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Lean Construction in the UAE: Implementation of Last Planner System®

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Abstract

Question: Is there a possibility of applying the Last Planner System® in the UAE construction environment?

Purpose: Investigating the success and failure factors of implementing the Last Planner System® (LPS®) in UAE construction projects.

Research Methodology: The research was conducted through exploratory interviews with construction professionals and an explanatory case study in the UAE.

Findings: LPS® implementation is applicable within the UAE construction market. The challenges on the level of operation can be addressed by using the concept of gradual change operations.

Limitations: limited interview sample; use of a single case study; the implementation is newer in UAE.

Implications: The procedure used within the case study will conform to the LPS® as a tool until it becomes an accepted concept.

Value for authors: Enriches the efforts of studying the implementation of the LPS® within the Gulf area and the Middle East in general due to minimal research covering the LPS®. In addition, the approach used for implementing the LPS® is unique to the context studied.

Keywords: Lean, Construction, Lean Construction, Last Planner®, Last Planner System® Planning, Project Management,

Paper type: Case Study

Introduction

The LPS® is one of the solutions to resolve the problems of traditional planning systems, and this research was based on a literature review of LPS® development and implementation. Many studies (AlSehaimi et al. 2009, Ahiakwo et al. 2013, and Hussain et al. 2014) confirmed

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performance issues in the construction industry and that one of the most important steps toward addressing this issue is learning from the manufacturing industry's performance.

Planning-controlling systems for construction are a significant problem, especially in the UAE (Ghias et al. 2015), due to uncertainties (Atkinson et al. 2006), which lowers the planning-controlling system reliability and leads to planning tools failure in managing project activities.

In addition to the adversarial environment and culture among construction project parties, looking for self-benefits instead of project benefits and the fear of accountability (Khaleej Times 2018) create an atmosphere of mistrust; thus, the need for a solution to improve the situation and enhance the industry performance has always been deemed necessary.

The LPS® has been the most useful lean technique in construction for the last +20 years (MacOmber et al. 2005, Daniel et al. 2015, and Paz and Oscar 2016). The LPS® implementation proved to have far superior project results compared with the usual critical path scheduling methods (MacOmber et al. 2005). It is founded on a collaborative, commitment-based planning system that integrates constraint analysis, weekly work planning grounded upon reliable promises, and learning built upon the analysis of PPC (percent plan complete) and reasons for variance (The Lean Principles 2004).

Regularly used look-ahead plans in the industry helped introduce LPS® but suffered from not being used to drive a make-ready process to prepare performers for reliable promises. Companies also used daily stand-up meetings to address urgencies and give direction but did not use them to bring resilience to the network of commitments. Others used tracking and reporting performance in progress, cost, and productivity. Unfortunately, none of these reports is easy to continuously add to, modify, and report completion in the network of commitments. In addition, systems and practices that bring attention to more action needed to stay on the plan have been missing. As a remedy, the unique procedure of implementing the LPS® without a facilitator has been introduced as an initial step to move from the current traditional tools within the challenging environment of UAE construction industry and towards complete implementation to the LPS® components.

This paper studies the factors influencing the LPS® application in the UAE towards practical implementation. The purpose of this study is to examine the factors affecting the implementation of LPS® in the UAE. The research aims to gauge the understanding and feasibility of LPS® and identify the difficulties encountered, to enhance the knowledge base in the area and assist organizations in finding a suitable and feasible method for implementing the system.. The first section of this paper evaluates current planning and control systems and provides an overview of LPS® and its implementation challenges. The second section explores the applicability of LPS® in UAE construction projects and proposes a suitable approach to apply it effectively.

Problem Statement

The traditional planning process does not consider waste during construction (Bokor et al. 2011), thus leading to a failure to achieve project time objectives (Kar 2009 and Farrell 2016).

Another cause of problems is the widespread use of the critical path method (CPM), which contributes to expanding the non-adding value tasks due to its non-compliance with flow process design and perfection (Koskela, 1992).

Control of uncertainty

Uncertainty needs to be addressed in traditional scheduling as it is considered unavoidable (Luu *et al.*, 2009). Moreover, CPM needs to contain a method to handle those uncertainties, leading to unrealistic time completion and an unachievable plan of work (Jun-yan, 2012).

Waste modeling and elimination

CPM cannot model the set of wastes such as waiting for time, and inspections, where it depends on the contractor's, subcontractors, or supplier's compliance with the contract conditions. Therefore, the methodology of construction control was formed to suit the project, not the product (Ballard and Howell 1998), leaving the management of the product to the site team without taking care of it in construction management.

Resource idleness is a waste. It results in uncertainty in the planning stage (Yang and Ioannou, 2001). This waste comes from waiting for the entire preceding labor to complete their work to commence the successor activity. That is due to the reactive characteristic of project monitoring and relying on the output of the updated program (Koskela et al., 2002).

Lack of flow management

The current task of the planners has shifted to progress tracking and status reporting; therefore, task management deteriorated into disorganized action, and flow management became irregular (Koskela, 1999).

The traditional controlling system uses the push approach, which targets the buffer as protection against any uncertainty. However, the push approach could not promise appropriate deployment of the resources to the successor activity.

LPS® versus conventional planning systems

Construction is dynamic and includes a high uncertainty and diversity, reducing planning reliability (Koskela et al. 2002, Hamzeh 2011). This situation resulted in the development of LPS®. The system was formulated based on the principles of Lean Construction.

Ballard (2013) indicates that LPS® is a tool used in construction to form the workflow and identify project variability (Howell and Koskela 2000, Salem et al. 2005). Table 1 compares the conventional planning system and the LPS®.

LPS® works by converting what SHOULD be to what CAN be (Aziz and Hafez 2013, Gao and Low 2014), focusing on ready-to-do activities, which need to be highlighted in the weekly work plans promised by the Last Planners® for what they WILL execute(Ballard and Tommelein, 2021).

The Last Planner® means an individual or a team responsible for maintaining control of the production by supporting the workflow, verifying the supply stream, and designing the installation of each task (Gao and Low, 2014, Ansah et al., 2016).

The system has adopted the improvement recorded by Aziz and Hafez (2013) and has been confirmed by Hamzeh (2009) and Zaeri et al. (2017). In addition, the International Group for Lean Construction reported that 200 projects have used LPS® since 1996 (Gao and Low 2014), where the possibility of success, according to Aziz and Hafez (2013), requires the involvement of all project parties in all stages of the project production flow.

Table 1 Conventional and production control system evaluation(Aziz and Hafez, 2013. Pg10)

The critical path planning system	LPS®
Software built-in CPM logic	Sticky notes and whiteboard
Require complicated maintenance	No maintenance
Maintaining the critical path	Managing uncertainty
Concentrate on activity dates	Maintaining works flow
Follow the contract	Interdependent planning

LPS® component

The system of construction control depends on three stages, initial planning, look-ahead planning, and commitment planning (Ballard and Howell, 1998, Ballard and Tommelein, 2021) where;

- Initial planning is the plan prepared before the commencement of construction.
- Look ahead planning: a short-term period controlling production plan, including the modulation of the budget and resource assignments to suit pulling the production to achieve the targets.
- Commitment Planning is the stage of managing and scheduling the promises to what can be done, built on the availability of the resources and look-ahead production plan. Such steps will protect the task, productivity, and the flow of work from the uncertainties as aimed by LPS® (Hamzeh 2011).

The operation of the weekly work plan should take care of the following steps (Ballard 2013).

- The individual should identify the required activities sequenced on priority based on the site's well-known status.
- Examining the available workforce for the identified activities.
- Distributing the activities to the team of work according to their capacity (Ballard 2013). This step aims to increase the productivity of the group gradually.
- The work floated from the assigned tasks is to be listed as planned work for the next planning cycle if there is no opportunity to be implemented within the same planned week.

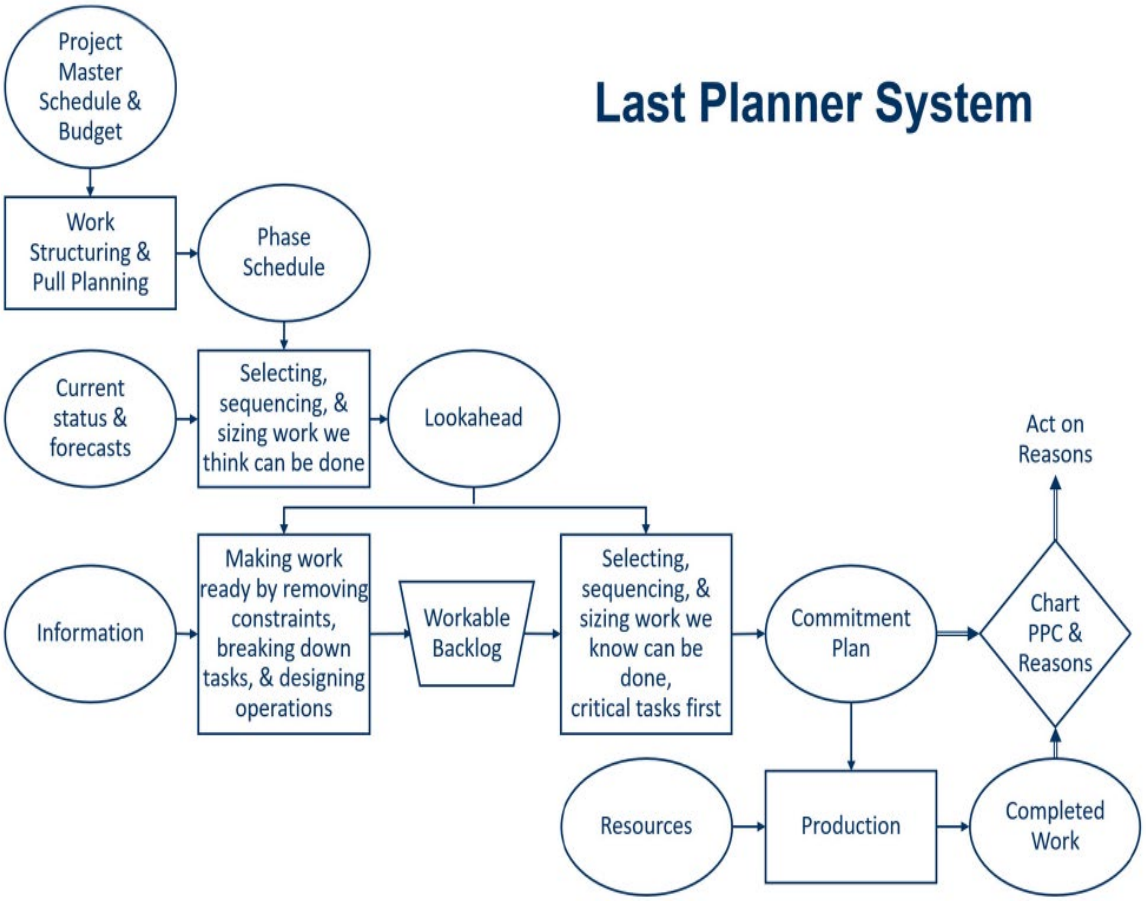

Figure1. Sequence of LPS® system implementation (Ballard and Tommelein, 2021)

Master Schedule

It is the same basic schedule used traditionally. It represents what **SHOULD** be achieved during a particular time (Gao and Low, 2014).

Reverse phase schedule

It is another expression of pull planning (Aziz and Hafez 2013, Hallman 2013), where backward scheduling is used to develop the activities under the considered phase (Hamzeh, 2011; Gao and Low, 2014). The scheduling process must include all the concerned individuals for the stage, the sub-contractors, and suppliers (Hamzeh 2009) to achieve collaborative planning, which reduces the possibility of uncertainty and increases the interfaces among different disciplines and teams of workers.

Look ahead plan

This plan includes the achievable activities during 6-8 weeks, using collaborative agreement for the production sequence (Aziz and Hafez, 2013), where the executable activities are scheduled reversely, and those inexcutable are excluded until the readiness of prerequisites (Hamzeh 2011 and Hallman 2013). In such a way, the constraints for the current non-executable activities are identified (Ballard 2013). Similarly, the second level of

activities breakdown (Aziz and Hafez, 2013) to smaller assignments are identified, which allows for assessing possible achievement of the 6-8 weeks window (Gao and Low, 2014) according to to project size and circumstances.

This part of the project controlling process is a common practice in construction (Ballard 2013) and represents the part of what **CAN** be implemented.

Weekly work plan

A weekly progress meeting represents the LPS® implementation mechanism through which the collaborative agreement for the tasks is fixed for the coming week (Hallman, 2013; Aziz and Hafez, 2013). At the first meeting, the list of assignments is established for the coming week, converting what **CAN be done** to what **WILL** be accomplished (Gao and Low, 2014). Then, when the first week is completed, the performance for what was implemented is recorded (Ballard 2013), and the reasons for failures discussion takes place. Finally, the weekly work is updated for the next week covering the activities not completed from the previous week and the activities that will be ready for implementation in the following week.

Percent plan complete (PPC)

PPC is the number of planned activities completed divided by the total number of scheduled activities (Ballard 2013, Aziz and Hafez 2013, Gao and Low 2014). It is recorded on a daily basis and gathered every week (Zaeri *et al.*, 2017). It became the standard scale for the performance of LPS® efficiency. Correspondingly a higher PPC refers to more capability to increase productivity (Koskela *et al.*, 2002). It also represents the reliability degree of the weekly work plan (Gao and Low 2014, Aziz and Hafez 2013, and Zaeri et al. 2017).

This indicator plays a crucial role in motivating the creation of the LPS® first line team, wherein the case of low PPC requires investigating the root of problems. Also, the PPC confirmation should be counted by the team that receives the work and not by the team handing over the job so that the quality control principles will be introduced (Bertelsen, 2004).

Barriers to LPS® implementation

Researchers stated particular challenges related to the application of LPS® (Aziz and Hafez, 2013). The lean production concepts in construction were gradually established (Gao and Low, 2014). According to Porwal et al. (2010), execution starts with an experimental project to test the benefits and challenges. The noticed challenges (Fernandez-Solis *et al.*, 2013) are categorized under organizational challenges at the commencement of LPS®, putting into practice encountered by high and mid-level management. The second category, during the use of LPS® by skilled teams, is related to technical issues. Table 2 summarizes the LPS® challenges as per each category.

Table 2 Categories of LPS® challenges

Barrier Category	Sub-barriers	Clarification
Organization Level	Adaptation	Prolonged process, and it needs a high level of organizational and management involvement to embrace the commitment to the application (Hamzeh 2011)

	Resistance to change	1. The unwillingness to change and the need to instill lean attitudes (Hamzeh 2011 and Daniel et al. 2016) 2. Local challenges include the new experience of lean production, deep roots in conventional project management methods, and fresh experience 3. The general challenges include project team experience, lack of interest, and technological barriers (Hamzeh 2009)
	Workforce investment	1. The project leader understands and accepts the concept and the procedure of implementing LPS® (Hallman, 2013) by having short-term training (Hamzeh 2009, Aziz and Hafez 2013) 2. Having key persons and LPS® implementers overcome project challenges (AlSehaimi et al. 2009)
1. Project Level	Lack of Awareness	1. The sensitivity of revealing production waste on projects (Al-Aomar, 2012) (Small, 2017) and (Kanafani, 2015) 2. Culture and Awareness (Small, 2017)
	Lack of Leadership	1. Teamwork and the need to follow a leader Daniel et al. (2016), Hallman (2013), Hamzeh (2011) 2. The work environment in UAE construction is an authoritarian style (Small et al.2017)
	Lack of commitment	1. Lack of transparency due to the blame culture of the construction industry (Daniel, 2016) 2. The unwillingness of the contractor's team to share their weaknesses with other parties(Gao and Low, 2014) that is due to the type of contracts used and procurement paths adopted. For example, FIDIC 1987 or 1999 and lump sum contracts are commonly used in the UAE.
	3. Lack of project team synergy	Fast-track construction, especially in the UAE construction market, makes it so challenging to gather busy and constrained teams (Hallman, 2013)
	4. Limited Involvement of Site Teams	The involvement of site engineers and supervisors is not considered in LPS® implementation within the construction industry in the UAE
	5. Satisfying client needs	The contractor work to meet the milestones set by the clients (Gao and Low, 2014). This dynamic of tightening milestones prevents the project management firm from pulling the work from the site team and prohibits complete LPS® application (McConaughy and Shirkey, 2013)
2. Operational level	6. Incomplete LPS® implementation	McConaughy and Shirkey (2013) studied the impact of incomplete employment and how missing one of the LPS® components could lead to failure to achieve the objectives. Consequently, implementing the system based on the expertise of the LPS® facilitator will not be enough to achieve the expected success

	7. LPS® technical issues	1. Zaeri et al. (2017) criticized the lack of a link between applying PPC and an improvement database which impacts follow-up and collecting of information from the site to produce accurate PPC for the WWP 2. Hamzeh (2009) introduced another point: the present application has drawbacks mainly related to the gap between the master plan and the look-ahead planning process.

Research Methodology

Explanatory - Case Study

The behavioural attitudes of project parties play a crucial role in LPS®. To delve into the main factors that influence this aspect, a case study approach has been employed. According to Fletcher et al. (1997), this methodology is ideal for in-depth investigation into behavioural actions and attitudes of individuals. The case study includes analytic, descriptive and explanatory elements. Moreover, It enables the researcher to gather more precise data concerning social and behavioural issues, by providing the flexibility to adapt and refine the research approach (Yin, 1994).

The need to explore interrelated factors affecting LPS® operation was the reason for selecting this type of research, which allows it to be merged into the construction environment and explore the obstacles leading to the ineffective implementation of the system in UAE projects. In addition, within LPS®, lack of understanding of the project circumstances, can prevent the immediate initiation of LPS® because of the expected challenges. This will involve leveraging existing methods to detail the work, providing a foundation for the gradual implementation of LPS®, so the pilot project is selected to facilitate the gradual implementation of LPS® and using that application as a case study for the purpose of this research.

Generally, understanding of the system is limited, but parts of it have already been implemented in the UAE indirectly. These parts were utilised as a starting point for the LPS® implementation as a new approach. The implementation process was guided by a gradual change in operation and then directed to satisfy each LPS® component (Luthans and Peterson, 2002).

The implementation process is a time consuming one, and the available time for this study was insufficient to fully prepare the pilot project for a holistic system application. Thus, a new approach was adopted based on the utilization of common system components frequently used in similar projects, such as weekly meetings, daily follow-up, and look-ahead planning. The concept of gradual change operation (Luthans and Peterson, 2002) is used in transforming the current system using a model that combines education, communication, participation, and involvement.

The pilot project is located in Dubai city. It comprises 44 precast concrete villas, including regular finishing items, external hard and soft landscaping works, clubhouse building and services rooms all under a lump sum contract price of 115,657,000 AED, using FIDIC 1999 standard form of contract.

The project duration is 455 days with the mock-up villa (Th Pilot Project) taking 233 days to complete. The case study started when the mock-up villa was at a stage of superstructure works for the first-floor level. Upon starting the case study, the client requested the project team to expedite the completion date of the mock-up villa, resulting in a reduced duration of 18 days.

The LPS® system was applied on a single mock-up villa during the superstructure construction stage and the remaining duration to complete was 44 days. These circumstances were suitable for investigating LPS® system acceptance in the project. This simple commencement reduced the facilitator's effort, satisfies the collaboration in the work, and prevents communication issues, enabling the effective use of constraint removal tools, WWP, and root of failure analysis.

It is important to note that the applied case study is limited to the short term and only one part of the project, and not all components of LPS® were fully implemented.

Exploratory- Interviews

The limited scope of the signle case study makes it insufficient to fully address the research objectives. Therefore, the use of qualitative exploratory research was necessary. It expands the information by allowing the respondents to to express their views and experiences. The data collected is non numerical and is categorised as exploratory or attitudinal research. It is particularly useful when when gaining a deeper insight into the subject matter and exploring individual perspectives. This research method, as highlighted by Amaratunga et al. (2002)leads to an expansion of the existing information and a deeper understanding of the subject matter which compensate for the limitations of single case study method.

The research was conducted through interviews with project management and control systems experts. The aim of these interviews was to gain a comprehensive understanding of the limitations and reasons behind the limited application of the LPS® system. A total of 20 interviews were conducted, guided by open-ended questions designed to elicit rich and detailed insights. To ensure a clear and organized approach, the interview questions were designed to approach the topic of LPS® knowledge gradually. This was done to minimize any confusion or misunderstandings on the part of the interviewees who may have limited awareness of the system. The interview questions have been included in appendix A for reference.

The interview schedule starts with current problems of the planning-controlling systems. The discussion then delves into the available tools that can be utilized to resolve these issues, focusing on their effectiveness and limitations. This is followed by a closer examination of the complete LPS® components and their implementation.

To ensure that the data collected is meaningful, it has been analysed and compared, highlighting the most commonly cited opinions. These repeated opinions are then prioritised as key factors that will drive the resolution of the issues discussed in the interview.

The research structure, as shown in Figure 2 highlights the major components of the research and the process followed to reach the desired objectives.

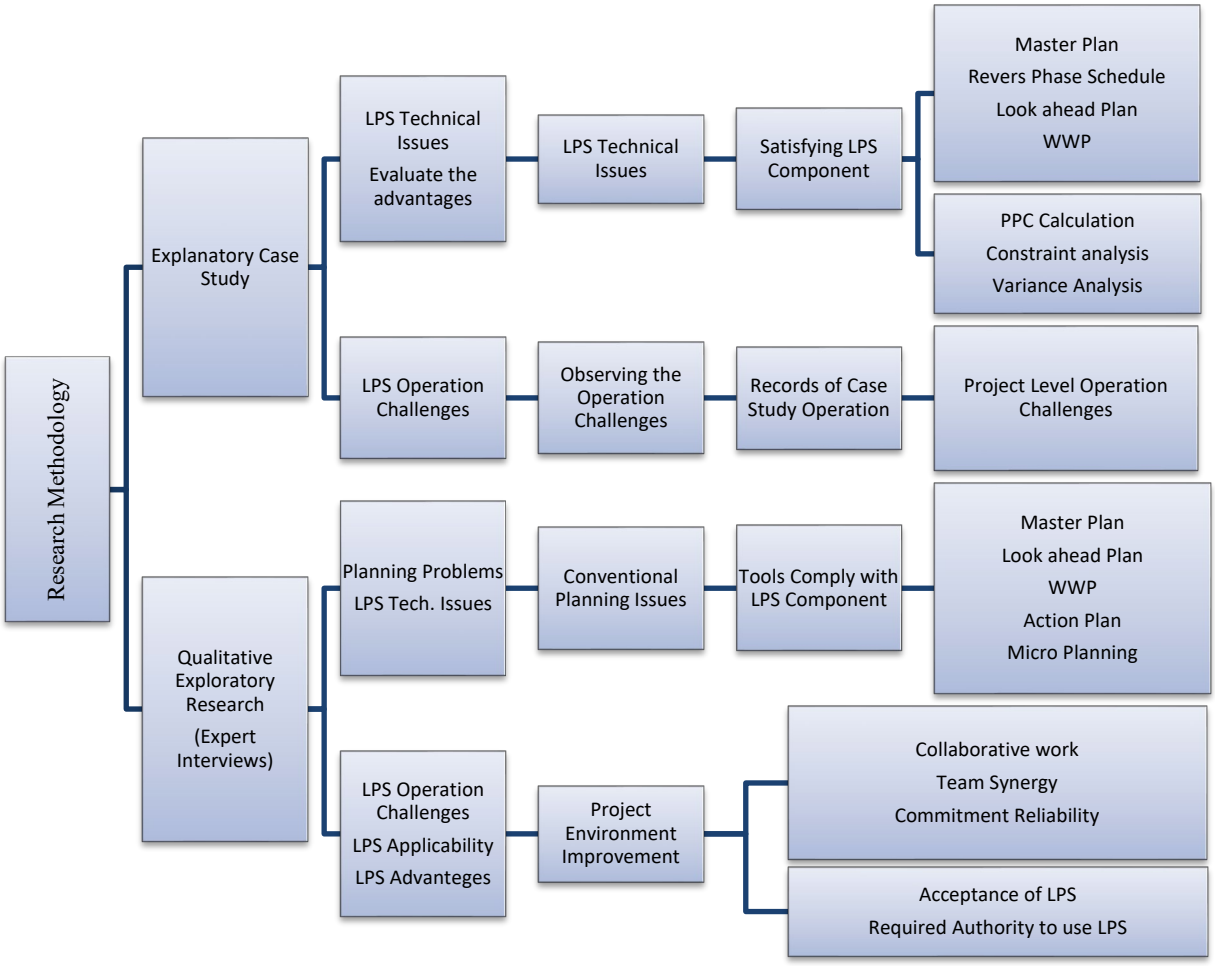

Figure 2. Research methodology structure

Data analysis

Explanatory - Case Study

The pilot project started with scheduling the remaining work for seven (7) weeks as a master program and as a look-ahead plan. WWP is discussed by involving the main project parties. The activities requirements and the assignment list have been prepared using a Microsoft Excel sheet. Details of satisfying the component of the LPS® within the pilot project are presented in Table 3.

Implementation Issues

Implementing the LPS® faced most of the challenges discussed in the previous sections. During the WWP meeting, the contractor resisted sharing the apparent status of site progress, which reduced the level of commitment and reliability at the initial stage of implementation. However, with time and through the collaboration expressed by the client representative and the consultant team, promises of reliability have increasingly improved.

Regarding uncertainties, the tiling delivery was delayed compared to the agreed during the WWP, which extended the project duration. This event demotivated the project team to complete the work on time, especially after the mitigation failure. Therefore, the tiling-related work has been excluded from the WWP due to the unavailability of the prerequisites.

Table 3 checklist for the system component in the pilot project

LPS® component	Case study	Satisfaction
Master program	Approved project updated program	Done
Reverse phase schedule	The targeted activities scheduled reversely for the mock-up villa	Done
Lock ahead planning	The schedule of the remaining duration for the mock-up villa is six weeks.	Done
WWP	The details included in the approved project program were fair enough to prepare WWP	Done
PPC	Calculated inaccurately for one week only	Not done
Constraints analysis	No dedicated planning & monitoring meeting and the constraints were discussed during WWP preparation and daily monitoring.	Partially
Variance analysis	No variance analysis due to no PPC	Not done

The organizational barriers noticed in the mismanagement between the project manager and the site team reduced the accuracy of updated information leading to an impact on the WWP and producing inaccurate PPC.

A delay has also occurred in one of the WWP activities due to unsafe high-level work. However, the investigation elaborated that the core reason was ignoring the safety requirement, which was not involved in the WWP because the construction climate in UAE considers safety a kind of a waste to spend time on planning meetings and represents the lack of involvement.

The WWP was prepared with limited information at the startup, and some technical issues were unavailable due to low awareness of the activities requirements, leading to low quality of the WWP outcomes.

Low synergy has been noticed among project teams due to inexperienced and outsourced staff, which leads to prolonged supervision processes and reduced coordination, increasing the uncertainties within the WWP.

The client's involvement was very limited in the WWP processes due to time constraints related to his attendance and the permissible duration of LPS® implementation; moreover, the client assignments were very limited in the WWP to warrant their attendance.

Evaluation of LPS® implementation

Project parties' organizations were not involved in the case study of LPS® implementation because the system was applied as a tool, not a strategic concept. In addition, the time constraint prevents generalizing LPS® to cover all organization levels.

Lack of awareness is the most recognizable factor among the pilot project parties. Also, due to the change resistance and the high requirements for time and cost investments needed to implement LPS® planning tools, the conventional tools have been retained for this case study, and the LPS® has not been introduced directly but gradually into the planning-controlling process. That provided a new approach to implement the system at the initial stage until achieving the required level of familiarity through continuous operation and performance enhancement. In addition, this approach would allow for presenting the system as a strategic concept and thinking, not just as a tool(Ballard and Tommelein, 2021).

Lack of involvement and supervision from the contractor and consultant teams have also been observed as significant drawbacks. For example, there were many revisions for the technical submittals without processing the investigation into the root causes from both parties, which extended the engineering work process.

In terms of commitments and promises, two types of failed commitments have been noticed: the first belongs to the site project teams involved in the WWP, and the second belongs to the supply and support teams not involved in the preparation process. So proper communication and synergy between all project parties are necessary for prerequisite evaluation and commitment accuracy.

Consequently, the implementation of the WWP system led to a significant improvement in coordination and collaboration among the contractor teams, as well as between the contractors and suppliers. Additionally, the consultant teams also experienced a noticeable improvement in their coordination.

The project team highly appreciated the effort and the procedure of detailing and assigning the work, making their work more efficient and streamlined. The positive outcome of this case study serves as strong evidence of the LPS® system's effectiveness and usefulness in the planning process.

However, it is worth noting that there is still room for improvement when it comes to collaboration among the different project parties. Further efforts and strong leadership are needed to achieve full acceptance and integration of the system in projects.

Exploratory - Interviews analysis and findings

The descriptive statistic method is recognised as the simplest method of data analysis (Naoum, 2013), where the data is analysed by comparing the answers of the interview questions. The result presentation could be either in percentage or absolute numbers. In the context of this research, where the sample size is limited, the descriptive statistic method is the most appropriate and effective way to analyse the data. By focusing on the frequency of the responses, the most commonly cited answers have been identified, providing a clear picture of the dominant trends and opinions among the participants.

The interviews were structured to elicit opinions related to LPS® implementation barriers at organizational, project and operational levels.

Eighteen construction professionals with extensive experience in construction and planning systems have been interviewed. Fifteen are at the senior level, and 11 are in managerial positions.

The interviewees' sample represents different types of organizations: 11 are from contracting companies, two are from consultancies, and five are from client organizations. These records, as shown in Table 4, provide a strong indication of the sample expertise and the awareness in construction management and planning and its coverage of project stakeholders involved in planning processes and site activities.

The use of current planning-controlling approaches and the compliance with the LPS® components prove the applicability of the LPS in UAE. In addition, it was confirmed that all the interviewees had used micro-planning and look-ahead schedules which are part of the LPS® system implementation as project management tools, despite their lack of full LPS® awareness. However, it is worth noting that other components that are not being implemented and/or not within the interviewees' knowledge, while not essential, are very important in supporting the effective LPS® implementation.

Alternative planning-controlling approaches represent the acceptance of the LPS®. When the program of work collapses, the project team manages the work through other tools like look ahead programs, action plans or micro plans, which are very similar to LPS® components. However, interviews revealed a lack of integrated and holistic implementation of LPS® in addition to the limited involvement of project team members during the preparation process. Therefore, the observed current practices have 60% - 71% compliance with the standards components of LPS®; four out of seven LPS® components are fully implemented, one is partially implemented, and two are not implemented (Refer to Table 3).

The comparison between LPS® awareness and the alternative planning approaches in Table 4 shows that 11 out of 18 interviewees lack awareness, although 71% are implementing the LPS® components, this can be explained by the fact that LPS® is a way of thinking and the project teams understood the importance of breaking down the work into smaller tasks and requirements to keep the project flow without interruption. This is reflected in the interviewees' total agreement on conditional acceptance of the LPS® applicability.

The Project parties' involvement shows that 15 out of 18 interviewees preferred individual work, mirroring the same barriers identified in the literature review. In addition, some considerable barriers added by interviewees include:

- Lack of regular commitments and discontinuous system implementation, especially for daily meetings.
- Selecting the contractor and the consultant on the lowest cost basis leads to further resistance to process improvements.
- The preparation cost for the daily LPS® meetings.
- Unfairness and lack of transparency in applying the concept of rewards and punishment.
- The gap between the project workforce and management teams in knowledge and skills.

Table 4 Interview Specifics

Description	Parameter		
Interviewee's years of experience	5-15	15-25	Above 25
	7	9	2
Position type	Managerial	Senior	Normal
	11	4	3
Organization type	Client	Contractor	Consultant
	5	11	2
LPS® awareness	Aware	Heard about it	Not aware
	5	2	11
alternative planning-controlling approach	Action or micro-planning	Look ahead plan	LPS®
	9	9	0
LPS® applicability	Applicable	Conditional acceptance	Not applicable
	0	18	0
Project Parties Involvement	Accepting	If necessary	Not accepting
	3	6	9

Discussion and Conclusions

The research investigated the applicability of LPS® in the UAE empirically while also using research methods that satisfy scholarship necessary for dissertation completion.

Explanatory Case Study

The applicability of the system components applied was rated 60-71% in the case study, and all the interviewees accepted many LPS® concepts components. In terms of collaborative aims, the acceptance conditions are as follows:

- Maintain the continuity of operating the system.
- The organizations should work on changing the concept of selecting project parties using approaches like Lean Construction concepts, supply chain systems, or partnering agreements.
- Fairness application to clauses of the contract conditions
- Closing the educational gap between the downstream and upstream staff by conducting training programs to raise awareness about the planning issues and the LPS® in particular.

The case study in the research revealed advantages and limited disadvantages, which could be summarised as follows;

1. LPS® advantages related to understanding sources of delay are as follows.
   - Project team coordination.
   - Project parties appreciated the LPS® system in terms of dealing in-depth with the requirements of each task and reducing uncertainty.
   - It raised the level of awareness related to technical and safety information.
   - Increased the motivation among the individuals of each team in the project.
2. LPS® disadvantages were typical, and it is unfair to relate them to LPS® as a concept. Instead, the main issues were the challenges during the case study implementation.

Exploratory Interviews

Eleven of 18 interviewees were unaware of LPS®, but they realized the advantages because 60 – 71% of the LPS® components are already conceptually considered.

The interviewees referred to the lengthy meetings involving many of the project team as disadvantages, which could disturb the work on the site and raise the cost of meetings.

WWP daily follow-up was the main requirement to be increased by the cooperation between the contractor and the sub-contractors as well as the consultant and the contractor. That was observed through the detailed assignments within the WWP as well as for the outputs of the work on the pilot project.

The results presented above provide a strong indication of the applicability of the LPS® within the examined construction environment, especially the planning part, where the collaboration still needs more effort and authority to reach the same level of acceptance.

Positive observations were concluded over the interviews and supported the factors identified for applying LPS® in UAE construction. In addition, the interviewees commented on the following as potentials to overcome the initial resistance of forming and storming the team for LPS®:

- Project-level barriers related to commitment reliability, team synergy, shared information, improvements with gathering projects' teams, and the responsibility for implementing LPS® to rest with the highest project authorities.
- Organization-level is getting more involved and applying the LPS® within the project team based on the currently used tools.
- In terms of LPS® technical issues, the interviewees commented on how to link the PPC calculation to the traditional performance indicators. That is possible since the listed tasks in the WWP are derived from the master program. In addition, linking the delay analysis to the records of the WWP meetings could also be a robust documentation system since it investigates the root cause of the delay.

Research recommendations

Organization-level recommendations

The research confirms the applicability of the LPS® in the UAE construction environment and recommends the following;

- Consider whether a company is on a Lean Construction journey as a competitive factor for awarding the contracts.
- Include the LPS® within the contract condition clauses related to the program of work.
- Apply fair use for the conditions of the contract among project parties.
- Increase the level of planning awareness for downstream staff by establishing training systems.

Project level recommendations

- Conduct WWP on the site.
- Respect project organization order in terms of responsibilities and positions to reduce the meeting attendees numbers and the cost of the meetings.
- Involve the concerned teams in the meeting to keep the discussion under control and reduce the meeting cost.
- Use the client's authority to unify project parties' targets.
- Establish an effective communication system to circulate meeting outputs to non-attendees.
- Establish an efficient recording system, especially for the root causes due to potential use for current and future projects.
- Establish the technical link between PPC calculation and the project KPIs.

Research Limitations

Some factors restrained the process or the gained results in both parts, the desk and field study.

Desk study limitations

It was perceived that minimal resources covered the topic in the region of UAE, which is considered a geographical limitation. Thus, the collected resources dealing with LPS® in the region were reviewed and compared to the other references, and it has been found that some of the differences were not related to the system itself but to the culture in the region. For example, multicultural work environment which could be a challenge to implement LPS®. Also, the foreman's involvement in UAE is a function of their education level.

Field study limitation

Case Study Limitations

Due to time constraints, no formal presentation of the system was made, and the implementation process began when the project team selected a more suitable tool to

address the issue of slow progress in the mock-up villa. They started with a simple tracking sheet, which served as the starting point for the implementation of the LPS®. As a result, the implementation duration was limited to one target.

The facilitator of the system needed to have complete authority to implement the system accurately, which posed challenges in updating the WWP and calculating the PPC accurately.

Interviews Limitations

The interviews were an evaluation of the traditional planning systems failures and the opportunity to have a complementary system. It was necessary then to explore the deep concerns of the interviewee related to the collaborative work by gathering all concerned parties, the commitment reliability, and the transparency of work.

Future Researches recommendations

LPS® is simple because it is a way of thinking to reduce waste and improve performance; the system includes the technical part, which is the easiest, and the human behavioural part is the most complicated.

Future research should focus on the second part aiming to increase the acceptance of gathering the project parties towards unified project goals using the grouping theories and change management, including the suppliers and sub-contractors due to their prominent role in progress performance. More research is also required to improve the recording system for the WWP meetings and link the PPC to the project performance indicators produced from the master program. In addition, it is worth considering the research recommendations as topics for future research.

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Appendix A – Interview Questions

- Interview No.

General Information

1. Company / Organization name:
2. Nature of the Company / Organization:
3. Position of the interviewee:
4. Years of experience in management or planning:

Projects Planning & Control Systems Questions

5. How much are you aware of the new planning systems like Lean Production System? Or the Last Planner System (LPS®)?
6. What is the type of control system used in your Organization?
7. Up to which level does the project control system contribute to project success? And how do you describe weak points?
8. The construction industry involves a lot of uncertainties; how is it covered by current planning systems?
9. Who is used as a contributor during the session of planning and assigning the tasks?
10. What is the suitable duration of look-ahead planning? Please justify the answer.
11. What is the regular period for reviewing the performance?

Change Management Questions

12. How do you think we can change the current controlling system?
13. Which type of resistance is expected to the change of controlling sys?
14. Which level of authority is required to implement the change in the current controlling system?

Collaborative Work Questions

15. Teamwork is essential in project planning; what is the suitable approach to implement it?
16. How do you describe the challenges of gathering project parties to plan, look ahead to works and monitor project performance?

Promises Management Questions

What is the degree of commitment reliability for the assigned tasks?