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Implementation of The Last Planner System (On The Construction Project of Al-Falah Junior High School)

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ABSTRACT

The construction sector increasingly adopts lean construction principles, derived from manufacturing production theories, to minimize waste and maximize value. The Last Planner System (LPS) holds significant potential for improving project performance by identifying tasks and resolving obstacles. This study analyzes the application of LPS in the construction of Al-Falah Junior High School, a project facing delays due to erratic weather. Field surveys were conducted to assess actual progress, with LPS workflows—including Master Plan, Phase & Pull Planning, Lookahead Planning, Constraints Analysis, Shielding Production, and Percent Plan Complete (PPC)—used to evaluate productivity. Results show that PPC reached its lowest point of 0% in week 7 due to stalled progress, while week 16 recorded a sharp increase to 96%. The average PPC was 51%, indicating that LPS implementation did not achieve the targeted planning reliability of over 70% Ballard (2000). These findings highlight the need for further optimization of LPS in similar projects to enhance planning reliability and overall efficiency.

Keywords: *Lean Construction, Last Planner System, Percent Plan Complete*

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ABSTRACT

Sektor konstruksi semakin banyak mengadopsi prinsip *Lean Construction*, yang berasal dari teori produksi di industri manufaktur, untuk meminimalkan pemborosan dan memaksimalkan nilai. *Last Planner System* (LPS) memiliki potensi besar untuk meningkatkan kinerja proyek dengan mengidentifikasi tugas dan menyelesaikan hambatan. Penelitian ini menganalisis penerapan LPS pada proyek pembangunan SMP Al-Falah, yang menghadapi keterlambatan akibat cuaca yang tidak menentu. Survei lapangan dilakukan untuk menilai progres aktual, dengan alur kerja LPS—termasuk *Master Plan, Phase & Pull Planning, Lookahead Planning, Constrains Analysis, Shielding Production, dan Percent Plan Complete* (PPC) digunakan untuk mengevaluasi produktivitas. Hasil menunjukkan bahwa PPC mencapai titik terendah 0% pada minggu ke-7 akibat terhentinya pekerjaan, sementara pada minggu ke-16, PPC meningkat tajam hingga 96%. Rata-rata PPC adalah 51%, yang menunjukkan bahwa penerapan LPS belum mencapai target keandalan perencanaan di atas 70% (Ballard, 2000). Temuan ini menekankan perlunya optimalisasi lebih lanjut pada penerapan LPS dalam proyek serupa untuk meningkatkan keandalan perencanaan dan efisiensi keseluruhan.

Keywords: *Lean Construction, Last Planner System, Percent Plan Complete*

INTRODUCTION

Construction refers to the process of building, which encompasses designing and constructing structures to serve human needs within specific constraints of cost and time. Building construction specifically involves methods that ensure structural strength, aesthetic appeal, and functional alignment. However, construction projects are often plagued by various challenges, one of which is waste. Waste is an inherent aspect of construction and, while it cannot be entirely eliminated, it can be minimized. Efforts to reduce waste by focusing only on value-adding activities are central to the concept of *lean construction*. As highlighted by Al-Sehaimi (2009), *lean construction* aims to minimize waste related to time, materials, and labor, thereby optimizing overall project outcomes. Furthermore, Forbes (2011) interprets *lean construction* not as a rigid set of rules but as a shared mindset and behavior that guides every stage of the construction process. Among the various methods under the lean construction umbrella is the *Last Planner System* (LPS).

The *Last Planner System* is a project management approach designed to enhance production control through effective scheduling and coordination of tasks. It improves the relationship between workflows, project performance, and overall productivity (Human & Zuldi, 2018). One key advantage of LPS is its ability to identify tasks along with associated obstacles, enabling improvements in construction performance. Despite its potential benefits, LPS remains underutilized in the construction industry. According to (Ballard, 2000), LPS has the potential to enhance construction performance by over 70%. Daniel, E.I., Pasquire, C., & Dickens, G. (2016) stated that the implementation of Last Planner System on joint venture infrastructure projects is influenced by various factors, including organisational culture, team coordination, and commitment to lean practices.

This study applies the concept of LPS to evaluate its effectiveness in improving project management and productivity in the context of a case study: the construction of Al-Falah Junior High School in Surabaya. This project was chosen due to its unique challenges, including weather-induced delays, making it an ideal candidate to explore the impact of LPS on addressing such issues. The objectives of this research are: to analyze the implementation of the *Last Planner System* in the Al-Falah Junior High School construction project, to evaluate the actual progress achieved compared to the planned progress using Percent Plan Complete (PPC) as a metric.

METHOD

This research utilizes the Last Planner System (LPS) workflow to evaluate and control the progress of the Al-Falah Junior High School construction project. The LPS methodology consists of several key components, each designed to minimize delays and optimize project performance:

Master Plan

The Master Plan serves as a comprehensive overview of the project, analyzing all activities, sequences, and durations. It provides the foundation for organizing tasks and setting benchmarks for subsequent planning stages.

Phase & Pull Planning

Phase and Pull Planning focuses on detailed planning for specific sections of the project, from initiation to completion. This research uses Phase & Pull Planning to identify potential delays and optimize workflows by analyzing the sequence and interdependencies of tasks.

Lookahead Planning

Lookahead planning has a conceptual interpretation of activities for the next 2 to 6 weeks. Creating a lookahead plan is attempted by pushing the work breakdown agenda from the beginning of the second project time span to the next 6 weeks. The lookahead planning in this research assumes that there is no accumulation of activity duration until the end of the project implementation era or milestone. The lookahead concept takes 5 weeks. The steps to create a lookahead plan are as follows:

a) *Lookahead planning* is made using lean tools in the shape of a sticky note and flip paper made of manila paper with columnar lines. The shape and illustration of the sticky note filling of the lookahead concept can be observed in Figure 1.

Figure 1. Format A dan B Examples of sticky note completion

b) Analysis of estimated work delays is made. This analysis refers to the progress of the work of each day or person. The use of this information is due to the movement of workers along the floor at a particular time. After that, calculations were attempted with similar methods as in table 1.

Table 1. How to calculate work progress until a certain date

Date n1	Date n2	Date n3	Date ni
Progress until n1	Progress until date n2 = Progress date 1 + Progress work/people/day x amount of work	Progress until date n3 = Progress date 2 + Progress work/people/day x amount of work	Progress until date ni = Progress date ni + Progress work/people/day x amount of workers

Source : Jurnal Evrizza Khoirunnisa, Mona Foralisa Toyfur, Betty Susanti

Weekly Work Planning (WWP)

Weekly Work Planning breaks down the lookahead plan into weekly schedules. For this research, WWP was further refined to include Daily Work Planning (DWP) due to the short duration and scale of the project. Daily reviews focused on progress tracking and task allocation to ensure smooth workflows.

Constrains Analysis

Constrains Analysis intends to recognize the obstacles before an obligation is completed. In this research, Constraints analysis restriction is tried every day in the morning. The benchmark limit of this research is as follows:

a. Submittals are requests or submissions for the application of work.
b. Materials are the availability of materials used in the implementation.
c. Space is the availability of a place to do work.
d. Equipment is the availability of equipment to do work.
e. Workers is the availability of the most important activity power of helper or workers to do work

Shielding Anlysis

Shielding Production ensures quality by analyzing and mitigating obstacles identified in Constraints Analysis. This process was conducted during daily morning reviews to enhance productivity and prevent rework.

Percent Plan Complete (PPC)

PC measures the percentage of completed tasks compared to the total planned tasks. It serves as an indicator of planning reliability and project productivity. The formula used is as follows :

$$PPC = \frac{amount\ of\ work\ plans\ that\ were\ successfully\ executed}{total\ work\ plan}\ x\ 100\% \qquad \dots\dots (1)$$

PPC is a measure of the extent to which the commitment to carry out the planned work has been realized. PPC can be used as a standard to control production units, determine project schedules, implementation strategies, and others. A high PPC indicates that more work is being done with available resources, productivity is high and progress is accelerating (Ballard, 2000).

RESULTS AND DISCUSSION

This research was conducted as a case study on the construction project of Al-Falah Junior High School in Surabaya, located at Jalan Darmokali No.62. The construction project commenced on December 22, 2022, and was scheduled for completion by November 22, 2023. However, the research focused on the period from Week 7 to Week 17, representing an eleven-week observation. The work began with earthworks, foundation, and structure, achieving a progress of 21.76% in the first week of observation. Despite this, the project experienced delays due to weather factors, which halted work during rainy days.

Master Plan

The Master Plan outlines the project's major work components, including structural work, and sets the project's overall timeline. The schedule indicated that the project started on December 22, 2022, with completion expected by November 22, 2023. However, the research period (February 2 to April 18, 2023) highlighted significant delays, primarily due to adverse weather conditions that halted construction work during rainstorms.

Phase Planning

Phase Planning breaks the project into sub-tasks, planning them from start to finish. This research specifically focused on analyzing delays caused by weather disruptions, which halted work due to rain and water accumulation. These interruptions notably reduced productivity in the earthworks, foundation, sloofs, and columns, ultimately hindering the performance of the construction activities.

Lookahead Planning

Lookahead Planning was implemented to track weekly progress and provide a more detailed picture of each assignment’s status. Different areas were color-coded for easy tracking, such as the ground area (yellow), foundation (dark blue), ground floor (light blue), first floor (green), and second floor (orange). Based on this system, the difference between planned and actual progress was calculated to assess work achievements and delays. The color-coded tracking system allowed for quick identification of the areas experiencing delays and helped identify where corrective actions were needed.

Weekly Work Planning (WWP)

Weekly Work Planning (WWP) focused on the more immediate tasks, with the research examining the preliminary earthworks and structural works like foundation, sloofs, columns, beams, and floor plates. WWP in this research was specifically targeted to monitor progress on these key tasks between February 2 and March 18, 2023. Despite the implementation of the lookahead plan, delays continued due to weather, highlighting that external factors such as rain still caused interruptions even with the detailed weekly planning system.

Constrains Analysis

The purpose of Constraints Analysis is to identify and address barriers before work begins. In this study, a daily morning review of potential constraints was conducted. The analysis consistently identified material shortages, space limitations, and workforce scheduling as key challenges that impacted work efficiency. These constraints were accounted for in the planning and regularly updated to reflect real-time project conditions.

Table 2. Lookahead Planning

Area	Assignments	Feabuari				Maret				April		
		2-8	9-15	16-22	23-1	2-8	9-15	16-22	23-29	30-5	6-12	13-19
Tanah	Galian Alat Berat Tanah Biasa 1-2 m	51,09	58,54	65,98	73,40	80,87	88,38	95,77	100			
	Buang Tanah keluar lokasi	51,09	58,54	65,97	73,40	80,86	88,36	95,75	100			
	Pemadatan Urugan	51,15	58,60	66,21	73,40	81,11	88,70	96,00	100			
	Intrusi Air Semen 10 kg/m2 Lapisan Sirtu	51,08	58,53	65,97	73,40	80,86	88,35	95,75	100			
Pondasi	Soldier Pile (strous pile Ø30cm)	52,83	60,53	68,31	75,82	83,70	91,39	99,09	100			
	Pilot Bor pile Ø 40cm	52,80	60,49	68,28	75,82	83,66	91,35	99,05	100			
	Pondasi Spun pile Ø 50cm, Pemancangan Hidrolis	52,78	60,45	68,13	75,82	83,52	91,21	98,90	100			
	Lantai kerja	59,12	60,64	68,80	75,82	84,32	92,52	100,00				
	Shear Wall	56,58	61,02	69,22	75,82	84,55	92,79	99,96	100			
	PHC	55,71	60,85	72,28	75,82	87,87	96,05	100,00				
	Pile Cap	52,85	60,55	68,17	75,82	83,56	91,37	98,94	100			
Lt. Dasar	Sloof	46,82	52,82	59,43	65,71	72,87	80,14	86,13	93,05	99,45	100	
	Kolom	47,44	52,84	59,30	65,71	72,64	79,88	85,93	92,55	99,25	100	
	Dinding Lift core	50,95	53,18	66,53	65,71	81,24	87,63	94,33	93,09	99,16	100	
	Rabat beton K-300 tulangan Wiremesh M6	53,56	60,87	68,23	75,82	83,60	91,73	99,00	100			
	Plat tangga	73,62	51,87	59,72	65,71	73,05	79,61	79,82	94,55	99,73	100	
	Ground Water Tank Kap. 54 m³	49,71	52,80	60,41	65,71	73,74	80,41	87,26	92,63	100,43	100	
Lt. 1	Balok							30,63	61,39	91,73	100	
	Kolom						15,59	42,31	69,65	96,15	100	
	Dinding Lift core											
	plat tangga										100	
	plat lantai t=12cm								31,55	88,99	100	
Lt. 2	Balok								7,58	57,64	100	
	Kolom								15,33	50,00	85,76	100
	Plat Tangga											100
	Dinding Kolam Renang									38.80	83.33	100
	plat lantai t=12cm									31,58	69,30	100
Lt. 3	kolom										25,21	50,17
	Balok											
	Plat tangga											
	plat lantai t=12cm											

Source : Resourcher

Shielding Production

Shielding Production analysis was carried out each morning after the constraints review. This analysis helped identify the root causes of delays and developed strategies to shield the project from further disruptions. Shielding measures were focused on allocating additional resources during periods of delay, such as providing extra labor during weekends or evening shifts to catch up on lost time due to weather delays.

Percent Plan Complete (PPC)

The PPC results from the study revealed an average weekly PPC of 51%. This indicates that the implementation of the LPS methodology did not significantly increase planning reliability beyond the 70% threshold that Ballard (2000) suggested as optimal. The delays experienced during Weeks 7 and 8, particularly the lack of work achieved, contributed to the low PPC during those periods. However, after addressing these delays, particularly through overtime work, the PPC improved dramatically in Week 16, reaching 96%. This improvement was driven by additional shifts, including overtime work up to 9 nights, allowing the team to recover lost time and make significant progress.

Analysis and Discussion

The low initial PPC scores, especially during the first few weeks, suggest that the LPS approach was initially ineffective in mitigating delays. This finding is consistent with Ballard's (2000) assertion that LPS can improve performance, but only if implemented effectively and consistently. The weather-induced delays were a significant barrier to progress, and while LPS components such as Lookahead Planning and Constraints Analysis helped identify the delays, they did not fully prevent their occurrence.

However, the dramatic improvement in PPC after Week 15, especially the 96% in Week 16, indicates that LPS had a strong corrective effect when combined with additional efforts, such as overtime work. This aligns with existing literature, which suggests that the success of LPS depends not only on proactive planning but also on reactive measures to address emerging challenges

(Ballard, 2000). The ability to overcome delays through increased work hours highlights a critical aspect of LPS—its flexibility in adapting to real-time project conditions.

In terms of the broader impact, these findings suggest that while LPS can lead to significant improvements in project performance, its effectiveness is contingent on careful and constant adaptation to both internal and external project dynamics. Future research could further explore how weather and other external factors can be better integrated into the LPS planning process to minimize disruptions.

CONCLUSION

The implementation of the Last Planner System (LPS) in the construction project of Al-Falah Junior High School highlighted both its potential and its challenges in enhancing project planning reliability. The results showed significant variations in Percent Plan Complete (PPC), with the lowest value recorded at 0% in Week 7 due to delays caused by weather and material shortages, and a drastic increase to 96% in Week 16 following the implementation of corrective measures, such as overtime work. Despite these improvements, the average PPC remained at 51%, which is below the expected target of 70% as suggested by (Ballard, 2000)

The primary causes of delays in this project were bad weather conditions and late material deliveries. To address these challenges, several solutions were proposed, including the use of special tents, tarpaulins, raincoats for workers, additional lighting, and thunder protection. These strategies are expected to mitigate the adverse effects of weather on productivity and prevent similar disruptions in future projects.

However, the findings also raise important questions about the sustainability and adaptability of LPS in projects with significant external uncertainties. While LPS offers a robust framework for improving planning and workflow, its success in this project was heavily reliant on reactive measures, such as overtime, rather than purely proactive planning. This suggests that for LPS to be more effective, it should incorporate more comprehensive risk management strategies, such as predictive modeling for weather disruptions or integrating buffer times for material delivery delays.

For future projects, especially those facing similar challenges, it is recommended to enhance the adaptability of LPS by combining it with advanced project management tools, such as real-time monitoring systems or weather forecasting technologies. Additionally, more emphasis should be placed on continuous training and collaboration among all stakeholders to ensure the consistent application of LPS principles throughout the project lifecycle.

In conclusion, while LPS has demonstrated its potential to improve project performance, its effectiveness is contingent on its implementation and the ability to address external challenges dynamically. Further studies are recommended to explore the integration of LPS with other management frameworks to ensure its sustainability and reliability in diverse project environments.

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