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Evaluation of the Application of Last Planner System in Construction Projects

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ABSTRACT

This study aimed at evaluating the application of LPS in construction projects. The study specifically sought to evaluate the current state of LPS application in construction project delivery and ascertain the extent of LPS implementation processes application in construction project delivery in Imo state, Nigeria. The study was guided by the Management-as-Planning and Management-as-Organizing Theory. The study used a descriptive and survey research design methods of investigation and a purposes sampling technique was used to select a sample size of 193 from a population of 374 respondents using the Slovin's formula for sample size determination from the sampled professionals in Imo state. The data collection and survey instrument included a well-structured questionnaire from respondents. The data collected was presented using frequency distribution, figures, and charts with aid of statistical tools via IBM SPSS Statistics version 26.0. While frequency distribution charts, Relative Importance Index (RII) was used to analyse the main objectives of the study. The study's results show that the current state of LPS application in construction project delivery in Imo State is abysmally low. This was buttressed by the fact that (164) 93.18% of the respondents had a working experience of less than 5 years of experience on LPS, while 29.55% of the respondent are aware of the existence of LPS between 6 to 10 years ago. On the projects undertaken using LPS, 164 of the respondents representing 93.18% have had a working experience of 5-10 years. The concludes that the most important LPS implementation processes application in construction project delivery in Imo state is, daily huddle meetings, which is followed by constraints analysis, master schedule, process of phase planning and weekly work plan. This study recommends that the concludes the need for industry players, practitioners and government agencies at all levels to brace up to the paradigm change and embrace the "LPS". Fora such as conferences and professional associations meetings should be a breeding ground to help propagate the idea.

Key words: Last planner system, Construction Projects, Relative importance index, Imo state.

1. INTRODUCTION

The Last Planner System (LPS) is a collaborative approach employed in construction project planning and control, aiming to enhance reliability. It follows a three-tier strategy: a master plan with pull sessions, a look-ahead plan to screen make-ready activities, and weekly planning to ensure task completion [19]. Construction management faces various challenges, leading to delays and cost overruns. Lean construction (LC), derived from lean production principles, emerged to address these issues, improving project planning while minimizing resource usage [3]. Within LC, 'planning' defines success criteria and methods to achieve them, while 'control' ensures tasks align with the plan, allowing for re-planning and learning.

Originating in the 1990s from research in industrial construction [13]., LPS provides a platform for stakeholders to collaborate, reducing uncertainty and improving program quality. Often referred to as Pull or Collaborative Planning, the LPS promotes direct, face-to-face coordination, allowing all participants to contribute input into the execution of the work. This approach fosters a holistic view of the project, eliminates waste, enhances communication, and ultimately increases profitability.

The LPS promotes proactive identification of constraints, ensuring an uninterrupted workflow and fostering accountability, while avoiding inefficiencies such as rework and waiting. [16] describe the four stages of LPS: (a) the master schedule, (b) phase scheduling, (c) lookahead planning, and (d) the weekly work plan. The master schedule outlines key milestones based on contractual requirements, while phase scheduling breaks these milestones into phases, often using reverse scheduling. Lookahead planning aligns the phase schedule with the weekly work plan, breaking tasks into operations and determining their sequence and pace. The weekly work plan ensures tasks are clearly defined, appropriately sized, and completed on time.

Developed by Ballard in 1993, the LPS streamlines planning by focusing on weekly work plans and lookahead schedules, ultimately improving workflow management in both design and construction. The system is grounded in lean principles, which seek to maximize value and reduce waste in business processes, from product development to customer relationships.

As a lean tool, LPS:

1. Enhances planning detail as execution nears.
2. Fosters collaboration with those performing the work.
3. Identifies and removes constraints to improve planning dependability.
4. Ensures reliable commitments through proactive collaboration with partners.
5. Learns from past planning failures, avoiding future mistakes [8].

Lookahead schedules identify tasks for the upcoming work period, ensuring tasks are achievable and materials and equipment are available. If tasks cannot be completed, adjustments are made, and a list of necessary pre-tasks is created. In project planning, these schedules bridge the gap between what "should" be done and what is realistically achievable. This study seeks to evaluate the application of the Last Planner System in construction project delivery in Imo State.

Problem Statement

[4] found that Nigerian clients have a poor understanding of Lean Construction, with many unfamiliar with its principles or tools. They also explored the feasibility of adopting Lean practices, particularly the Life Cycle Performance System (LPS), in Nigerian construction. Implementing Lean Construction methods could effectively address sector challenges. Conventional project management methods achieve an average of 54% completion of planned tasks weekly, while projects using the Last Planner System (LPS) reach 85%.

[27] notes that Lean Construction enhances coordination among stakeholders, offering better outcomes than traditional management, benefitting owners, architects, engineers, and others. Its focus on reducing waste whether in materials, resources, or time—demonstrates the effectiveness of collaborative Lean teams in identifying and eliminating inefficiencies.

Modern construction projects are complex and prone to uncertainties and changes. According to [17], forecast accuracy declines with time, especially for long-term projects. Nigerian projects suffer from high rates of abandonment and failure, often due to missed deadlines, budget overruns, and compromised quality. These delays can extend for years, with some projects becoming obsolete due to technological advances. One key factor contributing to these failures is the lack of competent Project Managers, as expertise in design or engineering alone is insufficient for effective project oversight.

Despite recognising the benefits of LPS, the Nigerian construction sector has yet to fully adopt it. Challenges include the need for more resources during planning, inadequate training on LPS, poor constraint analysis, resistance to change, and limited communication between stakeholders [16].

Had large-scale government projects been managed by skilled professionals using LPS, the planning would be more strategic, addressing limitations and improving efficiency. As a result, the frequency of failed or abandoned projects in Nigeria would significantly reduce, if not disappear entirely.

Objectives of the Study

The aim of this research work was to evaluate the application of LPS in construction project delivery in Imo State. Specifically, the study aims to:

i. To evaluate the current state of LPS application in construction project delivery in Imo State.
ii. To ascertain the extent of LPS implementation processes application in construction project delivery in Imo State.

Research Questions

The research questions that need to be answered in the course of this project are as follows:

i. What is the current state of LPS application in construction project delivery in Imo State?
ii. How can the extent of LPS implementation processes application in construction project delivery in Imo State be ascertained?

2. LITERATURE REVIEW

Concept of the Last Planner System

LPS was introduced in construction projects by Glen Ballard in 1993. The Last Planner system embodies the principles and human values of lean thinking. Lean is a business philosophy and a system for organizing and managing corporate processes including product development, design, production, operations, supply chain, and customer relationships to increase value and minimize waste. Lean is a perpetual quest for perfection pertinent to organizational purpose, business processes, and developing people [25]

With LPS, Ballard focused on improving weekly work plans and controlling work flow of design and construction on projects. They described LPS as a planning, monitoring, and control tool based on lean construction principles of 'just-in-time' (JIT) delivery, value stream mapping (VSM), and pull scheduling (also known as reverse phase scheduling). They further indicate that the project master plan objectives are taken to a lower level of planning which is referred to the 'look-ahead schedule and weekly work plans. The look-ahead schedule involves the following process steps:

➤ Identify the assignments that can be completed in the next work period.

➤ Consult with production experts to confirm that the assignment can be completed within the specified period and that the material and equipment is in place for the assignment to proceed.

➤ Identify assignments that cannot be completed and amend the look-ahead schedule.

The primary function of LPS is the collaborative planning process that involves last planners for planning in greater detail as the team gets closer to doing the work. Moreover, LPS incorporates pull scheduling, whereby only the work that CAN be done is promised by last planners in weekly work plan meetings, as opposed to conventional ―push scheduling, where the work that should be done is planned in weekly meetings and the emphasis is on adhering to a master schedule.

Constraint analysis, an integral part of LPS, is applied to take a proactive approach to problem solving as faced during the day-to-day requirements of construction projects [23]. Additionally, the Plan-Do-Check-Act (PDCA) principle is followed by LPS as it encompasses a protocol to identify reasons for non-compliance to plan using the-Five-Whys analysis and maintaining a feedback loop. Figure 1 shows the Last Planner planning process.

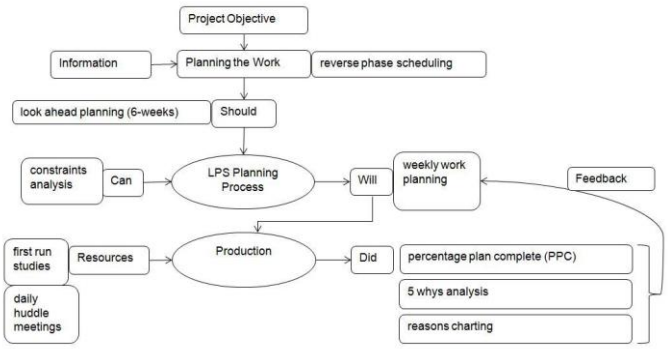

Figure 1: Last Planner System Planning Process. Source: [23].

History and Development of Last Planner System (LPS)

One of the inventors of the LPS is Glenn Ballard; in his earlier study on crew planning in the 1980's, at which time he was the Productivity Improvement Manager for Brown and Roots Construction in the United States. But it took over ten (10) years before the LPS could officially be adopted as a system for managing and planning production in construction. In the 1990s, the consulting work in the industrial construction sector done by Glenn Ballard and Gregory Howell led to the development of the LPS. At that time, principles such as 'make ready' and shielding workers from bad assignments were some key LPS principles practiced then. Professor Lauri Koskela's seminar on the Application of Production Principles in Construction is another vital contribution to LPS development. This work aided the creation of the field 'Lean Construction' which led to the creation of the International Group Lean Construction (IGLC) IN 1993, which was inaugurated in a conference in Expo, Finland. This conference was the first time the term 'Last Planner' was mentioned and published in the proceedings. Between 1993 and 1994, more experimentation and implementations of LPS on construction projects came into being; between 1995 and 1996, there was a full implementation of LPS on a major refinery project in Venezuela.

Over the course of time, there have been various developments coined into the LPS. It was in 1996 that the link between the 'lookahead plan', the 'make ready process', and the impacts of lookahead planning in improving the 'Percentage Plan Complete (PPC) was discovered and made part of the LPS. LPS was integrated with systems such as Building Information Education Modelling (BIM), Location-Based Management System, Takt Time Planning, and Visual Management. Many researchers around the world are painstakingly conducting research, and their new findings are constantly being incorporated into the LPS. Currently Glenn Ballard is creating an LPS benchmark with inputs from both industry practitioners and academics around the world, with the goal to list current practices of the LPS, provide Question and Answer (Q&A) to commonly asked questions on the LPS, give organisations the ability to measure their implementation of the LPS relative to the ideal state, and standardise the language used by the industry when referring to the different components of the LPS. Some argue that LPS emerged from the Toyota production system, but it wasn't; the LPS system was developed by construction practitioners for the sole purpose of construction industry benefits, and evidence has shown that in over 16 countries and on all the major continents of the world, LPS has been implemented. The exponential increase in LPS implementation reveals its widespread acceptance in the construction industry as an approach to eliminate constraints and enhance work delivery, [11].

According to [20] argument on LPS not being developed by Toyota Company, "LPS was developed by construction people for construction people." LPS began even before 'Lean Construction' became part of management vocabulary because Lean is a way of thinking common in Toyota, and like most tools used in Lean transformation, LPS supports 'Lean Thinking' about a specific problem that is unreliable and unpredictable in a project-based environment. The first experiment of LPS conducted in 1981 shows that on a site well managed and run by a respected piping contractor, fifty-four percent of one in two tasks planned for delivery in a given week were delivered in that week. LPS is first and foremost a way to make project work more reliable and predictable, and in the end, it improves productivity. LPS is a short-term project planning system first used by engineering construction twenty years ago. It continues to create significant improvements in projects and program safety, predictability, productivity, speed of delivery, profit, and feelings of wellbeing among project staff. According to Fuemana, [16]. LPS was developed as a production planning and control system for enhancing and improving the irregularities in construction workflow and has been a means to induce change in the construction industries of many countries.

Talking further about the history and development of LPS [6], it says, "The birth of LPS started in the United States after the studies by Professor Glenn Ballard and Gregory Howell at the University of Berkeley, United States, in the 90's, coupled with the work of Professor Lauri Koskela at the University of Helsinki, Finland, and in the year 2000 when Ballard presented his doctoral thesis at the University of Birmingham, United Kingdom, titled 'The Last Planner System of Production'". This thesis provides the definitive form for proper understanding of the LPS. Before the development of LPS, planning in construction had always existed, but the coming of LPS brought into use a new and more efficient way of planning in construction.

Last Planner System Implementation Processes

According to [15; 25), the concept of LPS arose from a need for control, with the goal of increasing work flow predictability, also known as production system stabilisation, and increased work plan predictability, by controlling the quality of assignments in weekly work plans. Pull scheduling, also known as reverse phase scheduling (RPS), was introduced later in response to the realisation that conventional scheduling was just as ineffective as conventional control. The Last Planner System implementation consists of five main operations as detailed below. These incremental procedures have substantial benefits, particularly in creating a collaborative connection. This study used the Last Planner System to analyse three aspects: Master Schedule, Phase Planning, and Pull Planning, as well as Percent Plant Completed (PPC).

Master Schedule

The Master Plan, also known as milestone planning, includes all of the tasks that must be accomplished throughout the project while also indicating how long each activity will take to complete [12]. A master schedule is a plan that describes the entire project's work from start to finish [25]. The master schedule serves as the framework for subsequent scheduling activities, such as phase scheduling, which entails breaking down the master schedule into more granular project components that change during the project [10]. The master plan, also known as milestone planning, includes all of the tasks that must be accomplished throughout the project while also indicating how long each activity will take to complete. It identifies project milestones and establishes the mechanisms to achieve them. It serves as the foundation for the development of the collaboration programme or phase planning. It identifies project milestones and starts the measures to achieve them [12]. This is sometimes referred to as the contract programme and is displayed on a Gantt chart or in Primavera. It serves as the foundation for the development of the collaboration programme or phase planning. The Master Plan's aim is to illustrate the target (milestone) for completing a specific task, and to use that knowledge to guide project delivery through collaborative programming or phase planning meetings [9]. The master programme demonstrates how the full project can be completed.

Phase Planning and Pull Planning

The purpose of the planning phase is to generate a comprehensive timetable that encompasses every stage of the project. This schedule serves as a basis for subsequent planning, establishing the structural framework, and completing the project [25]. Phase planning, also known as collaborative programming, is a method employed to create a dependable construction schedule. This is achieved by actively including subcontractors, contractors, suppliers, designers, and other stakeholders, including the client, in the development of the program. The aim is to ensure the engagement of all parties in the project. It heavily relies on the notion of the "next customer" to comprehend the interfaces inside the process. Handing off, also known as the process of transitioning from one activity to the next, is established early in the project planning phase through the use of logical reasoning. This ensures agreement on how each activity concludes and the subsequent action begins [25; 8]. The planning phase is often derived from the master program through a series of discussions and contributions from subcontractors, suppliers, speciality contractors, designers, and other project stakeholders. Enhancing transparency and fostering trust among the project team is crucial for establishing a shared comprehension of all project elements, as outlined in the eighth flow [22].

Process of Phase Planning

Adequate collaborative programming of construction activities adds value to the entire project delivery process [12]. This is because the client requirements are most times clearly defined and the supply chain proposals are constantly deliberated on to arrive at best optimal solution. [8] identified eleven key processes in developing a Phase Scheduling or collaborative programming which must be done collaboratively by those required to do the work.

1. Define the work to be included in the phase

2. Determine the completion date for the phase

3. Use team planning notes to develop network of activities

4. Apply duration to each activity

5. Re-examine logic to shorten the duration

6. Determine the earliest start date for the task

7. Decide on activities to buffer by asking
a. Which activity duration are most fragile

b. Rank order the fragile activities by degree of uncertainties

c. Allocate available time to the most fragile activities.
8. Remember the contingency is meant to be spent

9. Check to be sure the teams are comfortable with available buffers, if not re-plan or shift milestones

10. If there is time in excess, accelerate the schedule or use it to predict on-time completion

11. Reverse unallocated time in a general contingency buffer for the phase.

This approach provides opportunity for the subcontractors and the suppliers to participate meaningfully in developing the overall programme for the project, thus gaining their commitment. According to Ballard and Howell, (2004) the process is used in producing a plan that is mostly based on team approach and uses reverse phase scheduling.

Look Ahead Planning

Another important scheduling activity is the lookahead plan, which lists activities that must be completed in the upcoming six weeks. This plan is updated weekly, considering any constraints impacting workflow reliability [10]. Look ahead planning describes the steps of LPS planning with period of

time is usually between two to six weeks, then take action in the future now so as not to cause additional work in the future. The essence of the process This look ahead is a schedule that contains potential jobs to be done. Some assignments that are included in look ahead planning are done constraints analysis to be actually implemented [25]. Once the lookahead plan is established, responsibilities are identified, and assignments are made by analysing resource management information.

The look-ahead planning is a medium-term plan for project activities and is developed from the collaborative programme considering the work to the next level of detail. Usually, tasks that will occur within four to six weeks in the look-ahead window are screened for constraints in all eight flows. These include the seven process flows such as information, permissions, resources, space etc. and the plus one soft flow 'common understanding' [22]. However, in the traditional way of managing projects, the look-ahead plan (master programme) only provides advance notice of the start date of an activity and does not consider the complex network of flows, their sequence, matching work flow with capacity, or maintaining a backlog of workable activities.

The Lookahead Plan is used to decompose activities from phase level to operations level. The purpose differs depending on the progress of the Lookahead Plan as shown in figure 2 [17]. Lookahead planning is used to perform first run studies (virtually or physically), identify constraints, assign responsibilities, communicate workflow processes, and prepare the information and resources. In so doing it makes the tasks ready that *should* be done, so that they *can* be done. Lookahead planning uses activity screening and pulling to identify and remove the constraints. Screening exposes the activities to constraint analysis and used to decide which activities should be allowed into the six-week Lookahead Plan and which ones should be allowed to move forward.

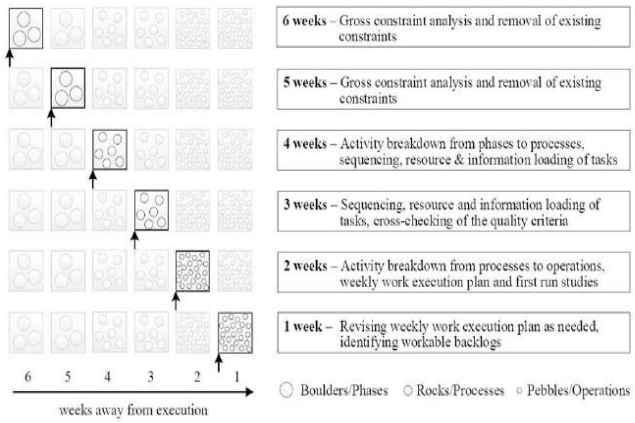

Figure 2: The six-week lookahead planning process in LPS

Extent of LPS Implementation

LPS Have been implemented partly or in whole across the globe and in any case the experience of its implementation reveals there always exist successes at the end of it project. According to the study in New Zealand [16]. A study on the top companies in the Auckland area using LPS in their production identified only three contracting companies. Interviews that were conducted on two site managers and four projects' managers, it was discovered that they have on the average five years' experience with LPS both in New Zealand and other jobs they have managed across the countries and on the average, they have implemented LPS in seven projects. All the six participants that were interviewed had a fair knowledge about the LPS processes and tools, and one of the participants was noticed to be very experienced in the use of LPS and have used it in twenty-five projects both in New Zealand and in other countries. The participants all saw LPS as an essential planning system tool that remove waste and improve productivity while reducing construction time as a result because it was reported that one hundred percent (100%) of project using LPS were finished on time, one of the manager who participated in the interview identified that their current project construction time has been reduced from ten (10) months to seven (7) months because they use LPS, and another manager experienced twenty (20%) to (30%) thirty percent saving on time, this reduction on time is interwoven in the reduction of cost for the participant and the overall benefits were found to be closer working relationship collaborative building team, and enhanced communication, increase planning reliability and reliability of delivery by subcontractors, more relaxed management when subcontractors manage themselves and continous improvement and forward thinking. From the study LPS can only improve productivity when it is implemented, and adopting it as a general part in construction project in New Zealand will improve the productivity of the industry.

In Saudi Arabia according to [5], a study conducted on two governmental facilities to examine the impact of LPS on improving construction planning practice, the aim of the study was to improve on the managerial practice which could not be achieved by means of other planning approaches. The projects are (i) the facility of Business and Administrative Science worth twenty-one million US Dollars, to be completed in seventeen months, (ii) General classrooms and laboratories worth ten million US Dollars, with same duration of seventeen months. Those projects occurred concurrently in the period where the people observe their fasting (the month of Ramadan) but all put together, implementing LPS helped to avart the tendencies to low productivity. In the first project the contractor implementing LPS in the two sites, the first project percentage complete rose from sixty-nine (69%) percent in the first week to eighty-six (86%) percent in the last week, peaked at one hundred (100%) percent in the first week after introducing look ahead planning and stabilised at eighty-six (86%) percent for the last two weeks of the project. In the second project, percentage plan complete rise from fiftey six (56%) percent in the first week to eighty-two (82%) percent in the last week, peaked at eighty-four (84%) percent at the middle of the period and stablised above eighty (80%) percent for the last five weeks of the project. The study was able to identify the importance and success rate of implementing LPS

in the Saudi Construction Industry, there was an improvement in the general project management practice suggesting that LPS is a powerful and general method that is applicable in different cultural contexts, and improvement also in the quality of work practice, knowledge expansion and learning. The LPS proved that it could enhance construction management practice in various aspects that bring about numerous advantages like in the first project the project team was able to reduce the time of structural activities by about two (2) weeks regardless of the obstables and challenges that was perculiar to the Saudi Arabian environment and that was experienced during the study.

The Egyptian construction industry according to [1] has been on the rise due to political and economic changes, and there is a need for increase productivity in that the construction market suffers in the term of time to deliver projects because most of the Government projects are fast-tracked and delivering in time becomes a major challenge. The study was divided into two phases with respect to the period in which each phase will occur to aid in the introduction of LPS gradually in Egypt. The first phase was to adopt LPS tools on a small-scale project half-way through the project lifecycle, and the second phase was to implement LPS and BIM tools on a more sophisticated project which had a higher budget from the start of construction. Although there exist this lack of awareness in the industry due to the lack of commitment from different stakeholder, the poor quality of time schedule, the study seeing LPS as a successful tool to solve the problem facing the construction industry was able to enlighten the construction industry of the need to implement LPS and it also offers insights on how to further refine the framework and to what extent the LPS adoption result in better project performance and mitigates the perceived challenges in the construction industry.

Finland also is another country where the need of the implementation of LPS is studied. According to [18], a study with the aim to evaluate and summarise the diffusion of LPS in Finland in the last ten years noted that the first pilot project in introducing LPS in Finland was in the year 2003 and training and texting of LPS lasted for six months on four construction sites. The texting concentrated on making weekly plans, where tasks done have any constraints and the pre-requisite are taken care of; getting participants to make commitments in the weekly plans, checking the percentage plan complete, arising interest and starting systematic lookahead planning, when the pre-requisite for the tasks to be done in the next couple of weeks are realized and finding the reasons and explanation why the goals were not met and trying to learn from the past to prevent similar difficulties reoccurring in the future. The first results were positive and in agreement with same results to the outcome of implementing LPS abroad. It was observed that the degree of weekly plans increased and site contractors considers the method very useful because it was seen to eliminate problems reoccurring in the sites and also the implementation of LPS was recommended in short term production control on construction sites in Finland. LPS has been adopted as part of the planning control system by construction contractors in Finland but before this adoption, after the first pilot project LPS seen to settle down as just a method in Finland because even though the system was accepted but it was not understood. Seeing LPS as an innovative way of improving production control in construction sites some individual construction managers accepted training on LPS from LPS trainers (certified by Lean Construction Institute) they embrace the new, modern approach to planning in the construction sites. The Finland construction industry understood the need and urgency of the LPS into the construction sector, this hungered-desire was evident when they published a manual for LPS, this shows the height of the acceptance of LPS in Finland.

In Mexico, [21] conducted seven case studies to examine the impact of LPS to improve construction planning in the Mexican companies. From the results of the participants interviewed and the reflection of the LPS implementation leaders shows that LPS implementation is very useful and a successful approach to planning, one manager in one of the seven (7) projects case study said; “At the beginning I have my doubts and fears about LPS but gradually I realized that it is a very useful tool”. From the study of the seven projects the author identifies several reasons to believe that LPS has large benefits in the Mexican construction industry ranging from improving the planning control and to organization of resources, clear definition of roles and responsibilities, perseverance to follow the entire process daily and involvement of all stakeholders. LPS integrates all the project participants and the study made useful contribution to construction management practice in Mexico and the companies studied is starting the dissemination of the theory and practice of LPS in the Mexican construction industry both in universities and in companies.

Also in Nigeria, according to [14], although LPS is still alien in Nigerian construction industry and relating on the benefits of LPS in other countries, were LPS has been implemented saw the need for its implementation in Nigeria. The study conducted in the Lagos metropolitan was of the intent to know the current practice on construction sites in Nigeria that reveals the LPS thinking from the result obtained from seventy-five (75) respondents, the result presented reveals that three construction sites frequently use the LPS ideas, and majority of the respondents claiming they have frequent meetings with client, consultants, contractors and subcontractors. Although there exist LPS thinking in Nigeria construction industry, the author argued that it should be or serve as a good platform for the full implementation of LPS on construction sites in Nigeria, all the respondents interviewed in the study strongly believed that effective planning, team work and training can minimize the occurrence of non-value adding activities in Nigeria construction sites but all these measures are all imbedded in the LPS principles.

LPS manages the relationships, conservations and commitment that enable program and production planning decision to be made collaboratively at the lowest possible level. Results show that there is a thirty percent improvement in the rebuilding

times for runways since LPS is introduced. The reasons whey Construction people uses LPS are numerous- to deliver project more safely, to create a more predictable production programmes, to reduce project durations, to better manage cost, to reduce stress on project management staff, to help improve the overall production process and to make project reliable to customers for just-in-time deliveries. [20].

Although there exist many challenges and barriers to the full implementation of LPS across the world because there are no explicit instructions for a systematic apply LPS available, but in recent years projects have increasingly used LPS in building construction to make planning more reliable, get smooth work flow and improve productivity. Because current initiatives to improving productivity and the adoption of differing project delivery strategies have failed to increase the industry productivity due to the systematic nature of the industry. But researchers have evaluated the effectiveness of LPS within different academic and industrial settings, the benefits of using LPS as a tool in construction production are outnumbered compared with other traditional planning methods, this makes LPS a reliable tool that should be learnt, understood and used by all construction personnel. [24].

Theoretical Literature

Management-as-Planning and Management-as-Organising Theory was employed as the basis for this study.

Management-as-Planning and Management-as-Organising Theory

The management-as-planning (MAP) theory dominates the current approach used in construction planning. The theory advocates that project consists of two parts; "the managerial part" (the planner who does the planning) and 'the effector part" (field workers) who are responsible for translating the plan into [12; 14]. [18] Koskela and Howell, (2002) observed that the management-as-planning theory advocates for plan centralisation, revision of plan and then implementation. This implies that in this approach, field workers are not involved in the planning at the beginning although they could be during revision. To overcome this, the management-as-organising (MAO) view is presented. In this approach, it is believed that each sub-unit in the system has the capacity to plan, sense and act, thus, the planning decision should not be left with "the managerial part" alone. In construction, this approach supports the inclusion of the supply chain in the planning process as demonstrated in the LPS.

The MAO theory also assert that the knowledge needed for planning is dispersed among the people doing the work. Apparently, this view supports and further shows the need for the planner to involve subcontractors, foremen, and site engineers in developing the construction programme. This will not only provide an opportunity for the people doing the work to do the plan but will also lead to the development of a more realistic and predictable plan which the LPS supports [18].

Empirical Literature

[3] did a case study of last planner system implementation in Nigeria. The work described in their paper presents preliminary results of an ongoing research project. It focuses on the implementation of Lean Construction (LC) technique to improve construction management practice in Nigeria. To achieve this, design science research strategy was undertaken with different data collection methods. These methods included direct observations, interviews, questionnaires and documentary analysis. The research was carried out in a University construction site, where four prototype hostel buildings were being constructed simultaneously by four different contractors. LC technique via the Last Planner Systems (LPS) was adopted by one of the contractors in the construction of one of the hostel buildings. The results reveal that the LC project made significant improvements in terms of; the timely completion of the project, 30% cost savings as against the others and an average Percentage Plan Completed (PPC) of 80%. These improvements were facilitated by the way the site was planned, managed and controlled using LPS. Last Planner System (LPS) is the most developed LC tool used in improving work plans and control of projects. The paper concludes by discussing possible barriers hindering the full potential of LPS. These barriers include; lack of commitment to change and innovation and starting off the implementation half way into start of the project. The critical success factors are also discussed and further research is being proposed.

[26] in a study on success factors and barriers of last planner system implementation in the Gaza Strip construction industry. The study contributed to a better knowledge of the lean construction and last planner concept, and therefore the efficiency of their implementation. The aim of the of the study was to determine the main factors supporting the applicability of Last Planner Concept (LPC) and to determine its challenges/barriers in the Gaza Strip construction industry. At first, all the relevant literature was systematically reviewed. At the next stage, 17 critical success factors and 18 barriers for LPC were identified. After that, a survey was conducted through a questionnaire to collect the data from 98 contractors. A Likert scale data was analyzed to rank the success factors and the barriers using Relative Importance Index (RII). The results showed that "Close relationship with subcontractors" and "Top management support" are the main factors that affect the successful application of LPC. Moreover, "lack of skills, training, and experience" and "lack of the training program for the managers" were deliberated as the key obstructs of the LPC implementation. It was recommended to choose the subcontractor based on his previous expertise and competence such as workers, tools, and machinery. The subcontractor should support all parties to address the project problems to make the right decisions for project objectives achievement.

[19] did a study on the influence of the experience of the project manager and the foreman on project management's success in the context of LPS implementation. The study aimed to analyze how the implementation of LPS and the construction

management experience of the project manager and the construction site foreman individually influence project management's success, getting minimum time and cost deviations. In this work, newly built single-family house projects were analyzed. Quantitative and qualitative analyses, based on the Mann–Whitney U test and qualitative comparative analysis method, respectively, were performed to constrain both the individual and combined effects of LPS, the project foreman, and the project manager in terms of cost and time deviation as measures of project management success. The results highlight that LPS implementation is significant in terms of time deviation and combined LPS implementation and the foreman's experience in construction management are sufficient to maintain time deviations below 10%. However, among the studied variables, only the foreman's experience is a required condition to maintain cost deviations under 10%. Overall, this study could help construction organizations to improve their managerial practices at construction sites.

[13] in a study on development of an approach to support construction stakeholders in the implementation of the last planner system. The aim of the study therefore, was to develop an approach to support construction stakeholders in the implementation of the LPS. Thirty semi-structured interviews and three in-depth case studies were conducted with construction stakeholders. The study developed a non-prescriptive but all-inclusive approach for supporting construction stakeholders in the implementation of the LPS on construction projects. The study contributes to knowledge in engineering management as it provides a new insight into how to apply the LPS holistically in the management of engineering projects. The study further provides evidence into the current practice and performance of the LPS in the management of civil engineering project as demonstrated in the case studies. Finally, the identification of the three "levels of support" (organisational, project, and external enabler) provides a focal point for construction practitioners to focus on in the implementation of the LPS in the management of civil engineering project.

[27] in a study on application of Last Planner System to Modular Offshore Wind Construction. The focus of the study was the applicability of the Last Planner System (LPS) to modular offshore wind construction. Following a design science approach, a conceptual model for LPS adapted to modular offshore wind construction was developed, then refined and evaluated in a field study. The field study investigated was an offshore wind project in the Belgium sector of the North Sea. Theoretical knowledge from academics as well as practical experience from field experts allowed adjusting LPS to the context of modular offshore wind construction. The case study organization participated in the artefact development and evaluated its utility through implementation. In comparison to the original as-planned critical path method (CPM) schedule, implementation of the developed artefact reduced project duration by 21%. Since offshore wind projects have tended to substantially overrun their scheduled durations, 21% may understate the actual improvement. Compared to current installation time within the industry the project made a 36% reduction, measured by average installation time per megawatt (MW).

3. METHODOLOGY

This section discusses the methodology and model to achieve objectives through implementing Last Planner System in construction projects.

Research Design

The actual state of LPS evaluation and how it is applied in construction sector are extracted from the help of a designed questionnaire which is a primary source of collecting data as a base of feedbacks.

Population of the Study

The population of the study is the entire sets of units which are references from the findings of the primary source of collecting data which are targeted on population of the construction firm in Imo state. The population size (N) in Owerri comprised a total sample size of (n) = 6 of construction firm, which are operational and provide effective result.

Sample and Sampling Technique

The study adopted a technique of sampling considering the population of the targeted area and its sample size, this sampling designs and sample techniques that is aimed at achieving a dependable result through the application of simple random sampling which is a type of sampling techniques.

This simple random sampling is a tool that produces a scheme which ensures that each sub group of the population size (N) has an equal probability of being chosen as the sample (n)

Population = N

Sample size = n

To justify the result obtained from the population (N) a statistical technique of simple random sampling without replacement to show that the sample obtained by the probability of choosing the same value will affect the population sample size (n).

The sample size for this study was determined using the Slovin's Formula, which is a method for calculating the required sample size (n) based on the population size (N) and desired margin of error (e). The formula for estimating the sample size is based on a random sampling technique. The population size is specifically aimed at construction professionals operating in Imo State, namely: architects, quantity surveyors, engineers, builders, project managers and others.

It is computed as $n = \frac{N}{[1+ N (e)^2]}$

Where:

n = the no. of sample

N= total population

e = error margin

$n = \frac{374}{[1+ 374 (0.05)^2]}$

$n = 193$

Upon analysing the output, it is evident that a total of 193 questionnaires was distributed to the respondents and subsequently collected. In sampling without replacement, the two sample values aren't independent. Practically, this means that what we got on the first one affects what we can get for the second one. Mathematically, this means that the covariance between the two isn't zero. That complicates the computations. In particular, if we have a SRS (simple random sample) without replacement.

Data Analysis and Presentation

The gathering of the questionnaire contributed a qualitative and quantitative data with the use of closed-end and open-end questions. This information gotten from the questionnaire, serve as a dependent variable to help analyse and evaluate the implementation of LPS on construction firm in Imo state.

In addressing the objectives of the research, the Relative Importance Index (RII) was used. RII is commonly used to measure the extent to which the occurrence of an outcome exists [4]. The following formula was used to calculate RII.

$$RII = \frac{\bar{x}}{k}$$

Where $\bar{x}$ = mean =

$$\frac{\sum fx}{\sum f} \quad \Sigma fx \Sigma f$$

k = maximum point on likert scale (e.g k = 5)
x = points on the Likert scale (1, 2, 3, 4...)
f = frequency of respondents' choice

For the interpretation of the *RII* values, *RII* is ranked from the highest to the lowest.
If *RII* <0.60 item has low rating
0.60 <*RII*<0.8 item has high rating
RII≥0.8 item has very high rating

4. RESULTS AND DISCUSSIONS

Presentation of Results of Data

Professionals from construction firms working on some projects completed the self-administered questionnaires. Amongst a total of 193 professionals, 188 completed and submitted the questionnaires, while 176 were found to be fit for the analysis proper resulting in a response rate of 89.64%. The substantial response rate of 89.64% facilitated the acquisition of sufficient data that could be extrapolated to ascertain the realization of the research objectives set. A response rate of over 50% is always considered necessary to be used to represent the opinions of the respondents in the target population. The response rates are displayed in table 1.

Table 1: Details of Responses from the professionals

	Professionals	**Population**	**Sample Sent**	**Sample Returned**	**Sample Used**
1	Architects	95	52	40	36
2	Builders	92	40	38	34
3	Project Managers	45	30	29	25
4	Quantity Surveyors	51	24	47	41
5	Civil Engineers	49	25	28	22
6	Others	42	21	25	18
	Total	**374**	**193**	**188**	**176**

Source: *Analysis of Field Survey data, 2024.*

LPS implementation process application in construction projects

In evaluating the extent of LPS implementation processes application in construction project delivery, data obtained was analysed using relative importance index (RII). Details of the analysis is shown in table 2.

Table 2: Relative importance index score for LPS implementation processes

S/N	**LPS implementation processes**	**SA** **5**	**A** **4**	**N** **3**	**D** **2**	**SD** **1**	**SUM**	**RII**	**Rank**
1	Master Schedule	82	45	13	15	21	680	0.45	2nd
2	Phase Planning and Pull Planning	62	42	18	23	31	609	0.41	6th
3	Process of Phase Planning	51	82	12	13	18	663	0.44	4th
4	Look Ahead Planning	48	65	9	23	31	604	0.40	7th
5	Constraints Analysis	63	62	19	21	11	673	0.45	2nd
6	Shielding Production	58	49	13	14	42	595	0.40	7th
7	Weekly Work Plan	53	72	12	18	21	646	0.43	5th
8	First Run Studies	46	38	19	42	31	554	0.37	10th
9	Daily Huddle	79	55	8	12	22	685	0.46	1st

	Meetings								
10	Percent Plan Completed	44	65	18	24	25	607	0.40	7th
	Legend: SA=Strongly agree; A=Agree; N=Neutral; D=Disagree; SD=Strongly disagree; RII=Relative Importance Index								

The findings presented in table 4.2 above indicates that the most important LPS implementation process application in construction project delivery in Imo state is Daily Huddle Meetings with a RII of 0.46 and ranked first. While the results show that Constraints Analysis and Master Schedule both had the next RII of 0.45 and ranked second. While the results show that Process of Phase Planning had the next RII of 0.44 and ranked fourth. Weekly Work Plan with a RII of 0.43 was ranked fifth. Phase Planning and Pull Planning with a RII of 0.41 was ranked sixth. The trio of Shielding Production, Look Ahead Planning and Percent Plan Completed with a RII of 0.40 were ranked seventh. While First Run Studies had a RII of 0.40 and was ranked tenth.

Discussions

The results of the assessment on the level of LPS (Last Planner System) implementation in construction project delivery within Imo State reveal key insights into the significance of different LPS components. These findings align and, at times, contrast with the existing body of empirical literature on LPS implementation in various global contexts.

Significance of Daily Huddle Meetings

Among the various LPS tools evaluated, Daily Huddle Meetings emerged as the most significant in facilitating LPS implementation, with a Relative Importance Index (RII) of 0.46. This finding aligns with several studies that emphasize communication and daily coordination as critical factors in LPS success. For example, [3] found that timely communication and planning were crucial to the success of LPS, particularly in the Nigerian construction context, where contractors adopted LPS for enhanced planning and control. Similarly, [26] highlighted the importance of continuous communication between team members as essential for successful Last Planner implementation in Gaza, further reinforcing the crucial role of daily meetings in ensuring smooth operations.

Constraints Analysis and Master Scheduling

Both Constraints Analysis and the Master Schedule, with RIIs of 0.45, were placed in the second rank in terms of importance. These components play a vital role in identifying and mitigating project barriers early, allowing for better planning and resource allocation. [19] emphasized the critical importance of project managers' experience in handling project constraints effectively. They found that the combination of skilled managers and LPS tools such as constraints analysis helped in minimizing time deviations, which also echoes the importance of comprehensive scheduling and planning.

In contrast, the Weekly Work Plan and other planning components are typically seen as effective only when coupled with a strong project schedule. A similar observation was made by [13] who highlighted the need for a holistic, integrated approach to LPS that spans organizational, project, and external levels of support. Such an approach ensures that barriers to effective scheduling are addressed at all levels, improving overall LPS adoption.

Process of Phase Planning and Pull Planning

The Process of Phase Planning and Pull Planning (RII = 0.44) rank fourth, which emphasizes their role in aligning project stakeholders and ensuring that work is properly scheduled and executed. The role of phase planning in LPS has been well-documented in the literature. [26] found that factors such as project design complexity and team coordination had a significant influence on the successful implementation of phase planning. Similarly, [3] found that the Lean approach, especially the implementation of phase planning, resulted in significant cost savings and schedule improvements, further corroborating the relevance of these planning phases in LPS adoption.

Pull Planning and Shielding Production

The ranking of Phase Planning and Pull Planning (RII = 0.41) is consistent with the study by [27] where modular construction projects also required significant upfront planning to mitigate project uncertainties. The adoption of pull planning, in particular, has been seen as a powerful tool in managing production flow in offshore wind projects, where [27] reported a remarkable 21% reduction in project duration and a 36% reduction in installation time per megawatt (MW). This outcome emphasizes the value of pull planning in optimizing the flow of work and resource allocation, which is directly applicable to the construction projects in Imo State.

Weekly Work Plan and Percent Plan Completed (PPC)

The Weekly Work Plan (RII = 0.43) and Percent Plan Completed (PPC) (RII = 0.40) reflect the ongoing importance of short-term, actionable plans in the construction process. These tools measure how well teams are adhering to their planned work, an area also addressed by [3], where an average PPC of 80% was achieved on the LC-adopted project, pointing to the importance of consistently tracking and improving work flow. Moreover, this is consistent with findings by [19], who identified that well-managed LPS implementation significantly reduced time deviations. Their study highlights that keeping track of daily and weekly progress through these tools is vital for maintaining control over a project's timeline.

First Run Studies and Look-Ahead Planning

Finally, First Run Studies and Look-Ahead Planning, with a Relative Importance Index of 0.40, were ranked seventh in terms of significance. These planning tools are central to identifying future constraints and providing solutions ahead of

time. According to [26], a major barrier to LPS implementation was the "lack of skills, training, and experience," which could hinder the effective application of tools like look-ahead planning. This observation underlines the importance of training and experience for project teams to successfully anticipate and manage potential issues before they arise.

Thus, findings of this study reinforce and complement a growing body of research on LPS implementation, especially regarding its impact on project delivery timelines and cost efficiency. The importance of Daily Huddle Meetings, Constraints Analysis, and the Master Schedule in the Imo State construction industry mirrors trends observed globally, as seen in the works of [4]. Furthermore, the study highlights the necessity for project teams to develop strong management practices, including regular updates and feedback loops (as suggested by Daniel et al. 2019) to overcome barriers like lack of skills and training.

5. CONCLUSION

From the outcomes of the results, the study now concludes that the current state of LPS application in construction project delivery in Imo State is abysmally low, given that (164) 93.18% of the respondents had a working experience of less than 5 years of experience on LPS, while 29.55% of the respondent are aware of the existence of LPS between 6 to 10 years ago. On the projects undertaken using LPS, 164 of the respondents representing 93.18% have had a working experience of 5-10 years. Thus, the most important LPS implementation processes application in construction project delivery in Imo state is, daily huddle meetings, which is followed by constraints analysis, master schedule, process of phase planning and weekly work plan.

6. RECOMMENDATIONS

Given the outcome of our findings, this study recommends;

1. Given the abysmal low level of the current state of LPS application in construction project delivery in Imo State, there's need for industry players, practitioners and government agencies at all levels to brace up to the paradigm change and embrace the "LPS". Fora such as conferences and professional associations meetings should be a breeding ground to help propagate the idea. The use of LPS tools and techniques like Phase planning and pull planning, look ahead planning amongst others have proven to be useful tools that are cost effective that would help curb waste in the entire construction project delivery process.

2. It is advocated that government and professional associations as well as all stakeholders in a project should see it as a matter of urgency to enact or promulgate laws and standards that would help strengthen the adoption and implementation of LPS in the successful delivery of construction projects as it is done in other climes. This effort would accord practitioners in the industry the needed push to deploy LPS in the delivery of the projects. On the aspect of resistance to change, all and sundry are expected to make a change by drifting from this idea of always trying to stick to doing things "the old ways".

7. CONTRIBUTION TO KNOWLEDGE

This study advances knowledge by investigating the current state of LPS application in construction project delivery in Imo State. This study has contributed in no small measure in revealing that there is an abysmal low current state of LPS application in construction project delivery in Imo State which no study to the best of our knowledge has been able to achieve.

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