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IMPROVING TRADITIONAL PLANNING WITH PARTIAL IMPLEMENTATION OF LAST PLANNER SYSTEM IN EGYPT

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Abstract: Construction projects constantly face the risk of time and cost over runs, studies suggest that those risks can be attributed to poor planning and coordination. This research studies the improve in traditional planning techniques by partial implementation of Last Planner System (LPS) to two turbine construction case studies. The paper demonstrates two identical projects (A and B) in which LPS was only applied to the project A. Percent Planned Completed (PPC), Reasons of Non-Completion (RNC) and schedule slippage were recorded in the weekly coordination meetings for both case studies. Partial implementation of constrain analysis and RNC discussions were introduced in one of the case studies during the coordination meeting with minimal disruptions. The results demonstrated a better PPC score, improved work flow, less schedule slippage, and, better schedule reliability for Project A. The results argue the fact that LPS implementation are disruptive to work environments and are a drastic change to accustomed systems. Adopting lean concepts in the form of partial LPS implementation minimizes the barriers associated with full implementation and are shown to improve the planning process with minimal disruptions. The research also highlights the various challenges in the application of the LPS in the Egyptian Market with degrees of success, feasibility of implementation and lessons learnt.

1. INTRODUCTION

The construction industry is considered one of the major and valuable industries for economic development and the growth in Egypt. Nearly 45% of the funds allocated for the national development plans in Egypt since 1981 were allocated to the construction sector (Goda 1999) and had been growing by nearly 20 % annually since then (AbdelRazek et al. 2009). Consequently, time and cost overruns are considered fatal to all project parties. (Alsehaimi and Koskela 2008) surveyed the causes of delays in construction projects in developing countries and determined that the most cited delay causes were poor planning and controlling process followed by poor site management and material shortages. Numerous studies examined the Egyptian market for delay causes, based on the study by (Aziz 2013) from the consensus of 250 experienced construction professionals, ineffective project planning and scheduling were ranked as the primary causes of delay. (Marzouk et al. 2014) highlighted that most frequent contractor related delay factors were attributed to ineffective planning and scheduling. This was confirmed by (Aziz et al. 2016) who cited lack of coordination between parties as the main delay factor in Egyptian infrastructure projects.
Improvements to traditional planning were attempted by adopting philosophies like Theory of constrains, action theory, and lean philosophy; benefiting from the development in the knowledge of production management in the manufacturing industry (Goldratt 1997, Bolivar 2009, and, Ballard 2000). The Last Planner System (LPS) based on lean construction principles was developed by Ballard and Howell to reduce a plan’s uncertainty and improve the construction workflow. Unlike traditional ways of enforcing a strict plan from the top management straight to the construction site; the LPS allows for a more collaborative planning approach through applying a system of close coordination with the people responsible for executing the plan, thus allowing them to discuss the

plan and perform collaborative constrain analysis and progressively learn from the reasons of non-completion. LPS faces different challenges in its application in several markets with several degrees of success, however, the literature is scarce of studies showing the feasibility of implementing the system in the Egyptian market.

2. BACKGROUND

2.1 Critical Path Method and Program Evaluation and Review Technique

The Critical Path Method (CPM) and its stochastic derivation; Program Evaluation and Review Technique (PERT), are the most widely used scheduling methodologies since its development in the 1950s, which speaks of its numerous merits. Most owners and government agencies require the use of CPM by project contractors as a requirement for payments, in addition, courts require CPM analysis for assessing project delays and disputes (Loulakis et al. 2005). CPM has enjoyed a wide acceptance by the upper management of construction companies as well as the construction management academia (Bolivar 2009). CPM scheduling popularity is attributed to its relative ease through managing the project using a top down approach and establishing the main schedule which helps enforcing contract milestones and project deadlines (Howell et al. 2011). Nevertheless, CPM is often criticized for providing no insurance that the work is ready to start whenever required which affects the work flow (Howell et al. 2011). In addition, the usage of safety buffers (activity float) in the durations of each activity causes problems in workflow as it’s not clear when the predecessor activity will precisely finish which results that the successor activities cannot precisely determine when to start after its predecessor has actually finished *(*Goldratt 1997). Current approaches in traditional planning adhere to a Rational Compressive Model (RCM). (Daniel et al. 2014) observed how this model dominates the CPM/PERT application, this model sees the planning process as a scientifically rigid process and claims that the knowledge required for planning is only available with planners. This view hinders the collaboration between project personnel and can isolate other stakeholders from the planning process.

2.2 Improving traditional planning

Breakthrough in the manufacturing industry offered different perspectives for productivity and process control using methods such as Theory of constrains, action theory, and, lean philosophy. Such methods provided new perspectives to improve traditional planning methods by borrowing some of their principles. The application of theory of constrain through the Critical chain scheduling method aims to address the unnecessary consumption of float in activities observed in CPM method. However, there is a lack of consensuses from the scientific body to the method of calculations. In addition, the results of applying this method can produce a schedule with unrealistic durations and misleading buffers (Fallah et al. 2010, Herroelen et al. 2001).

The action theory dealt with the traditional methods shortcomings by bridging the gap between the baseline plan and actual site work plan through involving the field personnel in the plan and detailing the schedule in an iterative fashion instead of providing details from the beginning (Johnston et al. 2005). These principles were present in the developing of lean philosophies and particularly in its application in last planner system TM (Ballard 2000) as a practical approach.

In 1997 due to the trend of UK construction projects falling behind in quality and time and cost, the deputy Prime Minister John Prescott set up the Construction task force and issued “Rethinking Construction 1998”. The report recommended dealing with the lack of collaboration through adopting lean production principles and implementing Lean’s LPS method developed by Ballard and Howell. The LPS, revolving around planning, execution, and control, focuses on reducing the workflow uncertainty, identified as the main drawback of traditional methods (Ballard and Howell 2003). With the support and action from several entities, they started making LPS implementation a required practice in UK and USA (Mossman 2015).

2.3 Lean philosophies

Lean philosophies, originally developed by Taichii Ohno in the 1950s, aims to maximize the value added and to reduce the wastes through applying the concepts of Just in time delivery, supply chain management, and, the involvement of all parties in the process, thus continuously improving the production process (Ballard 2000). The last planner system LPS was developed with the target of reducing workflow uncertainty through addressing the planning, execution, and control. According to (Ballard and Howell 2003), LPS focuses on planning and production control as opposed to directing and adjusting resources in the traditional project management approach. The LPS adopts five key principles (Ballard et al. 2009):

1- increase the details of the plan as execution date approaches,
2- involve stakeholders and first line workers in making the plans,
3- identify the constraints for the activities before execution by involved personnel,
4- commit to reliable promises increasing the reliability of the plan by involved personnel,
5- identify reasons of non-completion and work on them.

Several studies pointed out the benefits of implementing LPS system, among the top observed benefits were; schedule reliability, improved work flow, and, commitment enhancement (Daniel 2017, Daniel et al. 2014).

2.4 Lean implementation in the Egyptian market

Lean philosophies have been previously applied in Egypt. (AbdelRazek et al. 2006) attempted to improve labor productivity in Egyptian projects through applying two of the lean principles; benchmarking and reducing variability in labor productivity. Another application was done by (Marzouk et al. 2011) who built a simulation model to evaluate the suitability of implementing lean principles to the design process. LPS was also implemented in a flour storage industrial project in Egypt. (Issa et al. 2013) applied LPS during construction and observed its effect in the calculated risk factor. The authors measured the Percent Expected Time-overrun (PET); defined as the expected time overrun due to identified risks and their estimated probability and severity. The risk factors were identified by an experienced consultant group with input from the owner and the contractor. Risk assessment was repeatedly conducted every 3 weeks; the results showed the noticeable reduction of probability and severity of measured risks as LPS implementation progressed. Nevertheless, despite the benefits associated with LPS implementation, factors outside lean scope; changes in materials prices, delays in bills, design errors and poor quality of labor, still hindered the project. In addition, the comparison of LPS application effect was limited as the implementation was done within the same project with a sequence of changing activities (Issa et al. 2013).

2.5 Last Planner System components

The LPS implementation comprises several main components; namely, the master schedule, the phase schedule, look ahead planning, constraint analysis, weekly planning meetings, percentage plan complete, and, reasons for non-completion.

2.5.1 Master schedule

The master schedule is produced to represent the mile stones level of project planning and covers the whole project duration (LCI 2007). The master schedule demonstrates whether the LPS application to the project is feasible, it also supports planning the project phases under its umbrella (Howell 2004).

2.5.2 Phase Scheduling

In phase scheduling, the project main milestones and summary of the main activities are used to monitor the project phases and key milestones (Porwal 2012).

2.5.3 Look Ahead Planning

With the approach of the work time frame, a workable look ahead of weekly plans is developed to focus on the work supposed be done in the near future (Ballard 2000).

2.5.4 Constraint Analysis

For the look-ahead activities; the activities constrains are identified for all possible delay factors such as material, submittals schedule, equipment, coordination, and, work. This should provide early warning for problems, with sufficient lead time to plan around them (Ballard 2000).

2.5.5 Weekly planning meeting

The activity details are discussed with the project parties. The activities planned to be executed should be quantifiable, achievable and applicable with current resources, thus increasing the plan's reliability through having a reliable promise from the personnel responsible for executing the work (Ballard 2000).

2.5.6 Percentage Plan Complete

PPC (Percent Plan Complete) is calculated as the number of activities planned and completed divided by the number of activities planned. This helps in measuring the plan attainment, the commitment of the parties, and, provides an indication of the plan's reliability (Ballard 2000).

2.5.7 Reasons for Non-Completion

An important principle of lean is to always improve the process. Identification of the Reasons of Non-Completion (RNC) helps to avoid them in the future. identification of RNC should be made by the parties involved to identify the root cause of the problem. This is done through detecting Why the RNC occurred 5 times, every time looking for another level till root cause of the event is found and the proper correction measure can be taken. This process helps to prevent repetition of the event through solving the true root of the problem (Ballard 2000).

2.6 Challenges facing the implementation of LPS on site

Implementing the LPS system faces many challenges. CPM is currently the main method of controlling contracts and projects and is often required by owners for scheduling projects, hence, employing a new practice often faces resistance due the required time and effort to integrate them to the ongoing systems (Koskela et al. 2014, Pavez and Alarcón 2008). In addition, implementing the full system and using a proper pull technique for selecting the next week's activities often led participants to choose easy tasks to gain a good PPC, thus, jeopardizing the whole project due lack of knowledge of the system. Avoiding such drawbacks requires training and directing personnel on how to avoid it (Johansen and Porter 2003, Friblick et al. 2009, Pavez and Alarcón 2008).

2.7 Partial LPS implementation

(Kalsaas et al. 2014) debated whether planning methods with strong characters of traditional approaches may be aligned with the underlying principles of LPS. He conducted a case study, in which he struggled to adopt the methodology of LPS and relied mainly on GANTT charts and CPM, nevertheless, it ended up reaping many of the benefits expected from LPS. Collaborative Planning (CP) with partial implementation of lean principles and LPS were also explored. The study established that the currents practices of CP, as observed in the major sectors of the UK construction industry, align with some of the generally advocated principles of the LPS acknowledged in the literature; specifically, the high level of collaborative programming, weekly work plan meetings, and the measurement of PPC (Daniel 2017). It is thus clear that a degree of collaborative planning/lean principles can be achieved by applying last planner system procedures to the traditional planning which can mitigate some of the challenges to full implementation.

3 METHODOLOGY

The methodology implemented in this research is shown in Figure 1 and follows the five step LPS components, namely; (1) milestone planning (master schedule), (2) phase scheduling, (3) look-ahead planning, (4) make-ready process ,(5) weekly work planning (6) measurement and teaching (Ballard, 2000).

Figure 1 Research Framwork (adapted from Koskenvesa,2005)

4 CASE STUDY

4.1 LPS partial application

The case study depicts a power plant project in Egypt New capital. In an attempt to avoid delays that occurred in previous phases of the project; the management enforced regular coordination meetings on a four day or seven day basis. A proposal of LPS implementation was introduced with site Management support and was presented to the construction teams. However only partial implementation was agreed upon and in only one of the two scopes. The partial implementation strategy was selected as being the least disruptive to the traditional way a team would work.

The case study comprises the erection of two identical 400MW Steam turbines (A and B). The two turbines have the same scope but were executed by two different contractors. The two contractors share similar level of experience in erecting similar scopes. As shown in Figure 1, both case studies had traditional detailed CPM schedule adapted from the turbines erection manual and adapted to projects conditions to match the project's Master schedule's milestones. Coordination meetings were conducted with construction team, technical office, and, project controls. However, in case study B, LPS were partially applied and discussed below in more details. Metrics collected from both case studies were collected and compared against each other.

First, time frames were established from the master schedule, then the detailed schedule was adapted from the turbine erection sequence in turbine manual, meetings for the two turbine teams were scheduled with the construction team. PPC and delay metrics were recorded in both cases. Partial implementation of LPS procedures was done in case study B. LPS was integrated and partially implemented through the following steps;

a. Involvement of first line workers in the weekly coordination meetings. Invitation and participation of engineers involved with the construction activities in site was encouraged.
b. Next week look-ahead activities were discussed and slightly adjusted in weekly meetings to ensure plan reliability. The meetings involved brainstorming sessions to identify the possible constraints and perquisites of these activities and assign the responsible personnel.

c. Reasons for noncompliance were recorded and discussed to try to avoid them for the next week.

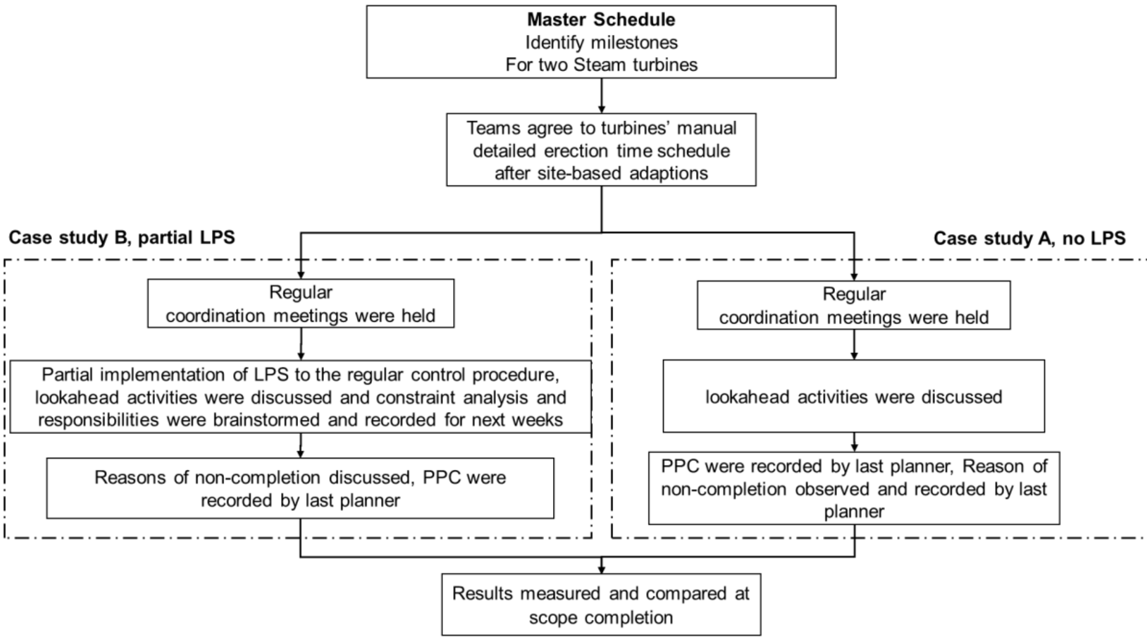


Figure 2 Case study summary for Turbine A and Turbine B

The activities in next week lookahead were identified, constraints were highlighted, and responsibility was identified and assigned. Table 1 shows a sample Constraints table and a post update checklist.

Table 1 Sample of Constraint table and post update checklist

Activity	Constraint		Responsible
Steel Platform 12	Moving material	√	Civil team
	Release for erection	√	Civil team
	Accessibility	√	Mech team / Civil team
1. Install, align steel bars for LP- Casing Horizontal centering guiders in foundation.	1. Access must be available for installation. (mainly scaffolding)	√	Mech team /scaffolding team
	2. Over Head Crane must be available to lift the guiders.	√	Equipment coordinator
	3. Openings in Embedded steel in foundation shall be finished and cured.	√	Civil team
	4. Alignment reference should be taken from the piano wire pulled across the 3 pedestals.	√	Technical Surveillance Supervisor (Vendor)
2. Weld steel bars for LP- Casing Horizontal centering guiders in foundation.	1. High qualified welders shall be responsible for welding the centering guiders. (manpower)	X	Mech team
	Technical Surveillance Supervisor shall be invited to check the alignment of the horizontal centering guider.	√	Technical Surveillance Supervisor (Vendor) /QC team
	Document for release of welding should be ready to be signed by the Technical Surveillance Supervisor	√	Mech team / Technical

	Surveillance Supervisor (Vendor

In case study A, RNC were recorded as observed by the last planner. The following meeting involved discussions of last week activities to determine RNC. Figure 2 shows the RNC as observed and recorded by the planner for the two case studies. The main observed difference for the non-completion of work was due to lack of coordination. This was principally existent in case study A and was observed almost 50% less in case study B. The lack of coordination included; failing to provide accessibility or scaffolding by the civil department to the other disciplines, failing to issue invitations for tests and walkdowns for the technical supervisors and client by the quality team, and, failing to issue work permits or any required documentation between disciplines. Contractual disputes were only existent in case study A, in which partial LPS was not implemented. Equipment availability was also among the causes of non-completion in both case studies, although, slightly higher in case study A.

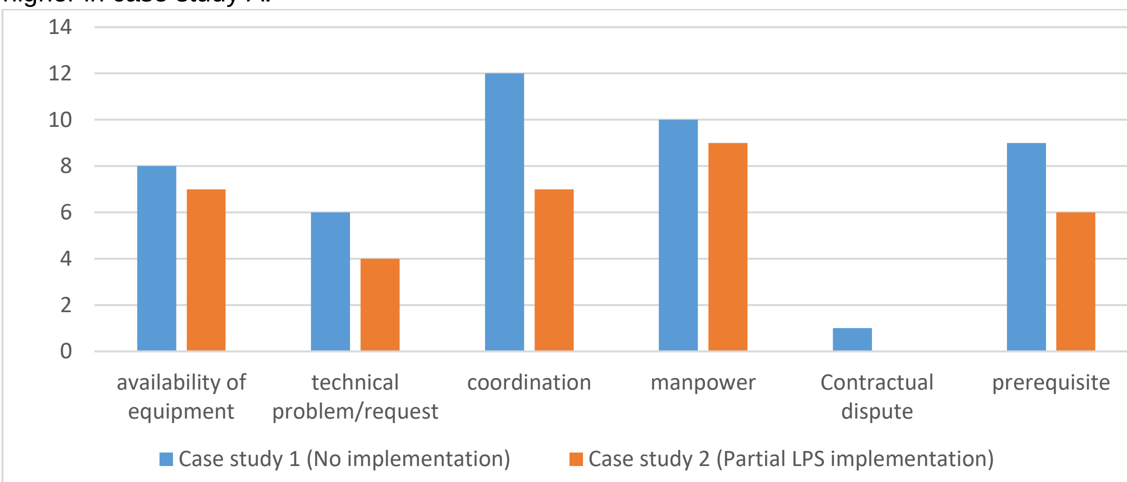
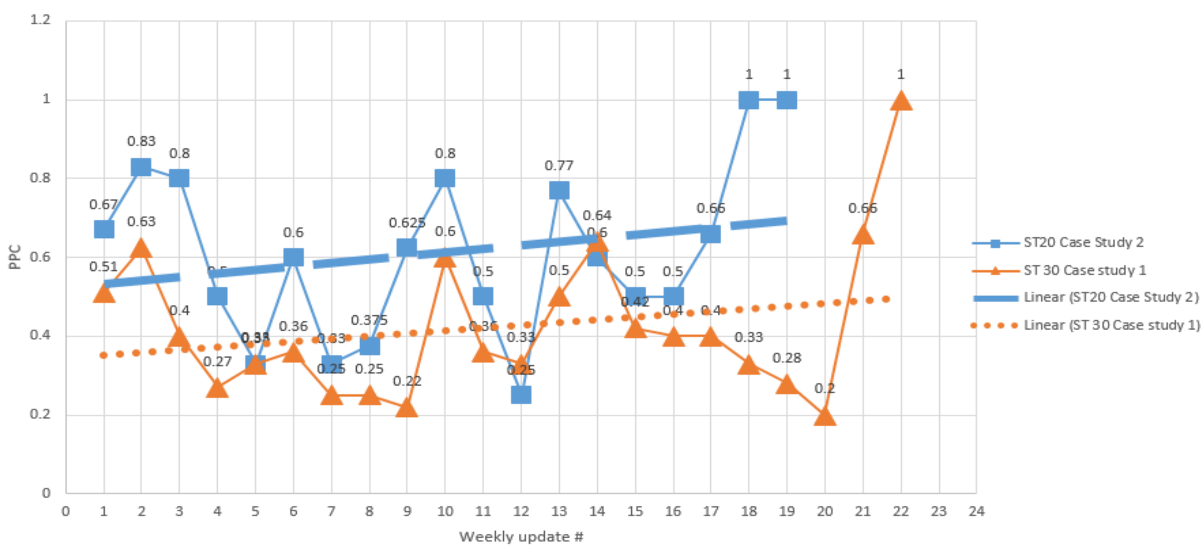


Figure 3 Comparison between reasons of non-completion recorded for case study A and B

PPC percentage and delays/shifts in milestones were also calculated for planned activities on a weekly basis for a total of 22 weekly updates. As expected, case study B, in which partial LPS was applied, had significantly higher PPC in comparison to case study A. Figure 3 shows the PPC for the two case studies, Case study two demonstrate improved activity preparation and an improved



workflow. This was directly reflected in a reliable schedule and decreased schedule slippage by two weeks in comparison to case study A.

Figure 4 PPC values in both case studies for all meetings conducted

4.2 Limitations:

Full LPS implementation barriers had to be identified to better understand how to maximize LPS application benefits. The following two reasons were observed as main barriers for a full LPS implementation;

1. Full implementation entails researching the reasons of non-completion and conducting a root case analysis session and keep asking the question “WHY?” at every deeper level to reach the root cause. However, this analysis was seen disruptive and required training for participants and could not be implemented. Hence, resistance and challenges to implementation need further efforts.
2. A true level of pull planning wasn’t an acceptable approach by the participants due the nature of the scope of being a complicated sequence of mechanical installations with no room for changes in the detailed erection schedule of the turbine manual. Therefore, the nature and complexity of the scope of work did not allow for much flexibility in choosing the work front.

Nevertheless, the partial application still increased the level of communication and brought to light minor issues that can be a showstopper if not addressed.

5 CONCLUSION

This paper proposes partial implementation of LPS principles to traditional planning process to improve the traditional system with minor disruption to the work flow and maximum possible benefits. the paper first surveys the available literature on LPS implementation with focus on the Egyptian industry. Despite the proven benefits of LPS implementation, yet, three main reasons were found to hinder its full application, namely; disruption to work, lack of personnel knowledge/training, and work complexity. Partial LPS application ensured the maximum benefits of the method are being utilized. A case study is presented for two identical projects of 400MW turbines erection in which LPS was partially implemented in only one of the two turbines. A detailed schedule was established that adheres to the milestone master schedule. Partial implementation was done at the regular weekly coordination meetings through performing constraints analysis for next week look-ahead activities. First line workers were involved in the weekly meetings, engineers were encouraged to participate in planning of construction activities. Next week look-ahead activities were identified and discussed in weekly meetings to ensure plan reliability. Brainstorming sessions were conducted to identify the possible constraints and perquisites of activities and assign the responsible personnel. RNC were recorded and discussed on a weekly basis to avoid its repetition. Turbine B, in which LPS was partially implemented, demonstrated significant improvement in terms of improved PPC conducted along 22 weekly meetings. Better workflow was also recorded for case study B, this was reflected in a schedule slippage difference of two weeks between the two case studies. RNC were identified for similar types of projects, among the top RNC were the lack of coordination between project parties, equipment availability, and, lack in delivering prerequisites in a timely manner. This research proves the numerous benefits of LPS implementation, even on a partial basis. It also highlights the need for further education about LPS and lean principles and ensuring their smooth integration to the currently used planning methods.

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