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LAST PLANNER® SYSTEM: IMPLEMENTATION IN A MOROCCAN CONSTRUCTION PROJECT

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"The Last Planner production control system is a philosophy, rules and procedures, and a set of tools that facilitate the implementation of those procedures. Regarding the procedures, the system has two components: production unit control and work flow"
(Ballard & Howell, 2003)

ABSTRACT

As Morocco is a North African country witnessing constant initiation of major development projects, this paper attempts to integrate the Last Planner System® (LPS), for the first time, in a Moroccan construction project. Our case study tackles the structural work of a 21 building-residential project consisting of 396 housing units with four floors each. Works were launched in the site in June 2015. This paper aims to describe the implementation steps of LPS into a Moroccan site, and to analyze the latter's evolution. Given that this system is still considered as unfamiliar in Morocco, we will try to answer the following questions while trying to apply LPS procedures on the Moroccan platform:
What are Moroccan specificities that can contribute to smooth integration of LPS?
What limitations may hurdle implementing LPS in Morocco?
Are there any recommendations that shall help to adapt and improve incorporation of LPS within the Moroccan construction atmosphere?
As far as data collection is concerned, we organized weekly site meetings with all the involved stakeholders of the project. During these meetings, activities of the following weeks were planned, and PPC of the previous one was calculated. Meanwhile, the root causes of variance were analyzed. As for the work flow, we drew a future six-week plan to check the probability of any potential constraints, in order to deal with them proactively. This work will considerably contribute to developing LPS implementation data base. It is indeed an unprecedented trial of its kind as this paper is about describing its first implementation in Morocco, a French-speaking country.

KEYWORDS

Last Planner System, Production Unit Control, Transformation Management, Workflow Management.

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INTRODUCTION

The construction sector in Morocco has become a strategic field of economic development. It currently involves more than 53.000 production units, nearly 1,500 structured companies, 10.000 units already located, and 40.000 units unallocated, which are independently working on construction sites. The total turnover of all of these companies exceeded an annual amount of 30 billion Dirhams, with an average turnover of 15.9 Million Dirhams (Zarouali, 2014).

The sector has achieved influencing numbers in 2012. Khalfaoui & Zenasni (2014) maintain that it has contributed to GDP with up to 6.5%, boosted the workforce with a share of 11.3%, and represented 50.1% of Gross Fixed Capital Formation (GFCF).

Unfortunately, this field is currently experiencing some sort of breakdown, and that is due to some obstacles that have directly affected the pace of its dynamism. These barriers fall into two main factors, external and internal:

- **External factors**: given that this sector has been influenced by international competition, agreements between Morocco and Europe to set up a free trade zone have had a negative impact on the area. "Foreign firms slash prices, destabilizing the Moroccan construction market" ((Benhamida, 15 janvier 2008.)
- **Internal Factors:** (these are company-specific factors) Moroccan companies acting in such economical activities run into several challenges, namely:

  Unsatisfactory competitiveness atmosphere: informal firms and SMEs, which alone shape 95% of the business, promote for either unfair or limited competition climate.

  Less activity, sticky prices, weak liquid assets, foreign supply, higher expenses, debt recovery, and local procurement. according to business surveys conducted by HCP (Haut Commissariat au Plan, 2013)

Being the case, Moroccan companies constantly need to optimize their activities in order to make more possible profits in light of the critical situation highlighted above.

In such a tight economical context, the new production control system LPS, the Last Planner System created by G. Ballard, has been applied on management of a Moroccan construction site. This system is supposed to optimize execution of the ongoing activities, along with preventing the maximum number of constraints. That has absolutely ensures smooth workflow.

LPS® - THE LAST PLANNER SYSTEM

In Morocco, project management is directly related to transformation management. The master schedule is frequently confronted with the progress of work, and, in case of deviation from the deadlines, a catch up plan is often suggested.

As mentioned in the CCAG-T (Cahier des Clauses Administratives Générales applicables aux marchés de Travaux executés pour le compte de l'état), after the company carries out its respective estimation procedures, the contractor is expected to provide the project ownership with an execution master plan in addition to the general measures needed for this end (CCAGT Article 37). The case where the general schedule conflicts with the actual progress amounts to an instance of delay. Be it retards involving the entire project,

or just a part of it, daily penalty is imposed on the contractor for execution deadlines (or target dates) are not successfully met, according to Article 60 **(CCAG-T)**.

This perspective of transformation management was criticized by Koskela and Huovila (1997), and (Koskela L. , 2000). According to them, the production process can be conceived in three different ways:

1) As a transformation process,
2) As flow of materials and information through time and space,
3) Or as a process of value generation for the end customer.

To integrate the flow within the production process, Ballard has developed LPS (The Last Planer System). This system takes into consideration the flow in a participative approach of project planning. Ballard (2000) asserts that "the Last Planner production control system is a philosophy, rules and procedures, and a set of tools that facilitate the implementation of those procedures. Regarding the procedures, the system has two components: production unit control and work flow".

- The production unit control

At the production unit, the key dimension of a planning system's performance is its output quality, namely the quality of the produced plans by the last planner.

Performance of the planning system is easily measured through schedule execution results. This is achieved by measuring PPC (Percent Plan Complete), which stands for the ratio of the executed activities to the total activities as were planned earlier.

This indicator serves to highlight the realization percentage of the fore planned activities. That is, a high PPC means that the contractor has executed more workload with the given resources, notably increasing work progress and productivity.

The second benefit of calculating PPC is that constraint analysis involves the planned tasks, which are not completed yet. By analyzing and eliminating any root causes that may lead to non-accomplishment of the planned works, work performance is significantly improved accordingly.

- Project Flow Control

While production unit control coordinates the implementation of work in the production units (site-based teams for instance), project flow control coordinates the flow of design, supply and installation through the production units.

An anticipatory planning (look-ahead plan) is established to highlight what needs to be done on the short term level.

PROJECT DESCRIPTION

Located in the North of Morocco, the project is a real estate program composed of 4 blocs covering a surface of nearly 10.600 m^2. The program consists of 396 housing units in the form of 21 4-story buildings. Works of this program started in June 2015. The main stakeholders in this project are: the project ownership, the architect, the design firm, the coordination office, the technical laboratory, the surveyor, and the main contractor. Representatives of the project owner were responsible for implementation of LPS.

What made this project present with some challenging specificity (compared to any other ordinary building project) is the fact that works were due to take place on a sloping platform, given the mountainous nature of the site.

RESEARCH METHODOLOGY

At the time of project launch, we held meetings with teams that used to manage transformation. By means of training, we tried to gradually introduce concepts of flow management and production control that is based on the spirit of Lean Construction, which aims to bringing about a step by step change in the team's habits.

To enable stakeholders from having a clear perspective on the contractor's productivity, we proceeded first by explaining the need of introducing weekly reports as an essential part of site management. We also calculated PPC starting from the very first week. During site meetings, we analyzed the constraints that led the non-accomplishment of the planned tasks. We realized that we succeeded at changing some site-based teams' habits (as the case of foreman -the last planer- who also started attending in-site meetings), and at identifying, in coordination with the contractor's project manager, the tasks to be executed along the weeks to follow. During the first weeks, we focused only on production unit control.

Secondly, we noticed that non-accomplishment of the planned tasks throughout the week was linked to constraints that were absolutely external to the project. These constraints needed to be identified in order to maintain a tied workflow. As a result, we explained that it was necessary to introduce the six-week look-ahead schedule in order to properly determine such constraints. Indeed, training on the subject matter was also conducted in the benefit of all the stakeholders. Figure 1 represents a timeline showing the evolution of implementation of the LPS.

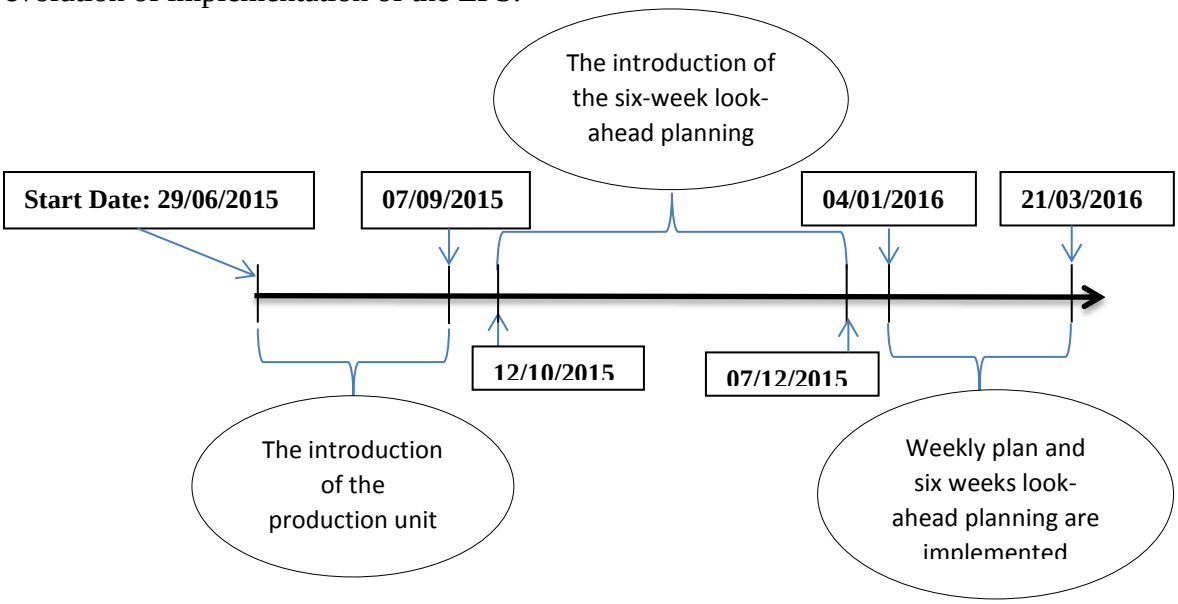


Figure1: A timeline of key events showing the steps of implementation of the LPS.

With regards to collecting information, we held weekly site meetings with all stakeholders. During these gatherings, we began by contrasting the project's progress against the predetermined schedule (transformation management). Subsequently, we tackled the contractor's productivity through both calculating the previous week's PPC

and analyzing constraints that had caused non-accomplishment of some other tasks. Later, pursuing a participatory approach, we attempted to draw the following week's tasks. Finally, we developed the six-week look-ahead plan, and predicted all possible limitations that may emerge during that period. For that, we tended to attribute every possible constraint to one of the stakeholders who was appointed as responsible for its treatment.

CASE STUDY

1st PHASE OF THE PROJECT (Between 29/06/2015 and 07/09/2015: before site off for holidays)

Phase Features:

Works on the platform were initiated and the site was installed.

The company encountered a problem due to the sloping nature of the site floor. The design firm requested to perform earthworks so to level all the footings of the building (which, unfortunately, was not mentioned during the geotechnical study of the project). This lack of coordination between the geotechnical laboratory and the design firm resulted in unforeseen earthworks of up to 7 m deep bellow natural grounds (instead of the 1.2 m that was predicted earlier).

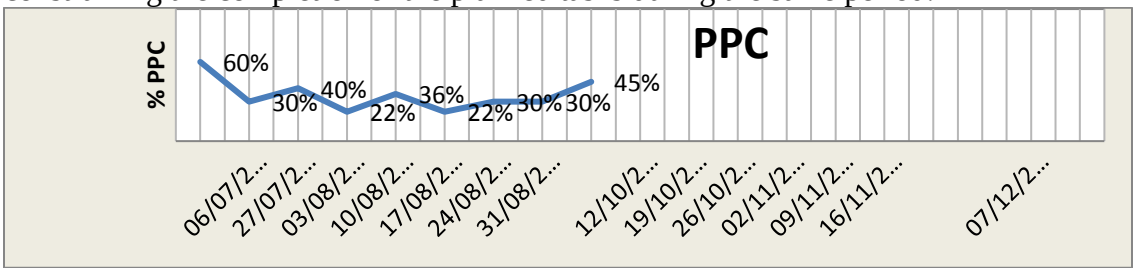
This was the first project undertaken by the company in this city, bearing in mind how far the site is from Rabat the capital.

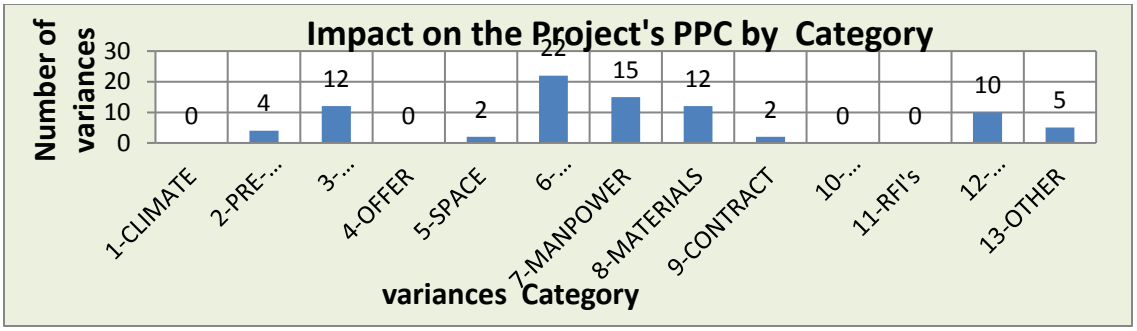
During this phase, the company had to stop the works due to religious holidays along the period between 13.07.2015 and 27.07.2015.

This phase marked the introduction of the production unit control. We held training for all stakeholders on the elaboration of the weekly report, calculated PPC, and analyzed the presented constraints.

Findings of the 1st phase:

The diagrams below show the evolution of the PPC during this period, and the factors constraining the completion of the planned tasks during the same period:





Results analysis

- Note that PPC was unstable during this period; this connotes that most of the scheduled tasks are not executed. To explain this PPC's instability, we had to analyze the type of constraints encountered.

Regarding constraints, we note that we faced almost all types of them.

It is clearly observed that the predominant constraint was equipment. During the excavation phase, the company outsourced this task to a subcontractor with whom it had no previous experience. This subcontractor confronted failures owing to the low quality of the excavation machines.

By the end of the 1st phase, launching concrete work (form and reinforcement works) marked accentuation of manpower-related problems. Furthermore, we encountered structural drawing problems. Drawings had to be redesigned to taking into account the nature of the field after excavation works.

2nd PHASE OF THE PROJECT (between 12/10/2015 and 07/12/2015)

Phase features

Earthworks were almost complete.

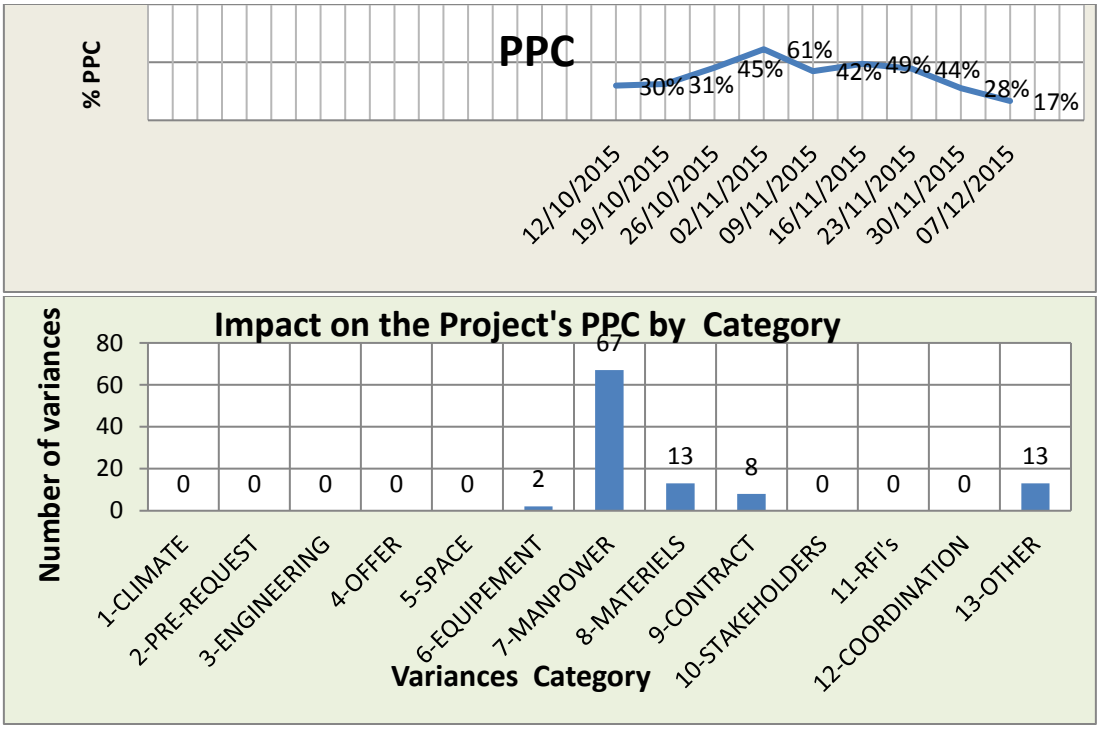
Foundation works were on-going, much of these works were accomplished by the end of this phase.

All problems linked to structural drawings have been resolved.

We deduced that the factors constraining good performance of the planned tasks are not always related to the production unit, given that stakeholders became familiar with elaboration of weekly reports, calculation of PPC and examination of the constraints. In this phase, we decided to introduce the six-week look-ahead planning and the constraints analysis linked to the overall flow of the project.

Findings of the 2nd phase

The diagrams below show the evolution of PPC during this period, and the factors constraining completion of the planned tasks during the same period:



Results analysis

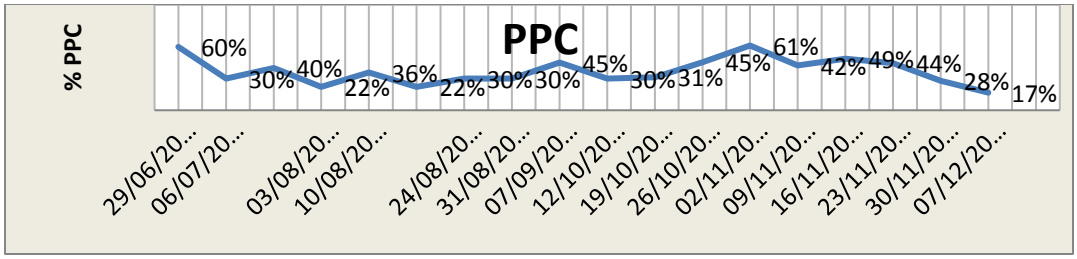
- Note that between restarting construction works and the week of 02.11.2015, the company's productivity was increasing while the evolution of PPC thereafter decreased.
- By analyzing the constraints that affected PPC, it is clearly noted that performance was hurdled by crucial lack in manpower, especially with progress of concrete pouring works.

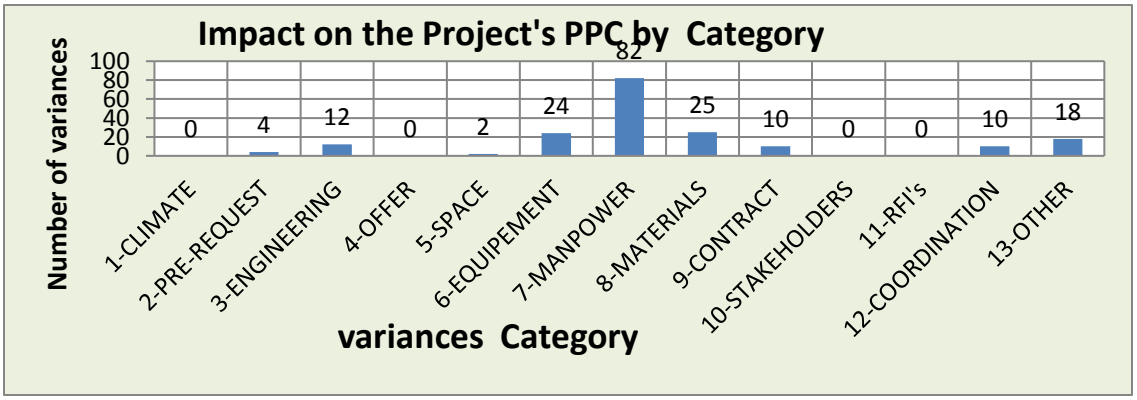
The contractor could not satisfy this need. That is because of scarcity of labor in the project area, as well as some of the company's internal financial problems. As a result, even if LPS weekly reports and the six-week look-ahead planning enabled us from identifying the constraints related to the production units and the project flow respectively, the contractor could not overcome these challenges.

PROJECT RESULTS FOR 2015

- In the second semester of 2015, the project PPC was far from being stabilized. That is owing to the large number of unexpected challenges the contractor faced (sloping grounds, inadequate drawings, etc.).
- The main constraint that hindered positive evolution of productivity is lack of manpower.
- To maximize the benefits of the LPS system, the company had to react regarding this constraint. The contractor found it difficult to successfully manage his internal financial constraints.

The diagrams below show the evolution of PPC during the second semester of 2015, and the factors constraining the completion of the planned tasks during the same period:





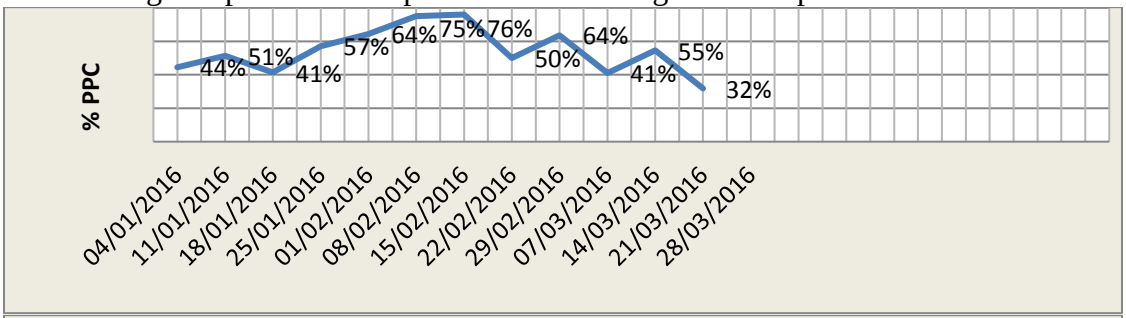
3rd PHASE OF THE PROJECT (between 04/01/2016 and 21/03/2016)

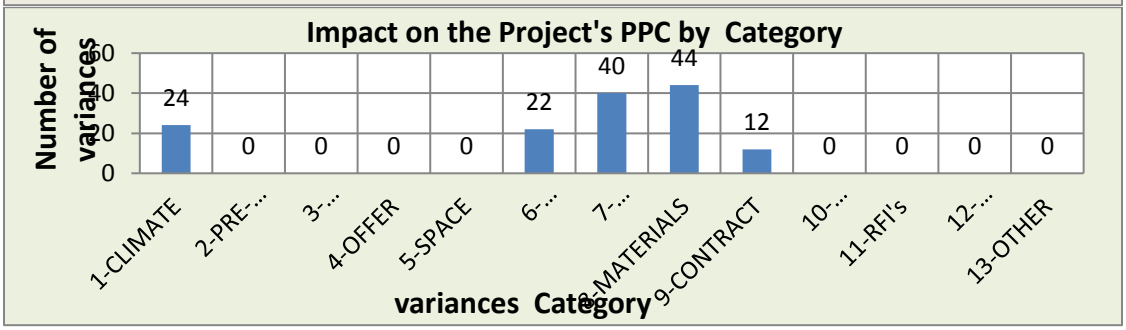
Phase Features

- Basement works were completed.
- Superstructure works were ongoing.
- During this stage, weekly reports and the six-week look-ahead plan were established. They are the key elements in the project's management.

Findings of this phase

The diagrams below show evolution of PPC during this period, and the factors constraining completion of the planned tasks during the same period:





Results analysis

- Note that the PPC curve has evolved in the period between 18.01.2016 and 15.02.2016.
- During this period, tasks were scheduled with more precision since we maintained a good mastery of the pace of the superstructure works (columns-slabs).
- After this period, as manifested above in the lack of manpower and materials, the contractor's productivity has dropped drastically; that was essentially a direct outcome of contractor's internal financial problems.

BENEFITS AND LIMITATIONS OF LPS IMPLEMENTATION

Benefits of implementing LPS

- Traceability is among the main advantages of implementing LPS. The project's history is easily retrieved since all weekly planned activities, the number of non-completed ones, and causes of their non-achievement were all kept track of.
- Applying LPS provided stakeholders with constant data regarding the contractor's productivity. As a result, decision-making proceeded with more fluency. For instance, based on the PPC value (17%) of the week of 07/12/2015, the project owner was obliged to warn the contractor, calling him on to review the overall schedule as well as the main project's milestones.
- LPS implementation ensured realistic weekly schedules, notably while involving the foreman (the last planner) in planning activities.
- The six-week look-ahead implementation enabled all stakeholders from discussing future constraints, which promoted team spirit and information sharing among all stakeholders.

Limitations of implementing LPS

- Training on elaborating weekly reports and planning the six-week look-ahead was sometimes effort and time-consuming. Such training needed to be taken by all the involved participants (representative of each stakeholder). So when a certain representative resigns during the on-going of the works, the same training had to be ensured for the newly recruited that is substituting for the one who had resigned.
- Implementation of LPS is successful at identifying the weekly and the six-week constraints only when all stakeholders are cooperative. As a case in point, we could have reached better results if the contractor had proved signs of better interactivity. Once the company had financial problems related to other projects, it was no longer positively responsive. Such lack in cooperation does not contribute to ensuring better anticipatory elimination of the various pre-identified constraints.
- Applying LPS provided us with a precise follow-up of the contractor's productivity, but not of his production (transformation management). During every weekly site meeting, we needed to contrast the phase planning to the current progress.
- After final accomplishment of the project, transfer of the knowledge acquired upon implementation of LPS as a first experience in Morocco is not likely to be ensured elsewhere.

CONCLUSION

After both describing the implementation steps of LPS in a Moroccan construction site and identifying the strengths and weaknesses of this implementation, it sounds of notable significance to develop a model that contrasts examination of the general schedule against the actual progress. Such a chart will help in making proper decisions regarding strategic milestones while including personnel from the project's hierarchy; that is, the foreman and his team to plan weekly tasks, and the project manager to control the project's milestones and make optimal decisions.

Therefore, it will be interesting to include LPS® production control system in the company's internal procedures. In our case, the project owner is currently establishing one within his own firm's internal procedures.

Finally, as was noted above, the success of LPS® implementation is closely linked to the positive involvement of the construction company through its commitment to resolving the constraints identified during the weekly and six-week look-ahead plan.

This is not obvious if the company undergoes financial problems in other projects. For this reason, it shall be of more satisfaction to link LPS® to the multi-project management in the construction field.

It is noteworthy to say that we are still intending to implement LPS in future sections of the same program with the same contractor, so as to evaluate to which extent this company will develop mainly in terms of adopting this system.

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