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# A ROUTE MAP FOR IMPLEMENTING LAST PLANNER® SYSTEM IN BOGOTÁ, COLOMBIA

**Camilo Mejía-Plata[1], Juan S. Guevara-Ramirez[2], Daniel F. Moncaleano-Novoa[3], María C. Londoño-Acevedo[4], Juan S. Rojas-Quintero[5] and Jose L. Ponz-Tienda[6]**

## ABSTRACT

In recent years, Lean Construction (LC) has come to be known among the construction industry in Colombia for its proven waste reduction potential, ability to increase value and improvement of project performance overall. The Last Planner® System (LPS) is one of the most valued and commonly used LC methodology in Colombia, however, there is not enough clarity about how it works or how to properly apply it. To this extent, this qualitative research proposes a route map for implementing LPS in Bogotá, based on a review of its current application, in order to guide companies toward a proper use of it. The assessment was carried out throughout a benchmarking process known as The Reading Model in which four of the eighteen competing companies that use LPS, were evaluated in terms of their commitment and scope in each aspect of the three main LC pillars: culture, philosophy and technology. The aim of the research is to identify possible improvements for the LPS implementation and to adapt the True North route map to the assessed context. Despite the fact that only four companies participated, it was found that all of them face similar barriers related to contractors' engagement, reluctance to change and lack of training.

## KEYWORDS

Last Planner System, Lean Construction, Culture, Production Planning, Benchmarking.

## INTRODUCTION

The Last Planner® System (LPS) of Production Control is a production planning method for construction projects (Ponz-Tienda, Pellicer, Alarcón, & Rojas-Quintero, 2015). This system was created by Glenn Ballard (1994, 2000) and Greg Howell (1998) in order to

[1] Graduate student, Universidad de Los Andes, Bogotá, Colombia, camilomejiaplata@hotmail.com
[2] Graduate student, Universidad de Los Andes, Bogotá, Colombia, juanguevarar@gmail.com
[3] Graduate student, Universidad de Los Andes, Bogotá, Colombia, dfmoncaleano@gmail.com
[4] Research assistant. Department of Civil and Environmental Engineering. Universidad de Los Andes, Bogotá, Colombia, mc.londono1449@uniandes.edu.co
[5] Instructor. Department of Civil and Environmental Engineering. Universidad de Los Andes, Bogotá, Colombia, js.rojas128@uniandes.edu.co
[6] Assistant Professor. Department of Civil and Environmental Engineering. Director of Construction Engineering and Management. Universidad de Los Andes, Bogotá, Colombia, jl.ponz@uniandes.edu.co

improve the predictability and reliability of construction production (Mossman, 2014). It has been implemented by numerous companies around the world for more than 20 years, which has allowed it to demonstrate its effectiveness in different cultures and work environments. (Daniel, E.I., Pasquire, C. and Dickens, G., 2015; Viana *et* al. 2010).

LPS was first introduced in Colombia in 2007 (Portafolio, unpublished data, 2008). At first, four companies started the implementation process, up to now, that number has increased to eighteen. (CAMACOL, unpublished data, 2015). Despite of the long track record LPS has worldwide, the adoption of this method has been difficult for Colombia, due to the high reluctance to change of the national construction companies. Moreover, there is almost no literature on the subject apart from informal unpublished university documents, undergrad and master´s thesis and one case study (Botero, L. F., Botero, F. and Álvarez, M. E., 2005). For this reason, an assessment of the LPS implementation in the city of Bogotá has been carried out to provide feedback for those constructors who have taken the initiative of applying this system. Furthermore, this study intends to promote the introduction of LPS in construction companies that still have not set it in.

LPS is not a Toyota's creation. The first appearance of the LPS concept in the construction industry took place in the 1990s. This method was created to promote and control the production in construction projects, through the management of the relationships, conversations and commitments. (Alarcón & Pellicer, 2009). LPS offers a realistic way to collaboratively manage project production, enables clashes to be identified and resolved before they turn into on-site problems and increments the possibilities that the work will flow and the projects will be completed on time. It is an essential link between logistics and assembly teams (Mossman, 2014).

## BENEFITS AND CHALLENGES IN THE LPS IMPLEMENTATION

Several studies talking of the benefits and challenges of the LPS implementation have been developed in different countries, some of their findings are mentioned hereafter. Fernandez-Solis et al. (2013) point out the following benefits: smooth work flow, predictable work plan, reduced cost, reduced delivery time, improved productivity and greater collaboration with field personnel and subcontractors.

On the other hand, certain challenges faced when implementing LPS are: lack of leadership, organizational inertia, resistance to change, lack of training, contractual issues and lack of experience and knowledge.

There are multiple reasons that promote the adoption of LPS in companies and projects, some of them are to: deliver projects more safely, create a more predictable production program, reduce project duration, manage cost in a better way, reduce stress on project management, improve the overall production process, create trust among clients, establish clear and simple deliverables, improve communication and participants' integration, create transparency in the information and certainty about activities and finally motivate strongly team collaboration. On the other hand, some of the aspects that shall not be expected for implementing LPS are: directly earning more money, automatically delivering the project before schedule, replacing software with this system and reducing conflicts in some of them. (Ballard, 2000; Fernandez-Solis et al. 2013; Formoso, C. T. and Moura, C. B., 2009; Hamzeh, 2011; Mossman, 2014)

### THE TRUE NORTH: A NAVIGATIONAL COMPASS TO GUIDE COMPANIES ON THE RIGHT TRACK

*The True North* concept evolved from Toyota. It is an absolute, fixed, immutable reference that serves as a guide towards the ideal way of how things should be done. (Smalley, 2015). As Rother (2010) said, besides of the application of a continuous improvement philosophy, a guide is needed. Thus, a long-term vision helps the company to navigate across this process until the goal is accomplished: the perfect implementation of LPS. In other words, the True North works is a compass for guiding companies from their current state to their target state, on the right track (Nesensohn, Demir, & Bryde, 2013; Nesensohn et al. 2013). Conducting a benchmarking process is a good methodology for a company who wants to find the appropriate path for improving LPS.

### BENCHMARKING

Benchmarking is a tool designed for measuring the quality of organizations in terms of policies, programs, products and strategies, among others. Likewise, it is used for determining which improvements should be implemented, for analyzing how other companies accomplish high productivity levels and in such a way applying it.

As stated by Mohamed (1997), there are three different ways of carrying out a benchmarking process in the construction industry: internal, project and external. Internal benchmarking compares internal operations for producing a continuous improvement. Project benchmarking compares projects within a company looking forward to creating a data base for the management of future projects. Finally, external benchmarking attempts to adapt the best practices from other industries to a certain company.

Similarly, McCabe (2001) describes three types of external benchmarking: competitive, functional and generic. Competitive benchmarking compares a company with any of its direct competitors. Both functional and generic benchmarking are very similar and aligned to the external benchmarking definition.

Lastly, *The Reading Model* is a benchmarking model especially designed for the construction industry because the existing ones were too detailed or inflexible (Pickrell et al. 1997), and the construction industry needs a simpler and more flexible method (Garnett & Pickrell, 2000). This approach is based on the following steps: 1) recognizing the need for change, 2) deciding what to benchmark, 3) deciding who to benchmark against, 4) deciding what data to collect, 5) collecting the data and analysing it, and 6) putting the results into practice.

## RESEARCH METHOD

For this case study, four companies that use LPS to some extend in Bogotá, were evaluated in terms of their commitment and scope in each aspect of the three main LC pillars: culture, philosophy and technology defined by Salvatierra et al. (2015). Contact was established with seven out of the eighteen companies that claim to apply LPS in Colombia; these seven were prepared for participating in the study, however, three of them withdrew for internal reasons. None of the four companies involved in this research had been applying LPS for more than three years.

Having in mind the purpose of evaluating the implementation of LPS, it was raised that the issues to be compared were all those which can be associated with a suitable implementation of the tool, and those which, according to the theory, a company who uses LPS has. Semi structured interviews, and open-ended questionnaires were performed to several members of each company. Also, the authors participated on these companies Pull Sessions and carried out on site observation.

The benchmarking was used to determine the quality of the LPS implementation in Bogotá. Particularly, a competitive benchmarking process with the purpose of adapting other companies' best practices to their direct competing companies was developed through the six step Reading Model.

## DEVELOPING A TRUE NORTH FOR LPS THROUGH THE READING MODEL

### Step 1: Recognising the need for change

Due to the reception of LC and the LPS method in Bogotá, many players, such as academics and managers, are worried and insecure with regard to the steps to take to accomplish the right LPS implementation. For this reason, the industry turned to the academy, inasmuch as they recognize the potential of this innovative philosophy versus the traditional management methodology (Pellicer & Ponz-Tienda, 2014) (Pellicer, Cerveró, Lozano, & Ponz-Tienda, 2015). They also have many doubts about how to apply it and this is why they demand a compass or route map for acquiring good practices and generating a continuous improvement.

### Step 2: Deciding what to benchmark

Considering that LPS success depends on the Lean Construction principles being implemented, the authors have made their benchmark based on the Lean construction principles, tools discussed in the literature, and the globally reported LPS practice. (Ballard, 2000). Some of these aspects are: Pull Sessions, Look Ahead, Weekly Work Plan (WWP), Percent Plan Complete (PPC), changing the culture form push to pull, Kaizen philosophy and training among others. (Ballard, 2000; Mossman, 2014)

### Step 3: Deciding who to benchmark against

As mentioned before, four companies that have started to introduce LPS in Bogotá decided to participate. While meeting with them, it was noticed that the chiefs of the Lean department were very motivated with the fact of being compared with other construction companies, who are their competitors, and of receiving a feedback about how to implement LPS in a better way.

### Step 4: Deciding what data to collect

After performing an extensive bibliographic review, consulting experts and attending the first SEINCO-2015 (Ingeco, Universidad de los Andes, personal communication, 2015) it was concluded that the three main pillars for LC can also be claimed to be the life triangle of LPS: culture, philosophy and technology. For an appropriate and accurate implementation of LPS, these three pillars are needed. The lack or weakness of one of them may cause the failure of the method. (Salvatierra et al. 2015)

**Step 5: Collecting the data and analysing it**

Different subcategories were defined for the three main categories previously mentioned: culture, philosophy and technology. The presence in at least one Pull Session from each of the companies that participated was fundamental for the purpose of harvesting information, and for objectively observing which subcategories were applied and which were not. The obtained results are shown in Table 1, Table 2 and Table 3.

Table 4. Benchmarking LPS culture

| CULTURE | Company | | | |
|---|---|---|---|---|
| | A | B | C | D |
| Just in time | X | X | X | |
| 5 Whys | X | X | X | X |
| 5 Ss | X | X | | X |
| Pull Sessions attendance | X | X | X | X |
| Genba – See with your own eyes and in the real place | X | X | X | X |
| Hoshin – Each person is the expert in his or her own work | | | X | X |
| Kaizen thinking – Continuous improvement | | X | X | X |
| Assistants participation | X | X | X | X |
| Pull Planning | | | X | X |
| Last planner | | | X | X |
| Acceptance of LPS by contractors | | | | X |
| Acceptance of LPS by company's workers | X | X | | X |
| Supervision of the LPS implementation by the head of the company | | X | X | X |
| Philosophy application | X | X | | X |

Table 5. Benchmarking LPS technology

| TECNOLOGY | Company | | | |
|---|---|---|---|---|
| | A | B | C | D |
| Software that allows them to calculate and evaluate the PPC | X | X | X | X |
| Software that allows them to see the project program | X | X | | X |
| Software that allows them to see the evolution of the project | | X | X | |
| Software that allows them to see the design of the project | X | X | X | X |
| "Value Stream Mapping" | | | | |
| Hoshin Kanri – Strategic planning | | | | |
| *Line of Balance | | X | | X |
| *IA3 report | | | | |
| *IPD | | X | | |

Table 6. Benchmarking LPS philosophy

| PHILOSOPHY | Company | | | |
|---|---|---|---|---|
| | A | B | C | D |
| Clarify doubts | X | X | X | X |
| Well-defined and free activities | X | X | X | X |
| Commitments | | | X | X |
| External training | | X | | X |
| In-house training | X | X | X | X |
| Visual management | | | X | X |
| Milestones - direction – where are we going? | X | X | X | X |
| Look Ahead | | | X | X |
| Main Program | | | | X |
| Phase Schedule | | | X | X |
| Weekly work plan revised/updated with daily data | X | X | | |
| Restrictions worksheet | | | X | |
| Plus-Delta | | | | |
| PPC | X | X | X | X |
| Publication of results in public areas | | X | | X |
| Pull Session | | | X | |
| Revision of the non-compliance reasons of the last plan | | | X | X |
| Revision of the PPC of the last plan | X | X | X | X |
| WBS | | | X | |
| WWP | X | X | X | X |
| Zones, areas, responsibilities and clients | | | X | X |
| Reverse phase scheduling | | | X | |

## Step 6: Putting the results into practice

With the previous results, the steps to be taken for generating a guide that serve as a compass for the implementation of LPS in Bogotá were identified. However, applying this route map does not guaranty that the best implementation of LPS will be obtained. There might be some extra steps that are not included in this guide and some others that might be useless. The important thing is that each company takes into account this recommendations and is willing to create its own path towards their goals and therefore achieve the correct implementation of LPS.

Figure 1 presents the fifteen steps that make up the compass for the Lean implementation proposed by Nesensohn (2013).

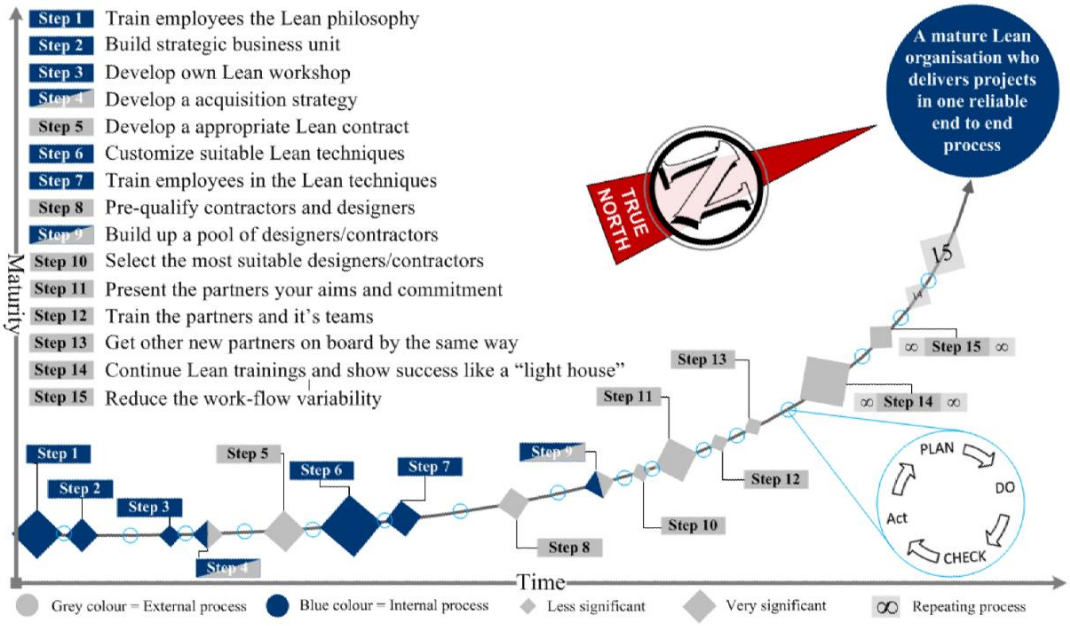


Figure 6. Compass for the Lean implementation. (Nesensohn C. et al., 2013).

For purposes of this study, the steps for implementing Lean proposed by Nesensohn were modified and adjusted in order to improve the implementation of LPS. The fourteen steps presented in table 4 are the achieved outcome of this adjustment and the suggested plan for the proper LPS implementation in Colombian companies.

Table 7. Steps of the route map for the LPS implementation.

| | **STEP** |
|---|---|
| 1 | Train every member of the company the LC culture and LPS. |
| 2 | Create a Lean department, where the head is a LC and LPS expert with experience. |
| 3 | Hire an external consultant that verifies and supports the start of LC and LPS. |
| 4 | Train employees the LC and LPS technologies and philosophies. |
| 5 | Rate contractors according to if they do or do not apply LC and LPS. |
| 6 | Create a data base with the contractors that apply LC and LPS. |
| 7 | Select the accurate contractor according to the project. |
| 8 | Start the LC an LPS implementation with a pilot project. |
| 9 | Learn from the mistakes made in the pilot project and avoid repeating them on future projects. |
| 10 | Apply it in every project that starts once the pilot Project has finished. |
| 11 | Promote communication between projects to: inform mistakes from one and avoid them from happening in another, inform advances from one project and to apply them in another, and to facilitate mutual support among workers from different projects. |
| 12 | Continuous external supervision while the implementation of the LC and LPS culture, philosophy and technology is achieved. |
| 13 | Internal supervision (everyone supervises everyone). The owner or general manager should be the most involved one in the supervision. |
| 14 | Training and continuous improvement. |

# FINDINGS AND RECOMMENDATIONS

Companies who have been implementing the system for more than a year claim that they have seen improvements on the development of their projects, the worksite is more organized, waste has been reduced, and changes regarding the way in which the construction site was traditionally managed were noted. However, several barriers for the LPS implementation related to contractors' and stakeholders engagement, reluctance to change, partial implementation and lack of training were identified. Detected barriers are aligned with the ones reported in the literature by Hamzeh (2011), Porwal et al. (2010) and Viana et al. (2010). It was found that two of the companies that claimed to apply LPS assumed that caring out weekly meeting would imply they carried out pull sessions and were Lean.

The study was limited by the number of companies who decided to participate and by the quality and amount of the collected data, this due to the fact that a rating scale would have been better than a yes/no assessment for the benchmarking process. To this extend, further research is required to assess the maturity level of the LPS and the Lean implementation in Colombia.

Based on the previous findings and on the on site observations, the following recommendations were formulated: visual aids are vital to gain interest and understanding from the ones involved in the sessions. Being open to change is a must. Sometimes actions that may seem strange or against intuition are needed. Some of them may bring strong improvements to the company. Do not force assignments on contractors. It is crucial that they acquire commitments on their own to ensure an increased percentage of promises completed. Curb malpractices, continuous monitoring of the implementation should be done to avoid committing the already amended mistakes. Using the PPC is important for qualifying contractors, determining the non-compliance reasons and preventing them from happening again. Nonetheless, the PPC should not be used to punish contractors whose yields are low. A little is good, more is better, everything is excellent. Meetings participation should be a contractual requirement, in order to establish the Lean culture in every stakeholder involved in the construction site. Team members who resists change should be brought in with training and understanding. Companies' staff who participate in the Pull Sessions should be trained about the proper use of the LPS method, throughout the interaction with the academy.

# CONCLUSIONS

While the assessment could not be conducted with the eighteen construction companies that currently implement LPS in Bogotá, it was found that they all face similar problems. The fact of passing from giving orders to contractors to encouraging them to assume their own commitments with the activities that should be performed was a very common difficulty. Some constructors claimed that if they allowed contractors to assume their own commitments, they would commit to do less than what they could actually do. However, the companies that applied it managed to see substantial improvements on the performance of the projects. It is important to understand that when the pace of change of the environment is greater than the one of the organizations, they tend to disappear. For this

reason, it is essential that companies work hard in innovation and be open to change to maintain their competitiveness and in such way assure their existence.

For the accurate LPS implementation three fundamental pillars should be taken into account: technology, philosophy and culture. It is essential to understand that the lack or poor development of one of them leads to the failure of the implementation. It could be seen that construction companies have excellent software technology at their disposal, the majority of them understand the philosophy, but they fail on the adoption of the Lean culture. It is therefore appropriate to emphasize on its proper introduction, since if not everyone is willing to change, issues in the implementation will occur in the long and medium term. Along the study it was noticed that many people consider themselves as Lean for applying LPS. The truth is that to be Lean many tools and methodologies have to be applied bearing in mind the three pillars previously mentioned.

One of the main challenges in the LPS implementation is to train the members involved in the construction site. Learning and implementing new procedures in any process is relatively simple. Nevertheless, when the stakeholders are not ready to change, everything gets more complicated. Furthermore, it should be stressed that even though Lean construction is far more than LPS, the usage of this method enables the introduction of the Lean concept in construction companies. On this particular assessment, an absence of professional wroth possibilities for the people devoted to Lean Construction was perceived. This is why, very often construction professionals find unattractive the study of this management philosophy.

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