

A FRAMEWORK FOR IMPLEMENTING THE LAST PLANNER® SYSTEM IN A VIRTUAL ENVIRONMENT

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ABSTRACT

The Last Planner® system (LPS) has witnessed a major shift in implementation at the onset of Coronavirus disease 19 (COVID-19). Governed by maintaining social distancing and many other safety restrictions, some construction practices including LPS implementation are now taking place in the virtual environment. However, potential challenges and enablers of implementing LPS in such an environment are yet to be investigated. This paper presents a framework based on lean philosophy and aims at successful implementation of LPS in a virtual environment. The framework calls for embracing a strong lean culture in the virtual work environment. The study also seeks to outline the challenges and enablers of this implementation. The framework was tested on a construction project through an expert panel. Results show that the framework is promising, and that although COVID-19 inflicted many challenges, it also had some positive impacts on LPS implementation. The framework will help practitioners and managers adopt a systematic approach from initiation to implementation of LPS in a virtual environment.

KEYWORDS

Last Planner® System (LPS), challenges, enablers, COVID-19, virtual environment.

INTRODUCTION

The Last Planner® System (LPS) is a production planning and control system aimed at reducing variation and uncertainty in construction works (Hamzeh et. al, 2012). However, the global pandemic Coronavirus disease 19 (COVID-19 infectious disease) that surfaced in 2019 was not accounted for in any production system; and it was first perceived as an external condition for construction projects. This pandemic imposed hurdles on various aspects of businesses including the construction industry. Furthermore, the rapid spread of the virus and the unfamiliarity with its transmission mechanisms induced officials to

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issue restrictions such as limited person to person contact (Parr et. al, 2021). This led to the online communication platforms replacing the face-to-face meetings.

Knowing that the human workforce is at the base of designing and making in construction projects, the construction industry is facing many challenges to adapt to the new work conditions imposed by the current circumstances. Indeed, construction projects are achieved by the collaborative efforts of engineers, general contractors and trades, managers, workers, foreman, suppliers, etc. Particularly, the pillars of the LPS are planning work in greater details, developing the plans with the people who will perform the work, identifying and removing constraints ahead of time, making reliable promises, and learning from failures (Hamzeh et. al, 2012). Proper implementation of the aforementioned pillars has been successful on many projects. However, governed by maintaining social distancing, current LPS practices are yet to be explored. Many research studies addressed the challenges and enablers of implementing LPS in normal conditions. Nonetheless, no research study has been found to tackle the issue of implementing the LPS in a virtual environment. This study presents a framework to guide practitioners and companies in implementing LPS in a virtual environment based on lean philosophy. It also employs an expert panel questionnaire to assess the enablers and challenges currently faced by a company following a similar framework.

LITERATURE REVIEW

Various aspects of lean practices are tackled heavily in the literature, especially LPS. Challenges and enablers of implementing LPS are discussed by many researchers. Table 1 below summarizes challenges discussed by some researchers.

Furthermore, the literature highlights many endeavours that complement LPS implementation in the industry. Several researchers have proposed frameworks that target successful implementation of LPS. These frameworks act as guidelines that highlight critical factors for effective implementation and how to address them. Daniel and Pasquire (2017) developed the LPS-PCA approach for effective implementation of LPS on construction projects. The approach does not describe the LPS implementation methodology, but rather serves as a guide for clients, main contractors, or subcontractors to help identify and remove constraints that were proved to obstruct LPS success. Hamzeh (2011) conducted an action-based research on three construction projects implementing the LPS. The author came up with a framework describing 11 guiding principles for successful and sustainable implementation of LPS.

Nevertheless, the discussion about LPS frameworks and implementations is limited to implementation in casual conditions. Casual conditions refer to the absence of a pandemic that imposed restrictions on face-to-face meetings and overall business practices. Still there are some studies that addressed the impact of COVID-19 pandemic on the overall construction industry. For instance, according to a study conducted by Assaad and El-adaway (2021a), COVID-19 has affected four main areas within the construction projects: (1) workforce, (2) project and workplace concerns, (3) procurement and supply chain, and (4) contractual, legal, and insurance processes. Furthermore, due to the COVID-19 infection, the workers' absence from the site witnessed an increase (Franzese, 2020) and so did the provisional suspension of on-site work because of the 14 days quarantine (Piro, 2020). Moreover, there was a decrease in the overall project productivity and labor productivity due to widespread pandemic infections (Assaad and El-adaway, 2021b).

Consequently, this study presents a framework for successful implementation of LPS in a virtual environment given the current conditions and addresses the challenges faced by practitioners.

Table 1 Literature Review on Challenges to LPS Implementation

Researcher	Challenges to LPS Implementation
Viana et. al (2010)	<ul style="list-style-type: none"> Difficulty in adapting to the new culture Incompatible personnel qualifications Long time spent on planning issues Incomplete information High interdependence between different processes
Ballard et. al (2007)	<ul style="list-style-type: none"> Strong resistance to change Lack of leadership Lack of commitment from upper management Lack of active support due to top-down management
Hamzeh et. al (2016)	<ul style="list-style-type: none"> Different levels of understanding of Lean Construction philosophy Repetition of failures Non-collaborative development of the master schedule
Porwal et. al (2010)	<ul style="list-style-type: none"> Lack of training Lack of leadership Failure of management commitment/organizational climate Organizational inertia & resistance to change Stakeholder support Contracting and legal issues/contractual structure

METHODOLOGY

The research methodology adopted is Design Science Research. This methodology includes three main phases: problem identification, solution design, and evaluation (Offerman et. al, 2009). This study tackles the problem of implementing LPS in a virtual environment. The literature identified and classified general challenges of implementing LPS. However, no study has been found to tackle the challenges and enablers of implementing LPS in a virtual environment. As for the solution design, a framework that targets these challenges to achievement of full potential of LPS is developed. Lastly, the evaluation is performed through the assessment of enablers and challenges of implementing a similar framework. This is done by interviewing an expert panel of practitioners working on different construction projects. The practitioners work at the same company where they apply LPS in the current situation governed by safety restrictions on many aspects due to COVID-19. The company, which operates in the field of general contracting, selected a software that facilitates LPS implementation and is currently involved in six projects. The following section presents the suggested framework.

SUGGESTED FRAMEWORK

The challenges faced when implementing LPS may still be faced in a virtual environment. COVID-19 is a warning for people to rethink the current management methods and have the urgency to adopt a new workstyle that aims at improving productivity and reducing the impacts of possible contingency. Therefore, the suggested framework reintroduces different aspects of lean philosophy to pave the way for successful implementation of LPS. This framework is inspired by the framework developed by Hamzeh (2011); the framework was used as a starting point and amended as per the authors' research on the challenges of applying LPS in a virtual environment. Since LPS is based on collaboration and communication between different project stakeholders, the new framework facilitates LPS implementation catering to well-known challenges from previous experiences and the imposed novel challenges. The steps for implementing the framework are as follows.

1- Top Management Buy-in: The first step is of paramount importance; it is about the top-down management devoting a strong buy-in for the lean principles within its vision and embracing a lean culture. A lean culture implies one where everybody is encouraged to contribute to improvements in a collaborative environment. AlSehaimi et al. (2009) classified top management support as a critical success factor of LPS implementation; and it acts as a prerequisite for the following steps. They have the highest influence of change in the organization's systems and people. Managers usually resist abandoning the traditional practices they have adopted for years, and this is normal. Also, some will come with preconceived beliefs that a new system will not work. Accordingly, a mentality shift within the work environment should be achieved; it is challenging but not impossible. Presenting the advantages of lean construction through a small pilot study and more importantly showing that it works is a good strategy to achieve the shift.

2- Mid Management and Last Planners Buy-in: The second step is also of great importance. After the top management firmly believes in the need for LPS, they will encourage and convince the rest of the team (mid managers and last planners) to implement the method. It is expected to experience ramp up time adapting to the new system and moving people out of their comfort zone. However, providing a training where people are walked through the rationale and the advantages of applying lean and last planner system eases this phase. In brief, the top management shall not push the system on the people, but rather highlight the effectiveness and the need of such a system. This will also build trust within the organization and enhance collaboration.

3- Creating a Cross Functional Team: "Work groups are the focal point for solving problems." (Liker, 2004). Creating a cross-functional team that brings together people from various trades and disciplines and investing in such a team is essential. Most of the improvements a company achieves could come from its people since they are the ones involved in various aspects and operations of the job. The team should have autonomy and freedom to suggest LPS implementation ideas. It is essential to have a lean expert on the team at this point to guide and oversee the whole process.

4- Providing LPS Training: The basis of the company's management approach needs to be one that integrates social systems with technical systems through training exceptional people (Liker, 2004). The lean expert should give a thorough and practical training on the principles and tools of LPS. It is crucial to build the discussion on the importance of embracing the long-term philosophy behind the lean culture, even at the expense of short-term financial goals; lean is way more than just tools and techniques (Liker, 2004). The training is a critical step in the overall process, it should not be pushed and forced on the team. The last planners should be highly involved as they will be the

ones who will utilize the LPS tool mostly. Several online communication platforms that allow screen sharing can be used to achieve this. This way, the expert providing the training can share their screen with all participants. Furthermore, virtual lean simulations are becoming a popular approach for educating people more about different lean aspects.

5- Mapping the Planning Process Using Value Stream Mapping (VSM): After training the team, members will have a better idea of the current practices and can contribute towards process improvements more effectively. There might exist great but undiscovered opportunities for improvements in the operations of a company; using a simple visual mapping tool such as VSM assists in uncovering such opportunities. It allows pinpointing deficiencies and wastes in the current operations and stimulates participants to think of effective alternative solutions using a common language. Therefore, the current planning process should be mapped by the team where they give feedback on how to improve the process based on their experience. This exercise can also be done using commercial applications that allow users to draw charts and diagrams seamlessly. This is equivalent to the teams meeting in a room and mapping everything with sticky notes. All participants can contribute through adding the improvement ideas they have using such online tools.

6- Investigating Available Software: Although meeting in one room became unfeasible due to safety restrictions, the project participants can still conduct weekly work plans and other LPS requirements through an online software. Many software support LPS implementation; the software should serve the team in achieving their needs and should have a simple interface. Essential features should include managing weekly work plans (WWP) and PPC, constraints, and coordination between trades. The last planners should still be able to link the front-end planning (master schedule) with production planning (look-ahead and WWP) using the software or else the PPC would not be a reliable indicator of the project performance (Hamzeh et. al, 2012). It is recommended to have software companies present their product and explain its features to the whole team; and the team could ask for any clarification they have in mind. To make a decision, the team should give feedback on the pros and cons of each software with respect to how well the software fits their needs.

7- Choosing by Advantage (CBA) a Software: The evaluation technique to pick the software is CBA which is a subjective and collaborative decision-making technique. Several potential software alternatives should be initially specified. The team must decide on the factors they are interested in such as the ability to integrate with Primavera P6, daily coordination, task duration flexibility, etc. The process could be done using simple tools such as a spreadsheet. This will help the team come to a united decision on what fits them best. At this point, a technical expert from the software company chosen should join the team for the implementation of the software and adjust it as per what the team needs and not necessarily pushing what the software does.

8- Providing Training on the Software: The software will be the tool the last planners use to effectively implement the LPS. The software should not be a burden on the last planners because it is critical for them to have a new system supporting their work rather than hindering it. It is highly recommended to have a representative from the software company and have flexibility to adjust according to last planners' need when possible.

9- Preparing a Dashboard with Various Metrics: Although PPC is the most used metric in practice, there are many metrics that are essential and complement PPC. There is a significant gap between near-term planning and long-term planning (Hamzeh et al.,

2019). A dashboard will serve as a tool to continuously monitor performance and uncover hidden problems on site. Also, it is as a proactive tool that will help projects stay on track.

10- Implementing a Pilot Study on a New Project/Project Phase: The implementation of LPS is easier and more effective when it is implemented at an early start of a project (AlSehaimi et al., 2009). This will help the team to set the foundations right and improve as they progress. People tend to be convinced more when they see tangible results. As mentioned earlier, seeing the advantages of the lean system and understanding that it works make the project participants aspire to adopt lean.

11- Developing a Standard Work Methodology: The team should be able to come up with a standardized work pattern on how things should be done (frequency of meetings, look-ahead planning window, daily huddles, etc.). The team should adopt the method and improve it as work progresses; they could go back to the mapping process to re-adjust it as per the needs if necessary. It is essential for the team to develop a checklist in each meeting to ensure that the objectives of the meetings are met. Also, it is important that all participants contribute during the online meetings.

12- Developing a Plan for Sustaining LPS: Having a plan for sustaining the LPS system and other lean practices is substantial. Failure to do so will impair all the efforts exerted in securing a lean environment for the current and future projects. LPS is sustained whenever the teams and the company realize the benefits and not just learn about them. Hamzeh (2009) stated that it is important to have a positive experience during initial LPS implementation. This is a significant factor for sustaining LPS since the last planners would pick up the pace on how to implement LPS and realize the benefits of it. Another contributing factor in this step is the top management. Sustaining LPS requires investing in tools such as the software, training workshops, experts... It also requires the company to embed LPS standards into the work methods and to have first run studies and trials to assess inefficiencies in the system.

The process aims at helping people challenge the status-quo and expand their knowledge. The human factor is highlighted in each step of the process and should be the driving factor of LPS implementation in any environment. If performed correctly, this will potentially increase the responsiveness of the organization which is a fundamental organizational trait in these turbulent times that the industry is passing through. The process is summarized in Figure 1.

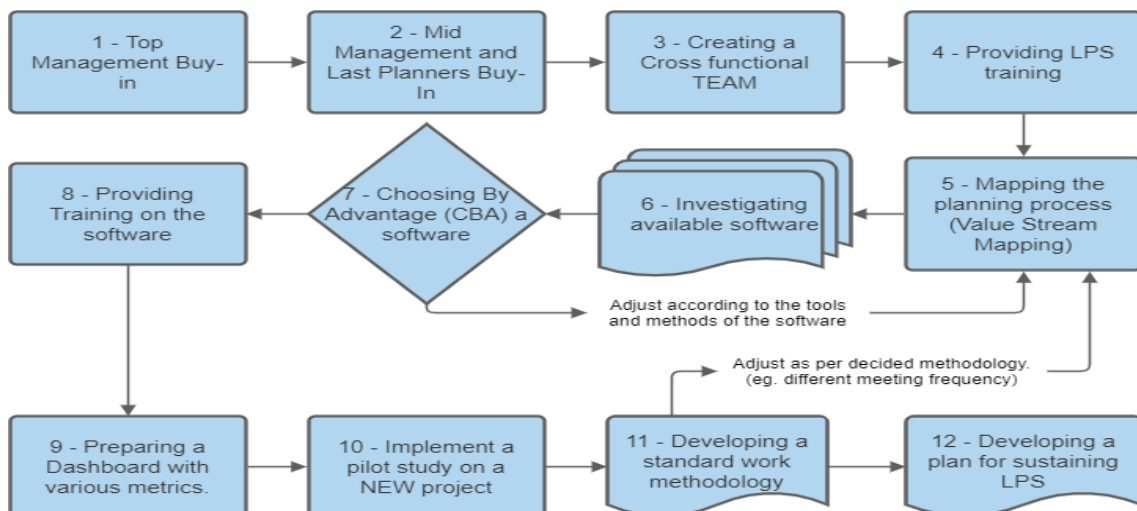


Figure 1 Flowchart of the Framework

APPLICATION OF FRAMEWORK RESULTS

A set of 14 questions related to implementation of LPS is prepared based on extensive literature review. These questions are addressed to three superintendents working on different projects but are from the same general contracting company. The 4th person represents an electrical trade company working with the contracting company.

Table 2: Expert Panel Questionnaire

Question	Sup. 1	Sup. 2	Sup. 3	Trade Partner
1-What is the level of engagement in the weekly planning meeting in a virtual environment?	Very High	Very High	High	High
2-What is the level of transparency between trades in a virtual environment?	Neither high nor low.	High	Neither high nor low.	Neither high nor low.
3-What trust level you have that the preceding trades will finish as promised?	High	High	High	High
4-How much do you rate team satisfaction in a virtual environment?	Very satisfied	Satisfied	Satisfied	Satisfied
5-What is the level of cooperation between the different trades within the virtual environment?	High	High	High	High
6-What is your level of awareness about the progress of different trades in a virtual environment?	Very High	Very High. It is easier to see the progress	Very High	Very High
7-It was difficult to move to online communication platforms.	Disagree	Agree; but got easier	Disagree	Disagree
8-The software used is comprehensive for LPS implementation and it covers all aspects of LPS.	Agree	Strongly agree	Agree	Strongly agree
9-The software can document failure reasons	Agree	Strongly agree	Agree	Strongly agree
10-Metrics used are enough for proper project control in a virtual environment.	Agree. PPC is enough	Neither agree nor disagree	Agree	Agree
11-LPS was implemented correctly.	Agree	Agree	Agree	Agree

The questions are aimed at understanding the practices, challenges, and enablers of implementing LPS in the current virtual environment. The first 11 questions are on a Likert scale; some have answers ranging from strongly disagree to strongly agree and others from very low/dissatisfied to very high/satisfied. These questions are summarized

in Table 2. The rest of the questions are open-ended and discussed afterwards. Finally, to get input on the challenges from an upper management perspective, one of the company's senior managers was interviewed. The interview results are summarized at the end of this section. Note that the interviews were done with each person independently so that no one participant would influence the opinion of other participants.

12-How can you improve the LPS implementation and increase trust and transparency in your opinion in a virtual environment?

All superintendents endorse the idea that more practice is needed to improve the LPS implementation. This includes training and practice on effective use of online communication platforms and active engagement of all participants during meetings. The superintendents emphasized the importance of buy-in from trades, which would increase the transparency between them. This is realized through proper training, assigning the right responsibilities to the right people, having accountability, and trusting others' work.

13-What do you think can be done to get culture lean in a virtual environment?

Although it is recurring, the concept of training seems to be a part of the solution to many issues; and this sheds light on its importance. The experts emphasized the importance of project participants getting together as a team to learn more about LPS and lean construction in general. Through proper training, the participants will embrace the lean way of thinking. Consequently, this creates a clearer visibility about the status of the project and the proactive management needed to properly steer the work. Empowering the participants with a good understanding of the advantages of LPS and lean concepts has proven to be a very useful approach, said the experts.

14-What is the main challenge you are facing in implementing LPS in the virtual environment?

All superintendents state that the main challenges include having a positive buy-in from the trades, but this applies also to implementing LPS in normal conditions. The main challenge for all superintendents was the absence of face-to-face interaction between team members which is essential for establishing and maintaining trust and high morale.

The manager had a different view on the challenges of LPS implementation. The interview focused on the impact of moving into a virtual environment from a management perspective. He asserted the importance of face-to-face interaction in learning more about the team members and building trust in each one of them. Having said so, the lack of physical interaction constitutes the major issue in moving to online communication platforms. Additionally, as a manager, he highlighted the challenge of keeping the trades engaged and winning their buy-in and belief in the effectiveness of LPS. According to him, this requires senses other than verbiage; the body language and tactile factor is a prerequisite for the buy in. Moreover, he highlighted the effectiveness of using a software to steer parts of the project and adopting it as a tool to build transparency within teams. The software serves as a tool to highlight areas of improvement and real-time progress for all the last planners and managers. However, he believes that the software cannot be used to manage the whole aspects of the project. Being physically on site is inevitable for building trust among the teams. For these reasons, current restrictions make it difficult to achieve this buy-in, build the necessary trust, and implement LPS effectively on projects.

DISCUSSION

From a last planner's perspective, it could be noted that the virtual environment embraced LPS practices because the survey results show that people are encouraged to work on the LPS software, and they want to adopt LPS. However, from a management perspective,

the challenges are more critical to deal with. This framework is promising in terms of fostering a successful LPS implementation. One drawback resulting from the shift to online communication platforms was spending time adapting to new technologies, but still it was not a major obstacle due to the fast-learning curve. Furthermore, sometimes people tend to be less engaged in online meetings where they get easily distracted away from their devices. Having the option to turn off the video and the microphone makes it easier to adopt such a behavior. On the other hand, contractors or stakeholders who are engaged in many projects found it way more effective to complete all their meetings online instead of wasting time commuting, moving from one site to another, and getting stuck in traffic. This does not eliminate the importance of conducting face-to-face meetings whenever possible.

This framework aims at spreading a culture of learning and cooperation, and it focuses on providing various types of training. Most importantly, the framework addresses the issue of maintaining physical separation, which has never been perceived an option for implementing LPS before COVID-19 hit. Moreover, the platform provides visual control over who fulfilled their promises, which in turn enforces commitment. Note that the company chose the specific LPS software based on its features that are compatible with the company's needs and capabilities, the participants' skills, and the project complexity.

CONCLUSIONS

The global COVID-19 pandemic modified the usual ways of running different businesses including construction projects, and it was not accounted for in any production system. Various restrictions arose as a response to the pandemic, encompassing mainly limited physical contact. This led to a shift in communication approaches from traditional-physical meetings to online communication platforms. Aside from the challenges that LPS implementation faces during normal conditions, its implementation holds the potential of new challenges after the newly emerged restrictions. This study aims at providing a framework for successful implementation of LPS in a virtual environment and seeks to assess the challenges and enablers of such implementation. The framework focuses on getting a strong buy-in for the lean system from all participants, providing LPS training, mapping the current process, choosing a suitable software to implement LPS, and implementing a pilot study along with other steps. The framework places great importance on providing a lean culture; one where each participant is valued as an effective member and is encouraged to contribute to improvements within the company. Evaluation of this framework was performed through an expert panel questionnaire with five practitioners applying a similar framework. The results showed that the practitioners found it effective switching from analogue mode to a virtual mode given that they adopted a similar approach explained in the framework. The challenges overcome were communication, collaboration, and technical challenges. However, from a management point of view, the main challenge that was still there is the absence of physical interaction which affected trust and buy-in; these are critical for proper management. Embracing a lean culture and facing these challenges with a lean mindset turned these challenges into opportunities; this was shown in the results of the interviews with the superintendents. The limitation of the study is that only five practitioners are interviewed. It is recommended for future studies to interview further practitioners from various trades and explore additional aspects of the virtual implementation.

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