LAST PLANNER SYSTEM IMPLEMENTATION CHALLENGES

Vishal Porwal [1], Jose Fernández-Solís [2], Sarel Lavy [3], Zofia K. Rybkowski [4]

ABSTRACT

Plan unreliability is a critical problem in the construction industry. Since the industry is fragmented and every project is unique, schedule delay is a common phenomenon. Ballard and Howell proposed that shielding construction and stabilizing work flow is a solution to this problem. These two researchers, along with other lean construction scholars, developed the Last Planner™ System (LPS)[5] of Production Control through a series of experiments beginning in the early 1990's. LPS has become a popular tool among the lean construction community to stabilize work flow and make plans more reliable. However, LPS users and mentors report numerous challenges with implementation and use of this system.

This paper discusses findings from a literature survey about the challenges faced by construction professionals during the implementation and use of LPS. The aim of this research effort was to identify the challenges faced by construction professionals during the implementation and use of LPS at both organizational and project levels.

KEY WORDS

Last Planner System, Organizational challenges, Project level challenges

INTRODUCTION

The US Bureau of Labor Statistics (Teichloz 2004) reported that the construction industry is facing a severe decrease in labor productivity. Current research in the industry (Fernández-Solis 2007, Tommelein 1999) implies that complexity, variability, and uncertainty are the major causes of this decrease in productivity. Howell and Ballard's (1994) experiments with Last Planner™ System (LPS) of Production Control indicated that the use of formal and flexible production planning procedures is the first step in keeping the production environment stable. LPS is designed to shield production units from work flow uncertainty (Ballard et al. 1997), and it is an effective tool for enhancing plan reliability (Alarcon et al. 2008). Several industry professionals have applied LPS to solve a

[1] Graduate Student, Department of Construction Science, College of Architecture, Texas A&M University, College Station, Texas, USA, Ph: +1-979-450-3604, vishalporwal@gmail.com

[2] Assistant Professor, Department of Construction Science, College of Architecture, Texas A&M University, College Station, Texas, USA, Ph: +1-979-458-1058, jsolis@archmail.tamu.edu

[3] Assistant Professor, Department of Construction Science, College of Architecture, Texas A&M University, College Station, Texas, USA, Ph: +1-979-845-0632, slavy@archmail.tamu.edu

[4] Assistant Professor, Department of Construction Science, College of Architecture, Texas A&M University, College Station, Texas, USA, Ph :+1-979-845-4354, zrybkowski@tamu.edu

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

range of problems associated with unstable work flow and uncertainty, the roots of unpredictability.

There is a substantial body of literature concerning the use of LPS for various construction projects. The majority of this literature is in the form of case studies from the academic and industrial backgrounds. Case studies report the use of LPS in different project settings (building construction, heavy civil construction, etc.), in different parts of the world, and for different project phases (definition, design, pre-design, and construction). Challenges faced and lessons learned by stakeholders during implementation (initial training and kick off) and later use of LPS in different projects are also reported in these case studies. This paper summarizes these challenges and assesses their current state.

LAST PLANNER SYSTEM

LPS is a planning, monitoring and control tool that follows lean construction principles such as just-in-time (JIT) delivery, value stream mapping (VSM) and pull scheduling (also known as reverse phase scheduling).

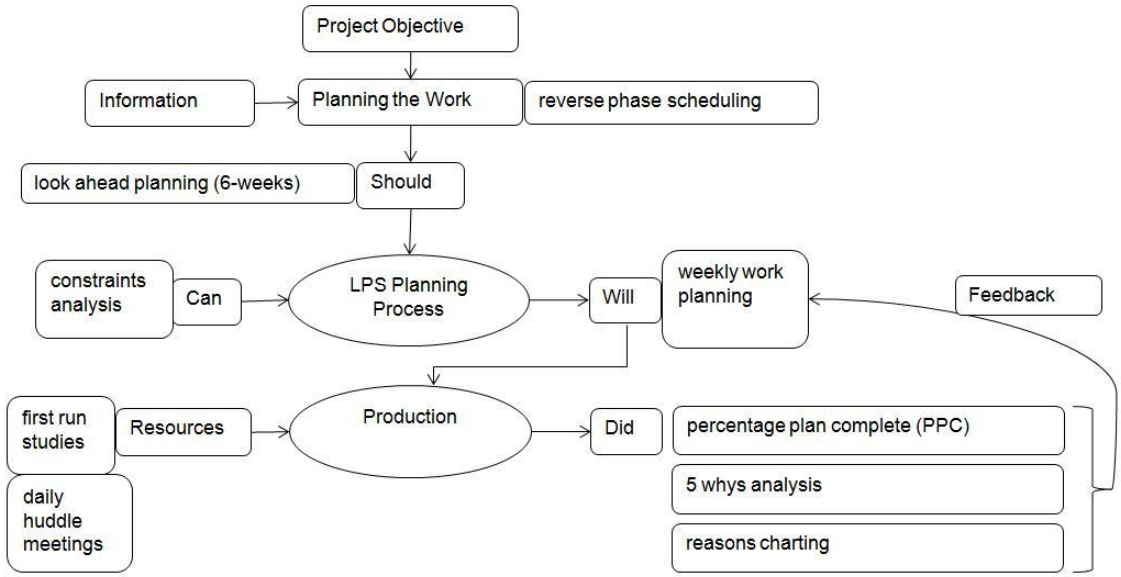

Figure 1: Last Planner System Planning Process

The primary function of LPS is the collaborative planning process that involves "last planners" for planning in greater detail as the team gets closer to doing the work. Moreover, LPS incorporates "pull scheduling[6]," whereby only the work that CAN be done is promised by last planners in weekly work plan meetings, as opposed to conventional "push scheduling," where the work that SHOULD be done is planned in weekly meetings and the emphasis is on adhering to a master schedule. Constraint

[6] A Pull technique is based on working from a target completion date backwards, which causes tasks to be defined and sequenced so that their completion releases work.

analysis, an integral part of LPS, is applied to take a proactive approach to problem solving as faced during the day to day requirements of construction projects (Ballard 2000). Additionally, the Plan-Do-Check-Act (PDCA) principle is followed by LPS as it encompasses a protocol to identify reasons for non-compliance to plan using the "Five-Why's" analysis and maintaining a feedback loop. Figure-1 shows the Last Planner planning process.

Ballard writes: "*The Last Planner system of production control can be characterized in terms of the principles that guide thinking and action, the functions it enables to be performed, and the methods or tools used to apply those principles and perform those functions*" (Ballard et al. 2009).

LPS IMPLEMENTATION AND USE IN CONSTRUCTION INDUSTRY

The Last Planner System of Production Control is in wide use throughout the world. In several instances of LPS implementation improvements in project delivery time, labor productivity, safety, and quality have been reported (Alsehaimi et al. 2009, Ballard et al. 2009, Ballard et al. 2007, Court et al. 2009, Formoso et al. 2009, Friblick et al. 2009, Garza et al. 2000, Khonzade et al. 2008).

LPS implementation typically starts with a pilot project in the majority of companies (Hill et al. 2007). Sutter Health, headquartered in Sacramento, California, implemented LPS on five pilot projects (David Medical Office Building, Modesto 8 Storey Bed Tower, Delta, Roseville Emergency Department, Roseville Parking Structure) as a part of the organization's lean initiative in 2004 (Ballard et al. 2007). After a series of experiments, LPS is in use on a number of Sutter Health construction projects (Hamzeh 2009). In Finland four major companies (YIT Rakennus Oy, Skanska Talonrakennus Oy, NCC Rakennus Oy and Rakennusosakeyhtiö Hartela) implemented LPS on four different pilot projects and developed a systematic implementation approach (training and theoretical justification workshops etc.). These pilot projects were followed with a second set of pilot projects. Productivity, safety, quality and schedule benefits were realized in these projects (Koskenvesa et al. 2009). In another example, the use of LPS improved communication and coordination among subcontractors on a multi-storey residential construction project (Song et al. 2008**).**

In addition to certain benefits, challenges faced by construction professionals during the implementation and use of LPS have also been reported by academic and industrial research. Table 1 lists the challenges and their occurrences in the literature. Construction professionals face challenges at two stages. First is the implementation stage, when the project team is introduced to LPS and pilot projects are in progress. These are organizational challenges faced by senior and mid-level management in the initial stages. During the second stage, LPS is used by an experienced team and technical challenges associated with skill building and human capital needed for using LPS are introduced.

RESEARCH METHOD

The aim of the research presented in this paper is to identify the challenges faced by construction professionals during implementation and use of LPS at organizational and project levels. To achieve this, the authors carried out a systematic review of literature in this field. The rationale used to select the LPS tool for study was related to the overall literature available on LPS use and implementation in different

countries. The scope was limited to publications dealing with LPS implementation and use at organizational and project levels. This means only descriptive articles reporting on real examples and cases were considered; purely theoretical, conceptual, and abstract works were excluded. An example of a publication that is clearly within the scope of this review process is that of Koskenvesa (2009) in which the author reviews the results of applying LPS to eight different construction projects.

The literature survey strategy was developed by first identifying relevant data sources, time frame, and key words. Initially, a very broad selection of databases was identified, covering journals, conference proceedings, books, and articles from trade journals. This included Compendex, Emerald, Elsevier and Construction Industry Institute (CII) & Center for Integrated Facility Engineering (CIFE) reports. These databases provide access to a wide variety of publications such as the *Journal of Construction Engineering and Management*, *Lean Construction Journal*, Conference Proceedings of the Annual Conferences of the International Group of Lean Construction (IGLC) and Conference Proceedings of the Construction Congress of the American Society of Civil Engineers (ASCE).

In order to restrict the search to more recent publications, the time frame for this study was chosen initially to include only literature published between 2005 and 2009. However, as the research progressed this was extended by widening the search criteria to include publications from 2000.

RESULTS AND ANALYSIS

The literature survey initially identified multiple relevant publications. Table 1 shows the 12 different challenges faced by construction professionals during the implementation and use of LPS and their occurrences, as documented in 17 different publications. The challenges fall into two categories: (1) challenges faced during the implementation phase, and (2) challenges faced during the use of LPS, as explained earlier in the paper. Following are lists of the challenges:

IMPLEMENTATION CHALLENGES[7]

1. Lack of training
2. Lack of leadership/failure of management commitment/organizational climate
3. Organizational inertia & resistance to change/"This is how I've always done it" attitude
4. Stakeholder support
5. Contracting and legal issues/contractual structure
6. Partial implementation of LPS & late implementation of LPS

[7] Implementation Phase: When the project team is introduced to LPS and pilot projects are in progress. These are organizational challenges faced by senior and mid-level management in the initial stages

Table 1: Challenges Faced by Construction Professionals during Implementation and Use of LPS

	Challenges	Garza J.M. et al. (2000)	Alarcon L.F. et al. (2002)	Fiallo C. M. et al. (2002)	Kim Y.W. et al. (2005)	Koskenvesa A. et al. (2005)	Arbulu R. et al. (2006)	Ansell M. et al. (2007)	Ballard G. et al. (2007)	Jang J.W. et al. (2007a)	Jang J.W. et al. (2007b)	Kemmer S.L. et al. (2007)	Kim Y.W. et al. (2007)	Sterzi M.P. et al. (2007)	Alsehaimi et al. (2009)	Hamzeh F. R. (2009)	Jara C. et al. (2009)	Liu M. et al. (2009)
1	Lack of Training		✔		✔	✔			✔	✔						✔	✔	
2	Organizational Inertia & Resistance to change /"This Is How I Always Done It" attitude		✔	✔		✔		✔	✔					✔	✔			
3	Human Capital & Lack of Understanding of new System & Difficulty to make Quality Assignments/Human Capital –Skills and experience				✔		✔					✔	✔			✔	✔	✔
4	Lack of Leadership / Failure of Management Commitment / Organizational Climate		✔				✔		✔									✔
5	Lack of commitment to use LPS & Attitude towards new systems	✔							✔						✔			✔
6	Bad team chemistry & Lack of collaboration						✔		✔					✔				
7	Stakeholder Support	✔								✔		✔						
8	Contracting and legal issues/ Contractual Structure	✔								✔								
9	Empowerment of field management /Lengthy approval procedure from client and top management										✔				✔			✔
10	Extra resources/more paper work/extra staff/more meetings/more participants / Time		✔								✔							
11	Partial Implementation of LPS & Late Implementation of LPS																	✔
12	Physical Integration						✔											

USER CHALLENGES[8]

1. Human capital & lack of understanding of new system; difficulty making quality assignments/human capital–skills and experience
2. Lack of commitment to use LPS & attitude toward new system
3. Bad team chemistry & lack of collaboration
4. Empowerment of field management/lengthy approval procedure from client and top management
5. Extra resources/more paper work/extra staff/more meetings/more participants/ time
6. Physical integration

On projects based in California (Fairfield Medical Office Building, the Retreat at Fort Baker, and UCSF's Cardiovascular Research Centre), Hamzeh (2009) reported challenges during the implementation of LPS. The general contractor faced challenges in implementing LPS, including (1) inexperience with LPS, (2) resistance to change, and (3) introduction of new technology. He also reported contractual challenges during the implementation phase.

Alarcon (2002) reported the challenges in implementing LPS in twelve companies in Chile. The main difficulty in implementation was the lack of time for implementing new practices in the projects already underway. Partial implementation, intermittent implementation and insufficient preparation of the planning meetings were often problems in these projects. Lack of training was another issue during the implementation. Project participants looked at LPS as a "micro planning system" and did not fully appreciate the conceptual aspects that support the real innovation in the management practice. Another important challenge was the fear of change among project participants. AlSehaimi (2009) validates Alarcon's (2000) findings through experimenting with LPS implementation in a Middle Eastern construction project.

Boldt has cited several obstacles to lean implementation (Ballard 2007). Number one on the list is the resistance to change. Lack of commitment from the stakeholders on a project is also reported, and another major obstacle is contractual structure on the project. Koskenvesa (2005) implemented LPS in four major companies in Finland and reported that many key professionals passionately subscribed to conventional production control methodology; rejecting the master schedule as a primary tool for controlling a project was not easily acceptable to them.

CONCLUSION

The literature review reveals that lack of training, resistance to change, lack of leadership, and lack of human capital in implementing and using LPS are major challenges, among others. Although LPS is widely used throughout the world, it is new to many construction professionals. Development of LPS implementation strategies and training could be important steps in the successful implementation and use of LPS at organizational and project levels. Strong leadership and management commitment to the implementation are also important for bringing needed change for positive results and continuous improvement.

[8] Using LPS at Project Level: When LPS is used by an experienced team and technical challenges associated with skill building and human capital needed for using LPS are introduced

Future research should use these findings to assess the challenges faced by construction professionals during implementation and use of LPS and to propose guidelines to address these issues.

REFERENCES

Alarcon, L.F., Diethelm, S., Rojo, O., Calderon, R. (2008). "Assessing the Impacts of Implementing Lean Construction" *Revista Ingeniería de Construcción*, Vol. 23 No.1, Abril de 2008.

Alarcon, L.F., Diethelmand, S., Rojo, O. (2002). "Collaborative Implementation of Lean Planning System in Chilean Construction Companies" *Proceedings for the 10th Annual Conference of the International Group for Lean Construction*, Granmado, Brazil.

Alsehaimi, A., Tzortzopoulos, P., Koskela, L. (2009). "Last Planner System: Experiences from Pilot Implementation in the Middle East" *Proceedings for the 17th Annual Conference of the International Group for Lean Construction*, Taiwan.

Ansell M., Holmes, M., Evans, R., Pasquire, C. and Price, A. (2007). "Lean Construction Trial on a Highway Maintenance Project" *Proceedings for the 15th Annual Conference of the International Group for Lean Construction*, Michigan.

Arbulu, R. and Soto, J. (2006). "A Design Case Study: Integrated Product and Process Management" *Proceedings for the 14th Annual Conference of the International Group for Lean Construction*, Santiago de Chile.

Ballard, G. and Howell, G.A. (1997). "Shielding Production: An Essential Step in Production Control." *Journal of Construction Engineering and Management*, ASCE, New York, NY, 124(1), 11-17

Ballard, G. (2000). "The Last Planner System of Production Control" Ph.D. Diss., Faculty of Engineering, Birmingham, The University of Birmingham. PHD: 192 pp.

Ballard, G. (2009). "Production Control Principles" *Proceedings of 17th Annual Conference of the International Group of Lean Construction*, Taiwan.

Ballard, G., Liu, M., Kim, Y.W., Jang J.W. (2007). "Roadmap to Lean Implementation at Project Level" *Research Report 234-11*, Construction Industry Institute (CII), Austin, Texas.

Court, P.F., Pasquire, C., Gibb, A. (2009). "A Lean and Agile Construction System as a Set of Countermeasures to Improve Health, Safety and Productivity in Mechanical and Electrical Construction" *Lean Construction Journal*, pp 61-76.

Fernández- Solis, J.F. (2007). "The Systemic Nature of the Construction Industry" *CIB World Building Congress-2007*, p: 1598-1625, (available at: http://www.irbnet.de/daten/iconda/CIB5266.pdf, Retrieved on January 15th 2010.)

Fiallo C. M. and Revelo P. V.H. (2002). "Applying the Last Planner System to a Construction Project- Case Study in Quito Ecuador" *Proceedings for the 10th Annual Conference of the International Group for Lean Construction*, Granmado, Brazil.

Formoso, C.T., Moura, C.B. (2009). "Evaluation of the Impacts of the Last Planner System on the Performance of Construction Projects" *Proceedings of 17th Annual Conference of the International Group of Lean Construction*, Taiwan.

Friblick, F., Olsson, V., Reslow, J. (2009). "Prospects for Implementing Last Planner in the Construction Industry" *Proceedings of 17th Annual Conference of the International Group of Lean Construction*, Taiwan.

Garza, J.M., Leong, M.W. (2000). "Last Planner Technique: A Case Study" *Construction Congress VI: Building Together for a Better Tomorrow in an Increasingly Complex World Proceedings of Construction Congress VI*, ASCE, Orlando, FL, USA.

Hamzeh, F.R. (2009). "Improving Construction Workflow- The role of Production Planning and Control" PHD Diss., University of Berkley, California, USA, 274 pp.

Hill, K., Slivon, C., Draper, J. (2007). "Another Approach to Transforming Project Delivery: Creating a Shared Mind" *Proceedings for the 15th Annual Conference of the International Group for Lean Construction*, Michigan.

Howell, G.A., Ballard, G. (1994). "Implementing Lean Construction: Reducing Inflow Variation" *International Group for Lean Construction Meeting Procedures* – Chile.

Jang, J.W., Kim, Y.W. (2007a). "Using the Kanban for Construction Production and Safety Control" *Proceedings for the 15th Annual Conference of the International Group for Lean Construction*, Michigan.

Jang, J.W., Kim, Y.W., Park, C.J., Jang, W.S. (2007b). "Importance of Partners in a Challenging Lean Journey" *Proceedings for the 15th Annual Conference of the International Group for Lean Construction*, Michigan.

Jara, C., Alarcón, L.F., Mourgues, C. (2009). "Accelerating Interactions in Project Design through Extreme Collaboration and Commitment Management – A Case Study" *Proceedings for the 17th Annual Conference of the International Group for Lean Construction*, Taiwan.

Kemmer, S.L., Heineck, L.F.M., Novaes, M.V., Alexandre, C., Mourão, M.A., Alves, T.C.L. (2007). "Medium term Planning- Contribution based on Field Application" *Proceedings for the 15th Annual Conference of the International Group for Lean Construction*, Michigan.

Khanzode, A., Fischer, M., Reed, D. (2008). "Benefits and Lessons Learned of Implementing Building Virtual Design and Construction (VDC) Technologies for Coordination of Mechanical, Electrical, and Plumbing (MEP) Systems on a Large Healthcare Project" *ITcon*, Vol. 13, pp 324-342

Kim, Y.W., Jang, J.W. (2005). "Case Study - An Application of Last Planner to Heavy Civil Construction in Korea" *Proceedings for the 13th Annual Conference of the International Group for Lean Construction*, Sydney.

Kim, Y.W., Park C., Ballard, G. (2007). "A Case Study on Rebar Supply Chain Management by GS E&C" *Proceedings for the 15th Annual Conference of the International Group for Lean Construction*, Michigan.

Koskenvesa, A., Koskela, L. (2005). "Introducing Last Planner- Finnish Experience" *Proceedings of CIB Conference*, Helsinki.

Liu, M., Ballard, G. (2009). "Factors Affecting Work Flow Reliability -A Case Study" *Proceedings for the 17th Annual Conference of the International Group for Lean Construction*, Taiwan.

Song, L., Liang, D., Javkhedkar, A. (2008). "A Case Study on Applying Lean Construction to Concrete Construction Projects" (available at:

http://ascpro0.ascweb.org/archives/cd/2008/paper/CPGT201002008.pdf, Retrieved on January 15th 2010.)

Sterzi, M.P. , Isatto E.L., Formoso, C.T. (2007). "Integrating Strategic Project Supply Chain Members in Production Planning and Control" *Proceedings for the 15th Annual Conference of the International Group for Lean Construction*, Michigan.

Teicholz, P. (2004). "Labor Productivity Declines in the Construction Industry: Causes and Remedies" AECbytes Viewpoints, (available at: http://www.aecbytes.com/viewpoint/2004/issue_4.html, Retrieved on January15th 2010.)

Tommelein, I. D. (1999). "Parade Game: Impact of Work Flow Variability on Trade Performance" *Journal of Construction Engineering and Management*, September/October-1999, pp:304- 310.