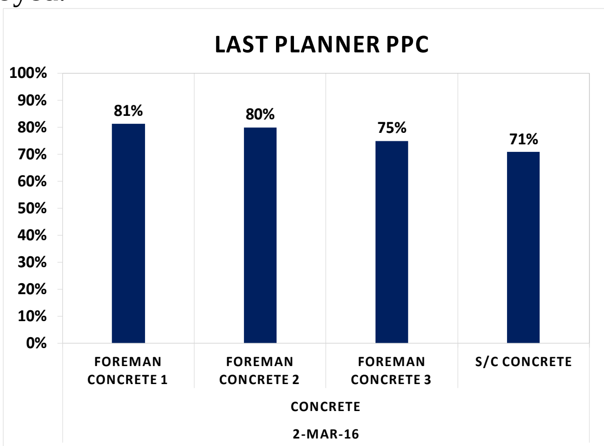

Figure 4: Weekly PPC attainment by last planner

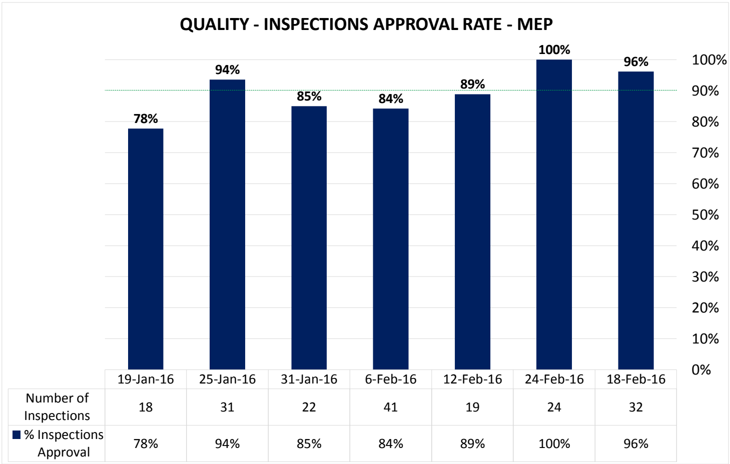

Figure 5: Quality - Inspections Approval Rate

Despite the improvements shown on site, the company encountered several challenges during implementation. Table 1 summarizes the major improvements, challenges and suggestions for various LC related methods employed on the project. One of the challenges faced was eliminating the root causes of delays or planning failures. Although the teams were aware of the root causes of the problems, most of them were recurring. Figure 6 shows the cumulative root causes of delays within various categories since the kick-off of the new system. It is recommended that the teams apply the 5 why's process, learn from failures, and try to avoid their reoccurrence in order to continuously improve.

As for constraints analysis, Figure 7 shows the weekly number of constraints identified and their resolution status. It clearly shows that most constraints were not removed. For better implementation, constraints should be identified with a certain lead time beforehand so they can be removed in time prior to execution. Furthermore, some employees felt that this new implementation brings extra work and hence they were resisting the shift to the new system. Additional training on the benefits of LC and LPS may help since practitioners are implementing the tools without fully understanding the philosophy behind them.

The company should focus on cultivating lean behaviors in its people company-wide and not just focusing on implementing the tools (Liker, 2004; Kalsaas et al., 2009). Moreover, an incomplete implementation of LC and the LPS will not reap the full benefits of an improved planning and control system (Wandahl, 2014). Since the LPS was implemented one year into the construction phase, the master schedule had been already developed by the planning department. This resulted in finding tasks with wrong time estimates or even wrong predecessors during the weekly meetings. That's why collaborative planning should have been implemented prior to commencing the project execution. Last planners and subcontractors have more experience in methods to perform work on site and can find better ways for execution reducing time and cost.

Table 1: Areas of implementation including improvements, challenges and suggestions

Areas	**Improvements**	**Challenges**	**Suggestions**
Planning	● Lower level players are involved in planning ● Teams discuss and coordinate their weekly work plans ● The Last Planners are responsible for their promises	● Uneven levels of involvement of engineers and foremen in the LPS planning process	● Involve all foremen in the planning process
Percent Plan Complete (PPC)	● Communication is enhanced between team members. The teams discuss the tasks completed versus those planned, and plan the work for the coming week(s) ● The teams analyze the constraints and try to find solution to improve the PPC	● The original master schedule was not developed collaboratively	● Apply LPS from project outset ● Develop all plans collaboratively ● Involve the client in the collaborative planning process
Root Causes of delays	● Causes of delay are investigated ● Teams are aware of them	● Failures are repeated ● Slow learnings from failures	● Apply the "five why's" process ● Remove the causes collaboratively
Quality	● Quality management indices are tracked	● Client representatives are not involved	● Involve the client representatives in the process
Safety	● Improved compliance to safety guidelines ● Enhanced site safety performance ● Teams with high safety performance are recognized	● Ownership of safety performance is mostly given to team leaders	● Task hazard analysis to be part of the LPS ● Developing a risk assessment manual ● Involving workers in hazard identification & mitigation
Cost	● Productivity indices are tracked, reviewed and discussed with all supervisory levels on a weekly basis ● Root causes are investigated, and lessons learnt are communicated	● Cost / Productivity rates for the subcontracted finishing activities is harder to impact	● Improving the Involvement of the Subcontractors in the Cost/Productivity monitoring process
The project as a whole	● An increased transparency, visualization and collaboration ● Key Performance Indicators are updated, posted on the dashboard, and discussed on a weekly basis	● The philosophy behind LC tools is not yet clear to all ● There are uneven levels of understanding of the LC tools	● Train all employees on LC and LPS ● Employ location based management ● Increase the involvement of stakeholders

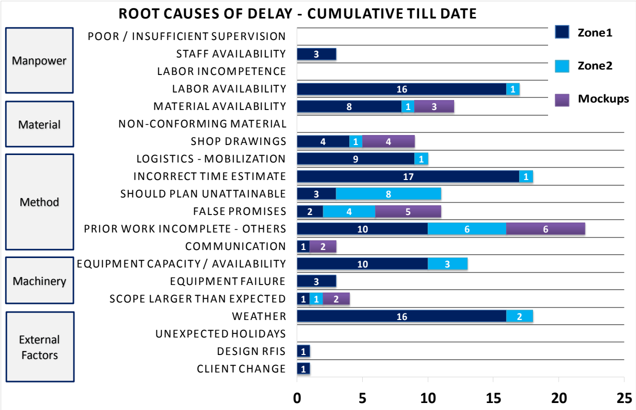

Figure 6: Root Causes of Delay – Cumulative till date

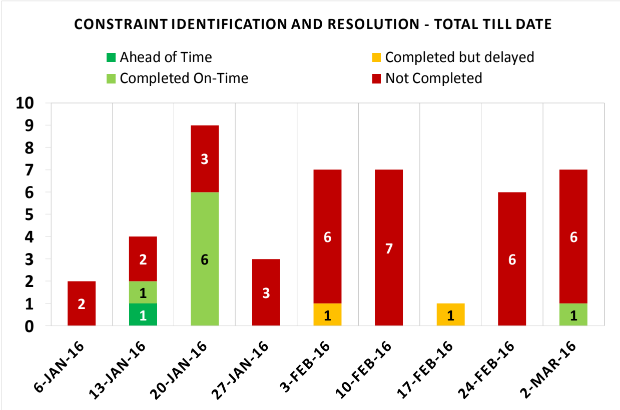

Figure 7: Number of Constraints Identified per week and their Resolution Status

Furthermore, location based management can be used in conjunction with the LPS to improve construction workflow and reduce task conflicts. The project team have heavily used precast concrete elements to speed-up the construction process. And since the project covers around 18,000 square meters of foot print area with several zones, lay down areas, cranes coverages, and precast unit sizes, employing location based management along with the LPS would have improved the overall workflow and reduced process waste.

Safety was given a huge focus by the team. Team leaders were in charge of enhancing their safety performance metrics within their zones. Recognition for teams accomplishing high safety performance figures had a positive impact on compliance with safety guidelines. However, several improvements are possible including: adding task hazard analysis to the LPS as suggested by (Wehbe and Hamzeh, 2013), developing a risk assessment manual for construction tasks, and involving all workers in hazard identification and mitigation.

CONCLUSIONS

This paper highlights the first implementation of LPS on a large scale project in Lebanon. Several improvements have been realized: visualization is improved, collaboration and coordination between team players are enhanced, the root causes of delays are identified, lower level players are involved in upper level decisions and the key indicators regarding safety, quality, time and cost are updated and discussed on a weekly basis to get optimal results. All of those improvements wouldn't have been present without the encouragement and motivation of the top management and lean champions. Despite all those improvements, many challenges were faced during implementation. The root causes of the problems were identified but not resolved. Furthermore, some employees resist shifting to the new system which is why more training is needed so that the people are more motivated to change. The teams are following a master schedule prepared by the planning engineer which is somehow not in line with the actual facts/problems. Moreover, foreman and engineers prefer to improvise on the job without being obliged to solve all issues beforehand.

Despite the implementation challenges encountered on the project, the overall implementation goals were achieved. However, various improvement opportunities were identified. Training for all employees on LC and LPS and relating them to the Lean philosophy, will help in building a lean culture. Involving subcontractors and the client's representatives in the process will create a chance for reaping more benefits from implementing LC methods.

Moreover, the introduction of novel planning methods such as location based management, as a complimentary system to the LPS, can help in improving workflow and reducing waiting times across project areas. This study was performed on the initial stages of the construction phase where few subcontractors were involved. The activities till date were mainly related to concrete works which are self-performed by the Contractor. The challenge would be to integrate the subcontractors in the new system during the finishing phase. The construction company is willing to implement LPS on all its projects and has already begun this initiative with two other projects in two different countries in the Middle East. So far, it seems that the second and third attempts are more effective than the first, since the system is better defined and elaborated before its initial introduction. This created a higher buy-in compared to the first project. A later study will be conducted to see improvements and barriers faced on the other projects and compare them to the first implementation.

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