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Implementing The Last Planner^{TM} System in a Road Construction Project in Nigeria

Ograbe Ahiakwo[1]; David Oloke[2]; Subashini Suresh[3] and Jamal Khatib[4]

[1]BTech, MSc, PhD Student in Built Environment, School of Technology, University of Wolverhampton, Wulfruna Str. Wolverhampton WV1 1LY United Kingdom

[2]BEng, MSc, PhD, Snr. Consultant-Built Environment, School of Technology, University of Wolverhampton, Wulfruna Str. Wolverhampton WV1 1LY, United Kingdom

[3]BEng, MEng, PhD, Principal Lecturer, School of Technology, University of Wolverhampton, Wulfruna Str. Wolverhampton WV1 1LY, United Kingdom

[4]BEng, MEng, PhD, Professor in Civil Engineering Material, Built Environment, University of Wolverhampton, School of Technology, Wulfruna Street, WV1 1LY, United Kingdom

ograbe.ahiakwo@wlv.ac.uk; d.a.oloke@wlv.ac.uk; s.subashini@wlv.ac.uk; j.m.khatib@wlv.ac.uk

ABSTRACT

This paper describes a research investigation into the implementation of the Last Planner System (LPS) in a road construction project. LPS is known to be the most developed practical use of Lean Construction. It focuses on minimising the negative impacts of variability, uncertainties, buffers, making projects more predictable, creating reliable work plans and convalescing collaborative planning. LPS is unpopular in highway and road construction projects, as a lot of case studies have been recorded of its application on infrastructure and building projects as against highway and road projects. However in the road project. In order to achieve this aim, an Action Research strategy is adopted using different data collection methods such as interviews, observation and survey questionnaire. The initial state of production plan reliability within this case project was observed to be highly unreliable with a high degree of variability. However as the implementation commenced, production plans were stabilized with an improved reliability in the schedules. The results from this study demonstrate that although a road construction process is a linear process, a number of benefits were still recorded in terms of improving construction planning and control processes, during the implementation.

Keywords: *Action research, Last Planner System, Lean construction, Planning, Road construction.*

INTRODUCTION

Nigeria ranks tops compared with other countries in Sub-Saharan Africa in terms of road network infrastructure with an estimated road network of 200,000 km connecting different villages to cities (FME 2013). However, the highway industry in Nigeria suffers from many problems and most of these problems can be practically linked to the construction culture within the industry.

This construction culture at the project level is often associated with such attributes as fragmentation, antagonism, mistrust, poor communication, short-term mentality and blame culture (Odeh and Battaineh, 2002; Oke and Ogunsemi, 2011). As a result, the entire construction industry is overwhelmed by poor quality work, cost and time overruns resulting from poor project definitions during planning; inadequate planning; inadequate funds; inflation; bankruptcy of contractor; variation of project scope; political factors; death of client; incompetent project manager; wrong estimate; inadequate cost control unethical behaviours in the form of fraudulent practices and kickbacks (Mansfield *et al.*, 1994; Olomolaiye *et al.*, 1987; Oyewobi *et al.*, 2011; Olusegun and Michael 2011, Oke and Ogunsemi, 2011).

These attributes all affect the quality work of work produced, the final cost of executing the project and the time spent in carrying out the project (Aibinu and Jagboro, 2002; Odeh and Battaineh, 2002). Furthermore, Ankara (2007) looked at different cultural orientations in relation to project performances. It was revealed that dimensions of culture were found to be significantly associated with project performance outcomes.

Conversely, Mossman (2012) proposed that Lean Construction using the Last Planner System influences construction culture by encouraging collaboration, transparency, trust, reliability of scheduling and delivery of value while, consuming the fewest resources. Henceforth, overcoming natural cultural issues of poor quality work and overruns in time and cost.

THE LAST PLANNER SYSTEM

The Last Planner System (LPS) has been argued to be the most developed practical use of lean construction (Thomas *et al.*, 2003), and it is a trademark of the Lean Construction Institute (Kalsaas, 2012). Lean Construction on the other hand is a construction production management, philosophy that arose from the recognition of the limitations of the traditional project management philosophies while applying Lean Production to the construction industry (Howell, 1999). It focuses on improving production flow with a goal of better meeting customer needs while using fewer resources and maximizing value (Gonzalez *et al.*, 2010, Ballard 1999, Howell 1999, Koskela 1992).

The general idea behind the Last Planner™ System (LPS) of Production Control originates from the need to collaboratively manage program co-ordination, so as to increase work flow and work plan predictability (Ballard, 1993; Ballard, 1997; Ballard, 2000; Ballard and Howell, 2003). It operates with buffers in the form of ‘workable backlogs’ that level the workflow by buffering against unpredicted plan variation. The basic function of LPS thus is to make projects more predictable, minimising buffers, learning from plan failures, reducing uncertainties, creating reliable work plans, decreasing workflow variability and improving collaborative planning, (Ballard, 2000; Ballard *et al.*, 2009, Gonzalez *et al.*, 2010, Mossman, 2013).

The Last Planner allows planners to produce a record of “what *can* be done”, from which workers choose tasks – “what *will* be done”, while a procedure of system appraisal allows a review of “what *was* done”, whereas all the time steps are taken to shield tasks from the effects of dependences with other tasks (Ballard, 2000; Ballard *et al.*, 2007, Ballard *et al.*, 2009). In a nutshell it develops a work plan using ‘should-can-will’ analysis (Ballard, 2000). The ‘should’ shows all the work to be carried out, but in most cases restrains arise which limit the work that ‘can’ be done. Then LPS works in such a way that it makes a commitment to the work that ‘will’ be done. The PPC calculates the ratio of tasks ‘did’ to the task that ‘will’ be done. A low PPC shows poor planning and the reasons for poor results are investigated to promote better planning (Ballard 2000; Ballard and Howell 2003; Salem *et al.*, 2005)

Generally LPS involves five levels of planning: (1) The Master Schedule, (2) Phase Schedule, (3) Look-ahead planning, (4) Weekly work plans and (5) Percentage Plans Completed (PPC). Details of these are explained as sighted in Koskela *et al*., (2010) Tommelein and Ballard, (1997); Ballard and Howell, (2004); Ballard, (1997); Hamzeh *et al.*, (2008), however a summary of their description is shown below.

The Master Schedule

This is generally referred to as the master plan, and it is the first phase of the production planning system (Hamzeh *et al*., 2008). Here the objective is to provide an overall view of the project, and to analyse feasibility of project completion (Tommelein and Ballard, 1997). The aim is to bring all the major actors together early in the process, so that critical interdependencies can be discussed, assumptions tested, with a collaborative creation of an agreement to the production sequence and best practice for the entire project (Alsehaimi, 2011).

Phase Schedule

This entails phase planning i.e. breaking the entire master plans into phases and planning based on those phases. This is achieved by using reverse-phase scheduling – i.e. working backwards from the desired delivery dates; tasks are scheduled in reverse order, allowing them to be performed at the last responsible moment, thus minimising unnecessary accumulation of work in progress (Ahiakwo *et al.*, 2014). Phase scheduling involves developing more detailed work plans and providing goals that can be considered targets to the project team. It basically entails a face to face conversation that establishes context, define the milestone deliverable, develops an execution strategy, identifies tasks and organises them in a pull plan working from the end of the phase back (Patel, 2011).

Look-ahead planning

Look-ahead planning breaks activities down into the level of processes/operations, identifies constraints, assigns responsibilities, and makes tasks ready by removing constraints (Hamzeh and Bergstrom, 2010). They also make tasks ready so that they can be done when the right time comes. Look-ahead planning states the preconditions that must be evaluated by breaking down activities into the level of processes/operations, so that possible constraints are identified, responsibilities are assigned, and assignments are made, while frantic efforts are made to remove the constraints (Hamzeh, 2011). Any tasks whose constraints have been removed are put on a list called the 'workable backlog'. They are usually the outcomes of mid-term planning by showing activities at the level of processes and operations (Ballard, 1997).

Weekly work plans

Weekly work planning develops the look-ahead plan into a weekly work plan by presenting activities in the most detailed level required to drive the production process (Hamzeh and Bergstrom, 2010). Consequently, they contain only tasks that are ready to be performed after thel constraints associated with performing the planned task has been removed (Patel, 2011).

Percentage Plans Completed (PPC)

PPC is a measure of the proportion of promises made that are delivered on time and it is calculated in percentage as the number of completed planned activities divided by the total number of planned activities (Ballard, 1997). The aim of PPC is to learn about planning failures and to measures whether the planning system is able to reliably anticipate what will actually be done (Patel, 2011)

The Last Planner System has been predominantly implemented in building and infrastructure projects, with only few case studies recorded for road and highway construction. This is because the planning and management of road construction generally involved the use of Linear Scheduling Method (LSM) (Trofin 2004). LSM was developed mainly for scheduling repetitive linear construction projects, such as roadways, pipelines and rail construction (Song *et al*, 2008). These activities are usually positioned in a time and space format, along with the production rates for the activities and it integrates the schedule in the form of the slope of the lines that represent them (Javkhedkar 2006).

LSM in comparison with LPS involves an accurate representation of the inherent space time relationships of the activities (Javkhedkar 2006). In LSM, repetitive activities are represented as the same line segments (Trofin 2004). Furthermore, LSM provides a basis for superintendents and foremen to either schedule their work using computers or using pencil and paper as it assists in analysing the overall impacts of the detail assignments on a weekly schedule (Javkhedkar 2006). In addition, Yamin and Harmelink (2001) stated that LSM offers an intuitive visual representation of the sequence in which the activities will perform, as well as the location they will occupy at specific times.

However, Javkhedkar (2006) and Song *et al*, (2008) integrated LSM and LPS in linear construction projects as shown Table 1.0.

Table 1: Integration of LPS and LSM (Javkhedkar 2006; Song et al, 2008)

Last Planner System	**Linear Scheduling Method**
Should/can analysis	LSM time/space buffer
Work continuity	Activity continuity
Pull driven scheduling	Easily represent pulling of activities
Involvement of many levels of participants in developing schedules	Easy to add/delete assignments by different users

Nevertheless, this research entails the implementation of LPS on a road construction project in Nigeria. Road infrastructure has been identified to form a major factor for economic growth and development in Nigeria (Onolememen, 2012). Willoughby (2004) identified the relationship between transport and economic development. Here Willoughby (2004) advocates that socioeconomic development of any nation can be catalyzed by the presence of infrastructure especially roads transportation.

In Nigeria, the estimated at 200,000km within the country represents the principal means for freight and passenger movements across the entire country. The Road transport accounts for nearly 95% of all modes of transport and is estimated at N200 Billion (Approx £800 Million), growing at 10% per annum compared with other developed economies such as South Africa, UK and US (FMW, 2013)

THE CASE PROJECT

The project entailed constructing a 4-Kilometer standard single carriageway road with sidewalks on both sides of the road and an 80 meters span bridge over river Ebeku to link up with an existing road. The pavement was proposed to have a total thickness of 450mm consisting of 150mm lateritic sub base; 150mm crushed stone base and 100mm asphaltic concrete and 50mm wearing course. The project involved both the construction of an access road and a bridge (as already pointed out). The road segment entailed pre-fill surveys, clearing, fillings, compaction and scarification, priming and asphalting. While the bridge section entailed retaining walls, abutments, erosion control works and pilings.

The project was a unique one, and this was as a result of the existing terrain of the area. The terrain was gently sloping or near flat and it was typical of the Niger Delta environment. The vegetation along and around the project was the coastal type of thick evergreen tropical rain forest, comprising of palm trees, coastal grasses, cassava farmlands etc. Geologically, the entire road alignment lies within the 'Back Swamp' of the coastal plain sand of the Benin geological formation. Benin formation is the most recent of the three lithostratigraphic units (i.e. Benin, Agada and Akata formations) of the Niger delta (Amajor, 1991).

RESEARCH METHOD

The research method used in carrying out this research is a prescriptive kind of research and is termed Design Science Research (DSR). DSR is a research method used in solving problems faced in the real world by producing an innovative construction that can make contribution to theory in the area where it is applied (Lukka, 2003). The basic idea in DSR is that the entire research process is not linear but generally involves fundamental activities; 'build' and 'evaluate' (March and Smith, 1995). 'Build' here refers to creating things that serve human purposes. While 'evaluate' entails evaluating the performance of what was built.

Similarly, Vaishnavi and Kuechler (2007) indicated that in DSR, knowledge is produced during the research process and this knowledge strengthens the relevance of an academic research. Consequently, DSR is a research approach for conducting research in Lean Construction (Formoso *et al.,* 2012). This is because, Koskela (2008) revealed that to help solve the problem of relevance affecting construction management as a discipline, other than carrying out explanatory studies in the form of explanatory science, such studies should be positioned as a design science research. Similarly, Alshehamni *et al.*, (2009) and Simeon (1996) points out that in order to connect research and practice while producing theoretical knowledge, research should be positioned as design science. In view of these, this research is positioned under the umbrella of DSR.

The research strategy adopted to provide a structure for a plan of actions, which would guide and govern this research process, is an Action Research strategy. An Action Research (AR) is an established qualitative research method used for scholarly enquiry by building and testing theories with a perspective of solving practical problems in a real setting (Azhar 2007). It is usually carried out within a five phase cyclical process of: diagnosing, action planning, action taking, evaluating and specifying learning.

Step 1: Diagnosing: This entails analysing the current situation to identify all the problems that can be derived. It also involves holistically interpreting complex research problems that lead to the development of theoretical assumptions (Baskerville, 1999; Jang *et al.*, 2011). Within this research however, diagnosing involved analysing the current state of Nigerian highway construction process. It was identified that road construction projects and other construction projects are faced with a lot of challenges.

Step 2: Action planning: This involves setting up plans based on the theoretical assumptions identified. In this phase, the researcher and practitioners collaborate, specifying the actions that would improve the problems identified (Azah *et al.*, 2010). The Last Planner System is identified as the tool to tackle the basic management challenges that usually occur within highway projects.

Step 3: Action taking: For Action taking, the planned action is implemented with a collaboration of the research and practitioners. These actions result in changes within the organisation (in which the intervention is carried out) (Baskerville, 1999; Azah *et al*, 2010). Here the LPS is implemented within the road construction process. It comprised of five levels of planning processes of: The Master Schedule, Phase Schedule, Look-ahead planning, Weekly work plans and Percentage Plans Completed (PPC).

The master plan was the first phase of the production planning system. The objective was to provide an overall view of the project, and to analyse feasibility of project completion and to display the execution strategies, demonstrate the feasibility of completing the work within the available time and identify the important milestones and these milestone schedules are used to divide the project into logical phases. The duration within these schedules are established in a manner so that those responsible for the project are confident that the work can be completed as planned

The phase plan involved developing a more detailed work plan and providing the goals that served as targets to the project team. It basically entailed working backwards from the desired delivery dates, scheduling tasks in the reverse order, allowing them to be performed at the last responsible moment, so as to minimise unnecessary accumulation of work in progress.

Look-ahead planning broke down activities down into the level of processes/operations, so that possible constraints were identified, responsibilities were assigned, and assignments were made ready by removing possible constraints.

The Preparation of the weekly work plan was in consultation with the last planner (the researcher served as the last planner) and it involved negotiating with all project team managers in a meeting to achieve a plan for each week that contains only tasks that are ready to be performed.

Step 4: Evaluating: The researcher and practitioner critically assess the outcome of implementing the plan. This includes examining the theoretical effects of executing the plan (Azah *et al*, 2010). Percentage Plans Completed (PPC) checks were also used to evaluate the implementation process on a weekly basis. The aim of the PPC was to measures whether the planning system was able to reliably anticipate what will actually be done.

Step 5: Specifying learning: This is usually an ongoing process. The accumulated knowledge gained from the action research is directed to the organisation where the research was carried out and the scientific community as well. Consequently, where the results are negative and the planned change is unsuccessful and it also provides a foundation for further research.

RESEARCH ACTIVITIES AT THE SITE

The research plan was to implement Last Planner System in three phases of the project comprising of 8 weeks of implementation and PPC calculations. These phases are:

Phase 1- clearing and preliminary earthworks; Phase 2- comprehensive earth works and grading; Phase 3- Priming and asphalting.

At the end of each phase (8 weeks) a comparison and review of the implementation was carried out. Conversely, during the implementation, the look-ahead schedule and the constraint analysis chart were used to allow for the anticipation of future needs for materials, equipment and labour. They ensured tasks were ready to start when required with a certainty of labour, equipment and material requirements. The constraints identified during the constraint analysis were grouped under eight categories; contract, designs, submittals and documentation, operations, equipment, labour, weather and materials. This classification helped facilitate an enhanced co-ordination with the responsible persons resolving particular constraints identified.

The PPC charts and reasons for non-completion forms on the other hand were used throughout the implementation process. These reasons for non-completion were also subdivided into eight categories; contract, designs, submittals and documentation, operations, equipment, labour, weather and materials. A weekly PPC's of 8 weeks was measured and is shown in Table 2 to Table 5.

Figures 1 and 2 show the PPC analysis for the first phase, i.e. 8 weeks within the project. At the end of the phase, a meeting was held to evaluate the implementation process, discussing the lessons learnt from the implementation.

Table 2: Comparison of 8 weeks of PPC (19/11/12 – 21/01/13)

Start date for week	No. of completed tasks	No. of uncompleted tasks	Total activities/tasks	PPC
19/11/2012	5	6	11	45%
26/11/2012	8	6	14	57%
03/12/2012	10	4	14	71%

Start date for week	No. of completed tasks	No. of uncompleted tasks	Total activities/tasks	PPC
10/12/2012	9	6	15	60%
17/12/2012	8	3	11	72%
07/01/2013	8	2	10	80%
14/01/2013	6	1	7	86%
21/01/2013	6	2	8	75%
TOTAL	***60***	***57***	***90***	***67%***

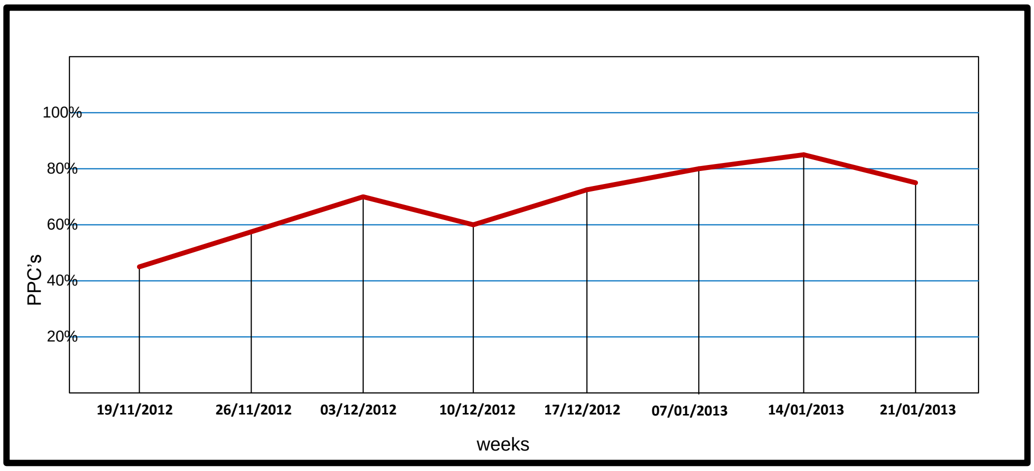

Figure 1: Weekly PPC's for 8 weeks (19/11/12 – 21/01/13)

From the review of the implementation process, it was observed that the involvement of all parties in the project was crucial for the success of the implementation process. Similarly, the reasons for incomplete assignments were analysed and documented for corrective actions to be taken during the next weekly meeting.

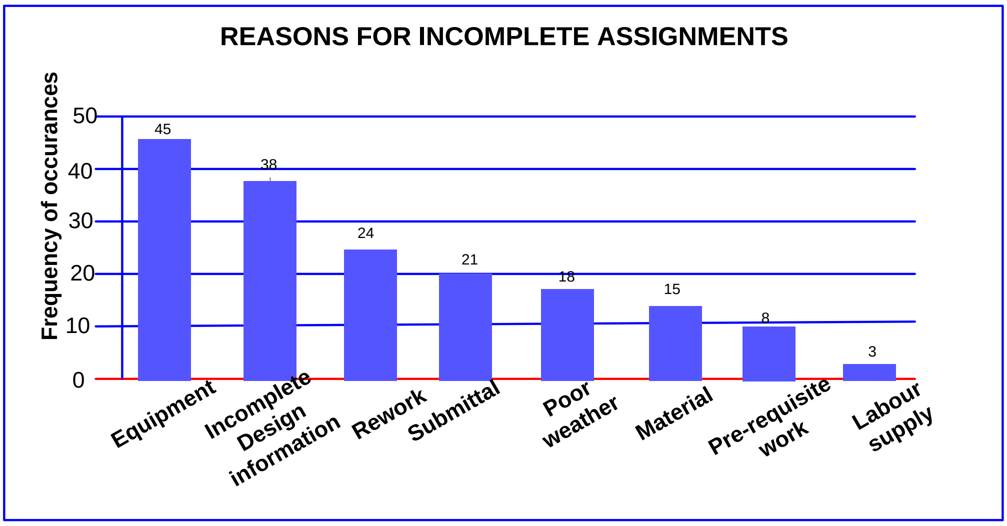

Figure 2: Reasons for incomplete assignments (19/11/12 – 21/01/13)

The reasons for the incomplete assignments within the first phase of 8-weeks are shown in Figure 2. The figure demonstrated that equipment break down was the most frequent reason for incomplete assignments. This was followed by incomplete design information; a lot of details were not included in the vertical and horizontal alignments designs. This made it difficult setting-out the project and calculating the levels for the cut and fill. In the same vein, this led to a lot of rework; which had the third highest frequency of 24. Other reasons for incomplete assignments included; submittals (late request), poor weather and materials unavailability, pre-requite work and labour supply. Although this analysis for incomplete assignments was limited to the category presented.

Furthermore, weekly PPC's were calculated for next 16 weeks with an evaluation process carried out after 8 weeks for the 16th week of the project. The evaluation process basically evaluated the implementation process with the project team also discussed the lessons learnt from the implementation. Tables 3 and figure 3 shows the PPC measure for the second phase which commenced on the 28th of January 2013 till 18th March 2013. Similarly, Figures 4 showed the reasons for incomplete assignments within this phase.

Table 3: Comparison of 8 weeks of PPC (28/01/13 – 18/03/13)

Start date for week	No. of completed tasks	No. of uncompleted tasks	Total activities/tasks	PPC
28/01/2013	8	3	11	73%
04/02/2013	7	2	9	78%
11/02/2013	9	4	13	69%
18/02/2013	9	3	12	75%
25/02/2013	8	3	11	73%
04/03/2013	10	2	12	83%
11/03/2013	11	4	15	73%
18/03/2013	9	3	12	75%
TOTAL	***71***	***22***	***93***	***76%***

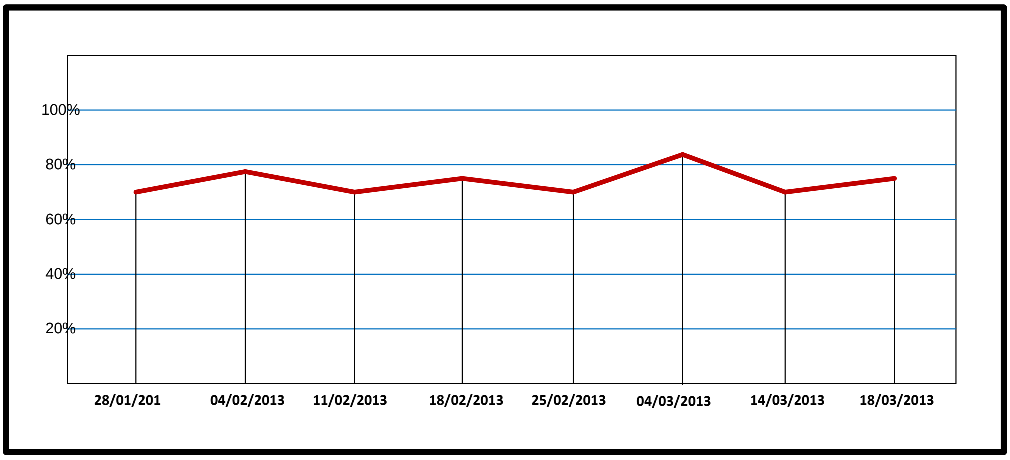

Figure 3: Weekly PPC's for 8 weeks (28/01/13 – 18/03/13)

From Tables 3 and Figures 3 it is observed that the average PPC within this period was 76% which was a remarkable improvement from the previous evaluation whose PPC was averaged at 67%. In addition, the highest PPC value of 83% was recorded on the week commencing from the 4th of March 2013, while the lowest PPC value of 69% was recorded on the week of 11th February 2013.

Furthermore, the reasons for the incomplete assignments within these 8-weeks are shown in Figure 4. It was identified that pre-requisite work was the most frequent reason for incomplete assignments and delays as a result of waiting for a task to be completed before another starts. This was basically because of the nature of the stage that the project had reached; i.e. this was the stage where most of the activities were dependent on the earth works. Particularly the compaction of the graded laterite in layers of 150mm by vibrating rollers; the compactor had to wait for the stock-piled materials to be spread along the road. However the site engineer had to stockpile the laterite materials to avoid setbacks experienced from community disturbances being experienced during haulage of the laterite materials.

In the same vein, the compacted surfaces had to be scarified and compacted over and over again and this rework was affecting the completion of assignments planed. This rework was also recorded in Figure 4 as the second highest percentage of uncompleted assignments. The third reason given was the un-availability of materials. This was because of community disturbances from the youths around a neighbouring community; this community was the only access to the project site and suppliers delivering materials to the site were delayed until government officials had to step in to resolve the situation.

The fourth major reason for incomplete assignments was equipment break down. This was followed by incomplete design information; especially during the construction of the side drains which was carried out within this phase. Similarly, details of the fill levels were not indicated hence the surveyors had to establish one. Other reasons for incomplete assignments included; poor weather, submittals (late request) and labour supply.

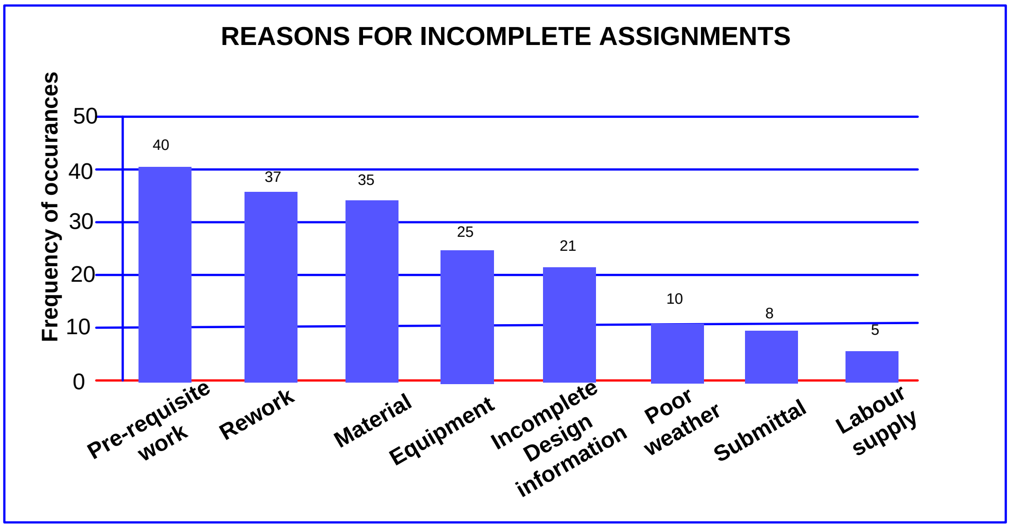

Figure 4: Reasons for incomplete assignments (28/01/13 – 18/03/13)

Finally, for the remaining 8 weeks to make up 24 weeks of the LPS implementation weekly PPC's were calculated and an evaluation carried out at the end of the 8 weeks. The project team discussed the lessons learnt from the implementation and evaluated the entire implementation process. Tables 5 and Figure 5 shows the PPC measure for week commencing on 25th March 2013 to week commencing 13th May 2013 while Figure 6 shows the reasons for incomplete assignments.

Table 4: Comparison of 8 weeks of PPC (25/03/13 – 13/05/13)

Start date for week	No. of completed tasks	No. of uncompleted tasks	Total activities/tasks	PPC
25/03/2013	9	3	12	75%
01/04/2013	8	2	10	80%
08/04/2013	7	2	9	78%
15/04/2013	6	3	9	67%
22/04/2013	5	1	6	83%
29/04/2013	5	2	7	71%
06/05/2013	6	2	8	75%
13/05/2013	7	1	8	88%
TOTAL	***53***	***16***	***69***	***77%***

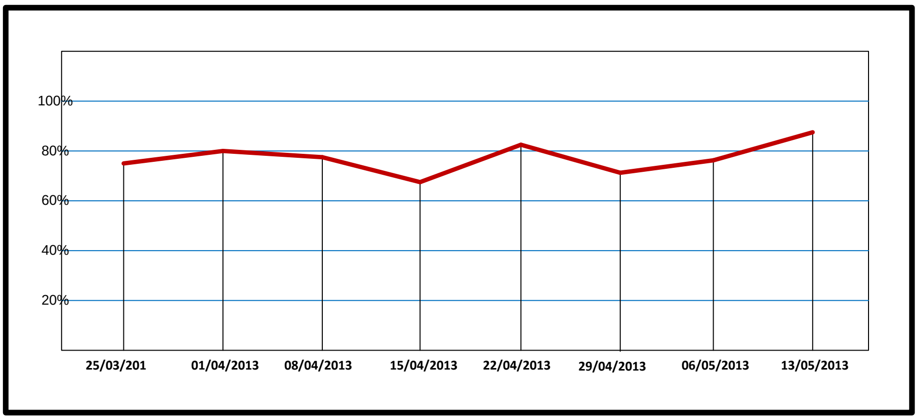

Figure 5: Weekly PPC's for 8 weeks (25/03/13 – 13/05/13)

From comparison of the 8 weeks PPC in Tables 5 and the chart of the weekly PPC's in figures 5 it is observed that the average PPC within this period is 77%. This stage of the project had just rounded up earth works while priming and asphalting commenced. It was recorded that the highest PPC value of 88% was recorded on the week commencing from the 13th May 2013. Major activities carried out within that week were the pavement works consisting of lateritic sub base, crushed stone base and asphaltic concrete. However, the lowest PPC value of 67% was recorded on the week of 15th April 2013; the major setback on the project within that week was poor weather. The reasons for the incomplete assignments within these 8-weeks are shown in Figure 6.

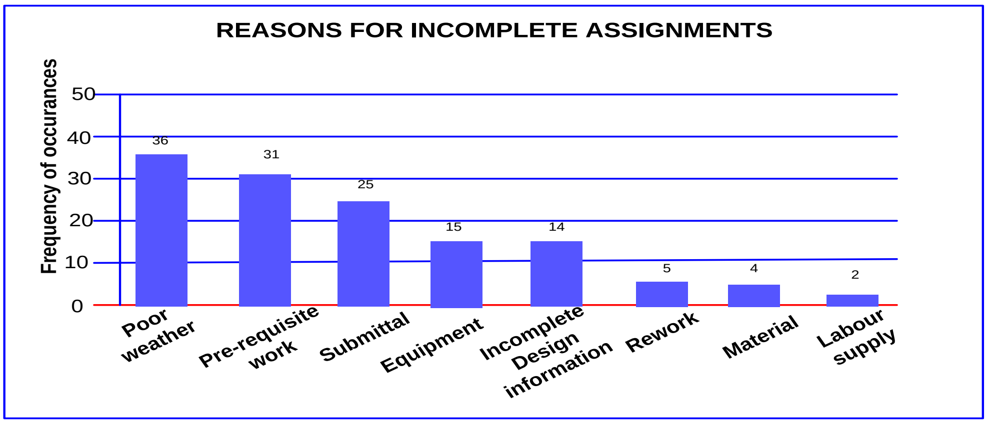

Figure 6: Reason for incomplete assignments (25/03/13 – 13/05/13)

The reasons for the incomplete assignments were captured in Figure 6. It was observed that poor weather was the major reason for incomplete assignments within this phase and it had a chain effect of affecting pre-requisite work. The rains poured out heavily and caused most of the tasks to be suspended and this resulted in workers waiting for task to be completed before another starts. Similarly, submittal (late request) was the third highest reasons for incomplete assignments; and it resulted in delays as requests were submitted too late for decisions to be made that would enable particular activities to start on time.

The fourth major reason for incomplete assignments was equipment break down. This was followed by incomplete design information; especially while constructing the pavements. Other reasons for incomplete assignments included; defects requiring rework, material unavailability and labour supply.

FINDINGS

Observation: It was revealed from the initial observations that there was no set out procedure for managing site activities. The site engineer gathered the project team every morning to assign work packages on a day to day basis. The back drop to this arrangement was that operators, subcontractors and suppliers did not know ahead of time what was planned out. This caused series of delays in the start-up process of the project. Nevertheless, it was observed that team-working was very evident at the site and responsibilities were well shared among the project team.

Interviews: From the interviews carried out, it was noticed that there was no planning technique in place. The answers to the interviews provided a comprehensive account of the organisation's project management practice and it was revealed that the project manager and the management team were motivated. They were made up of professionals who had good experience on road construction and a little knowledge of project management concepts with no awareness of Lean construction. Furthermore, it was also identified that there was no special communication tool such Walkie Talkies or ICT tools (such emails and intranet or internet communication) was available for the project. The project team relied on mainly on verbal communication. Finally, meetings were held daily before start of work at site to brief the operators of their tasks and management meetings were held if any issues went wrong within the site.

Implementation: During the implementation of the last planner system, a lot of data was gathered and different forms were completed on site by the project team, and these forms include the look-ahead schedule, constraints analysis charts, PPC chart and the reason for non-completion forms. The implementation occurred in three phases of 8 weeks per phase.

The average PPC's for the entire implementation period was 73%, with the highest PPC at 88% and the lowest at 45%.

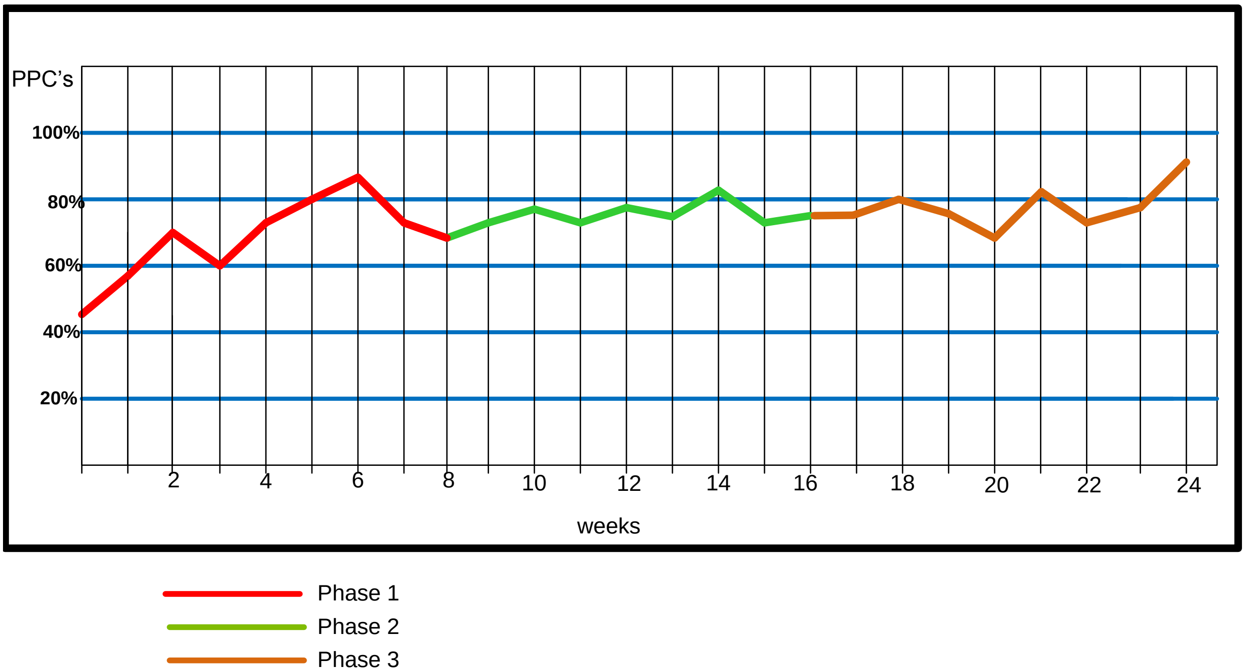

Figure 7: Comparison of Weekly PPC's for the three phases

From the assessment as depicted in Figure 7, after the PPC's stabilised for Phase 2 and Phase 3, the project participants became familiar with the implementation process. They showed great enthusiasm to learn and improve the project hence improvements recorded in phase 2 and 3. Similarly in phase 1, it was observed that after 2 weeks of PPC calculations, the project team was ready to keep their commitments and improve the project performance.

Similarly, a comparison of the reasons for incomplete weekly assignments were analysed for each phase and further compared for the entire project duration. This is depicted in Figure 6.16. From the analysis, it is observed that equipment breakdown was the major reason for incomplete assignment for the 3 phases of 24-weeks recorded. It had a total frequency of 85 occurrences. This is because during any road construction project in Nigeria, plants and equipment are the main items used in carrying out the project. Hence, when equipment and plants breakdown or are unavailable, there is a chain effect on the project program and outcome.

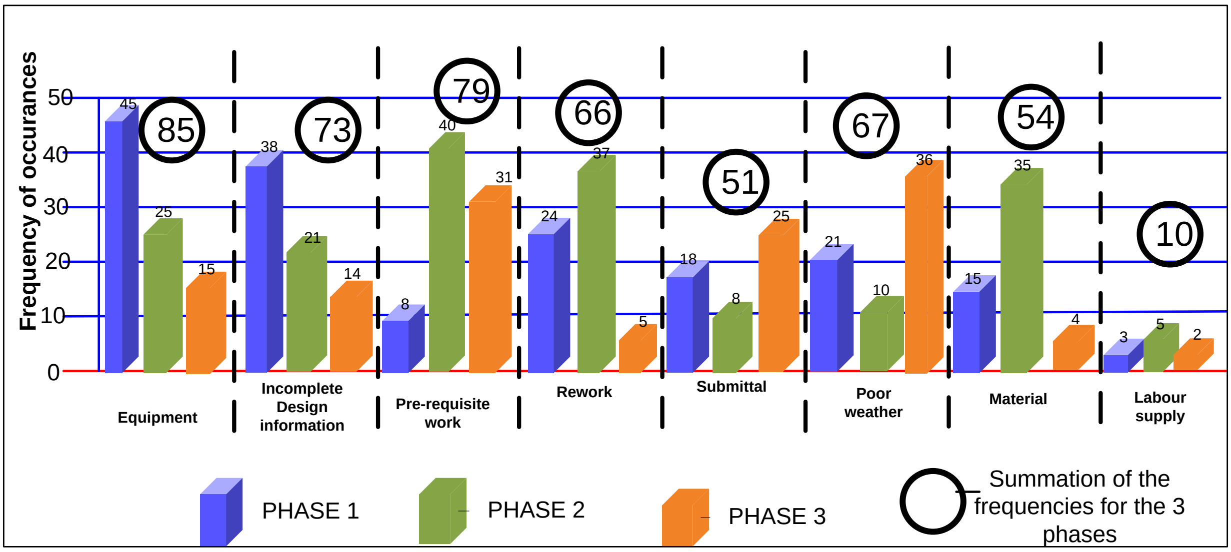

Figure 8: Reasons for incomplete assignment for the three phases

In the same vein, a road construction project is linear in nature; hence it is mandatory that some tasks have to be completed before others start. For examples, asphalting will only commence after the road section to be asphalted has been primed, and priming will only take place and all earthworks has been completed. Similarly, the earthwork depends on clearing and setting out of the road. All of these indicate the importance of pre-requisite work and pre-requisite work was observed to be the second most recurrent reason for incomplete assignments throughout the entire project implementation period, with a total frequency of 79.

Furthermore, incomplete design information was the third most frequent reason, with a frequency of 73. It was observed that three weeks into commencement of the project, the working drawings and specifications were not ready. The contractor had to wait for the consultants to furnish them with the specifications of the vertical and horizontal alignments. This however caused most of the planned assignments not to be completed.

The fourth was poor weather. This was a major reason for incomplete assignments during the third phase of the implementation. The poor weather was mainly excessive rainfalls resulting in flooding of the road sections, caused most of the planned work to be suspended. Most graded sections were scarified and re-graded which was counted as rework. Hence rework was recorded as the fifth most frequent reason for incomplete assignment throughout the entire implementation period.

Additionally, community disturbances caused material unavailability within the second phase of the 24 weeks of the full implementation period. This material unavailability reoccurred 54 times as reasons for incomplete assignments. While, submittals i.e. sending in late requests for materials and equipment resulted in the sixth most frequent reason for incomplete assignments and labour supply was the lowest reason for incomplete assignment; because equipment's were mainly relied upon to carry out majority of the tasks.

Questionnaires: The survey questionnaires were administered to the entire project participants to evaluate the LPS implementation process. The respondents to the question included the main contractor team, the consultants, the subcontractors and suppliers. Each questionnaire was divided into four sections (A-D) with section A focusing on the overview of the implementation. Section B dwelt on the barriers of the implementation, while the section C focused on the critical success factors of the LPS and the finally section D concentrated on the benefits gained from the LPS process. Tables 5.1 to Table 5.4 illustrate the results from the questionnaire surveys.

Tables 5.1: Overview of the LPS implementation

	Reasons	**weighting frequency (f)**									
		1	2	3	4	5	Σf	χ	RII	Rank	% Rating
1	*LPS was effective*	0	0	0	13	6	19	4.31	0.86	3rd	100%
2	*Results obtained were satisfactory*	0	0	0	4	15	19	4.79	0.95	2nd	100%
3	*WWP & PPC was useful*	0	0	0	2	17	19	4.89	0.98	1st	100%
4	*difficulty in carrying out the implementation*	5	10	3	1	0	19	2.00	0.40	4th	5%

Tables 5.2: Barriers of the LPS implementation

	Barriers	**weighting frequency (f)**									
		1	2	3	4	5	Σf	χ	RII	Rank	% Rating
1	*Poor supervision & quality control*	0	2	4	12	1	19	3.63	0.73	5th	68%
2	*Fluctuations & variation*	0	4	8	6	1	19	3.21	0.64	6th	37%
3	*Subcontractors involvement*	0	2	5	9	3	19	3.68	0.74	4th	63%
4	*Resistance to change*	0	0	6	10	3	19	3.84	0.77	3rd	68%
5	*Cultural issues*	0	0	1	13	5	19	4.21	0.86	1st	95%
6	*Lengthy approval*	0	0	2	9	8	19	4.31	0.84	2nd	89%

Tables 5.3: Critical Success factors of the LPS implementation

	Barriers	**weighting frequency (f)**									
		1	2	3	4	5	Σf	χ	RII	Rank	% Rating
1	*Training & empowering last planners*	0	0	0	15	4	19	4.21	0.84	3rd	100%
2	*Team work*	0	0	3	15	1	19	3.89	0.78	6th	84%
3	*Motivating people to make changes*	0	0	0	9	10	19	4.52	0.90	2nd	100%
4	*Appropriate human capital*	0	2	5	8	4	19	3.74	0.75	7th	63%
5	*Top management support*	0	0	0	8	11	19	4.58	0.92	1st	100%
6	*Managing resistance to change*	0	2	3	8	6	19	3.95	0.79	5th	74%
7	*Close relationship with suppliers*	0	0	1	16	2	19	4.05	0.81	4th	95%

Tables 5.4: Benefits of the LPS implementation

	Barriers	weighting frequency (f)									
		1	2	3	4	5	Σf	χ	RII	Rank	% Rating
1	*Solve problems on time*	0	1	7	4	7	19	3.89	0.78	7th	57%
2	*Reduces bad news*	0	0	0	10	9	19	4.47	0.89	1st	100%
3	*Reducing load on management*	0	0	1	8	7	16	3.68	0.74	9th	95%
4	*Predictable & reliable work plan*	1	1	3	7	7	19	3.95	0.79	6th	74%
5	*Projects are safer, faster and within cost*	0	0	2	11	6	19	4.21	0.84	4th	90%
6	*Stabilises projects*	0	0	1	9	9	19	4.42	0.88	3rd	95%
7	*Improves logisitics*	1	1	3	9	5	19	3.84	0.77	8th	74%
8	*Improves predictions of labour*	1	2	3	9	4	19	3.68	0.74	9th	68%
9	Reduces risks	0	3	0	10	6	19	4.00	0.80	5th	84%
10	completes project on schedule	0	0	0	10	9	19	4.47	0.89	1st	100%

The findings from the questionnaire on the overview of the implementation revealed that the respondents were in agreement that the LPS implementation was Useful, Satisfactory and Effective, with only few respondents indicating that they experienced difficulty in carried out the implementation. For the questionnaire response on the barriers during the implementation, lengthy approval ranked first as the main barrier, this was followed by cultural issues, then resistance to change and subcontractors. While poor supervision and quality control ranked fifth. The sixth barrier was fluctuation and variation.

The findings from the Critical Success factors (CSF) indicates that most identified important CSFs are Top management support, Motivating people to make changes and Training and empowering Last planners. While the respondents indicated that the main benefits recorded from the implementation are: Reduces bad news, Completes projects on schedule, Stabilises projects, Projects are safer, faster and within cost.

CONCLUSION

This LPS implementation has shown that LPS, which is rarely implemented in a linear process like a road construction process, could enhance construction management practice in an environment which differs from places where it has been previously implemented and characterised predominantly by poor quality, cost and time overruns.

On the whole LPS had a significant and positive impact on the project management process of the road project by enhancing planning practice, improving site logistics, removing constraints before they became obstacles and improving the entire site management.

Nevertheless, during the LPS implementation obstacles were encountered and these prevented the achievement of the full potential of the LPS implementation. Some of the obstacles include: cultural issues, lengthy approvals, resistance to change, sub-contractors involvement, supervision and quality control, fluctuation and variations. Besides its contribution in improving the project management practice within the study organisation, it has contributed to construction management by illustrating that irrespective of the nature of the construction project or the environment within which the project is occurring, the LPS can still be successfully implemented to record improvements.

Furthermore, the results from this case project can be used as a reference for organisations in Nigeria which look forward to improving their managerial practice. The study also suggest that implementing LPS in a road project in Nigeria can improve the process by encouraging collaboration among the project participants, transparency, trust and the reliability of the schedule.

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