Aminullah, A., Hermawan, H., Andini, M. A., Christie, B. N., & Susanto, T. (2026). Lean construction learning process based on corporate roadmap and LCPD implementation at PT Wijaya Karya (Persero) Tbk. In F. Hamzeh, M. Poshdar, & N. P. Garcia-Lopez (Eds.), Proceedings of the 34th Annual Conference of the International Group for Lean Construction (IGLC34) (pp. 704–714). https://doi.org/10.24928/2026/0299

LEAN CONSTRUCTION LEARNING PROCESS BASED ON CORPORATE ROADMAP AND LCPD IMPLEMENTATION AT PT WIJAYA KARYA (PERSERO) TBK

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ABSTRACT

Lean Construction implementation is often faced with challenges in transforming training into measurable project performance, particularly when learning is detached from real project environments. Despite the growing adoption of Lean principles, there is limited information on how structured learning systems can be effectively integrated into project environments to ensure sustainable performance improvement. Therefore, this study aimed to investigate the effectiveness of a corporate-based Lean Construction learning model. The investigation was carried out using a learning model developed and implemented by PT Wijaya Karya (Persero) Tbk (WIKA) through the LCPD program. Using a qualitative case study method, an evaluation was carried out to determine the integration of classroom learning, simulations, coaching, and project-based learning within real construction projects. Furthermore, learning outcomes were evaluated using pre- and post-tests, while organizational impact was assessed through Project Time, Output, and Budget (POTOB) performance indicators. The results showed that there was a significant improvement in participants' competencies and a 9.83% year-on-year increase in POTOB performance. This indicated that integrating Lean learning within a structured corporate roadmap enhanced workflow reliability and project performance. In line with the analysis, this study contributed by proposing an integrated model correlating Lean learning with project execution to improve organizational performance.

KEYWORDS

Lean construction, Last Planner System, experiential learning, project-based learning.

INTRODUCTION

A construction project is characterized by a life cycle typology consisting of planning, design, implementation, monitoring, and controlling stages, followed by a maintenance period and

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operational phase. Although each stage requires different resources, the implementation is often associated with various challenges such as complexity, distribution, variability, and uncertainty (Rodriguez et al., 2011). These challenges are common in various construction projects, such as low worker productivity caused by material delays and the accumulation of materials that remain unused. Material delays can reduce productivity, because labor is available but materials are not, leading to wasted time. However, accumulation of materials also represents waste, which occurs when subcontractors operate with individual targets that are not coordinated holistically, assuming completed work. This type of inefficiency has been addressed in the automotive industry to provide materials with just-in-time or Lean principles to optimize the production process (Womack et al., 1990). The principle was further adapted to be developed in the construction industry by Koskela (1992), which was called Lean Construction (Alarcón and Pellicer, 2009). Specifically, Koskela (2000) introduced a holistic view of construction as a flow of information and resources, with three main objectives, namely cost reduction, time savings, and added value for clients.

In this context, PT Wijaya Karya Tbk (WIKA), as a State-Owned Enterprise contractor, faces construction challenges related to productivity, waste, and uncertainty in project schedules and costs. Consequently, WIKA has adopted Lean Construction as part of the efforts to improve performance as well as enhance value delivery and workflow reliability. However, developing capabilities among project practitioners remains challenging when learning is detached from real project environments. Therefore, this study aims to examine a corporate-based Lean Construction learning model implemented at WIKA.

LEAN CONSTRUCTION ROADMAP

In adapting the principles, WIKA applied the framework developed in PMBOK 6th. The framework consisted of 10 areas and 49 processes, which included project integration, scope, schedule, cost, quality, resource, communication, risk, and stakeholder management. Based on this mindset, WIKA's Lean Construction Roadmap integrates people development, process improvement, and performance systems through staged implementation. The LCPD program serves as the primary execution mechanism, correlating learning activities directly to project outcomes. In the development of LCPD, the main frame of mind is based on PMBOK 6th, as shown in Table 1.

Table 1: Basic Framework of LCPD Development

Knowledge Area	Process Group				
	Initiating	**Planning**	**Executing**	**Monitoring & Controlling**	**Closed**
Integration	Develop Project Charter	Develop PMP	DWPW, MKM	MCPW, PICC	
Scope Mgt		PCDC		V Sc, Cont. Sc	
Schedule Mgt		P, D, S, E, D		Cont. Sch	
Cost Mgt		PC, EC, DB		Cont Qlt	
Quality Mgt		Pqm	M Qlt	C Qlt	
Resources Mgt		PR, Est Re Act	A, D, M	C R	
Communication Mgt		P Com	Mgt. Com	Mgt. Com	
Risk Mgt		PR, IR, PQRA, PQtRA, PRR	Imp RR	Mgt. Risk	
Procurement Mgt		Plan Proc	Condt Proc	Cont Proc	
Stake H. Mgt	I - SH	Plan SH	Stake H. Mgt.	Stake H. Mgt.	

The frame of mind in Table 1 is further developed into an implementing framework, as shown in Figure 1.

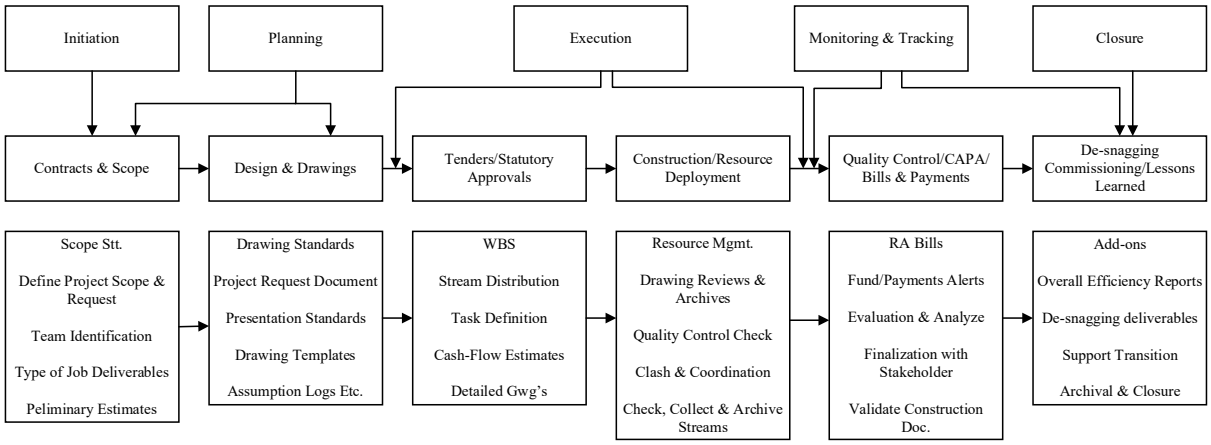

Figure 1: Development of Mindset in the Implementation of Lean Construction

STUDY METHODOLOGY

This study adopts a qualitative descriptive case study method focusing on LCPD Batch 1. The stages consist of:

1. Basic Lean Construction training includes pre and post-tests from the training participants
2. Implementation on each project
3. Project report collection

4. Management reviews
5. Lean construction advanced training

These stages can be described as shown in Figure 2.

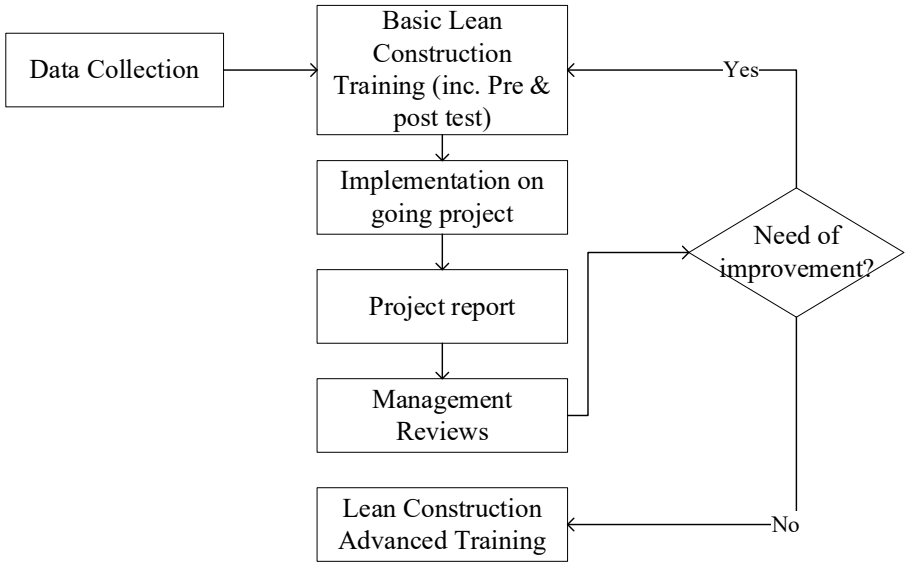

Figure 2: Research methodology

LCPD PROGRAM DESIGN AND LEARNING PROCESS

Using the frame of mind in Figure 1, LCPD was developed that integrated key Lean Construction principles, including collaboration, flow efficiency, waste reduction, transparency, and continuous improvement within the instructional design. These principles were operationalized through the tools introduced in the program, including the Last Planner System (LPS), pull planning, lookahead planning, constraint management, and Percent Plan Complete (PPC). Collaborative planning is practiced through pull planning exercises, while flow efficiency and waste reduction are addressed through lookahead planning and constraint removal. Continuous improvement is supported through PPC measurement to evaluate planning reliability, while transparency is supported through visual planning and shared planning sessions. The order of LCPD learning modules is shown in Table 2.

Table 2: LCPD

Basic Training Project Management (Project Management-1 TW-1)	**Basic Training Lean Construction (Project Management-2 TW-1)**	**Intermediate Lean Construction Training (The Last Planner System, Downtime, A3 Thinking TW-1)**	**Advance Lean Construction Training (Delay Analysis, Claim & Dispute Management TW-4)**
Training Description	**Training Description**	**Training Description**	**Training Description**
Project Management training is the basic foundation of how project management is conducted in an integrated manner.	This training is focused on the preparation and analysis of productivity standards for a project, which will become an input to the Project Master Schedule. This process includes: a. Logic link b. Activity duration calculation c. Productivity basics Logistic plan	Training Description Training at this stage will focus on the technical implementation of WIKA Lean Construction using three tools, namely: 1. The Last Planner System (LPS) 2. Waste Production 3. A3 Thinking (Integrated Dashboard) By implementing the Integrated Dashboard, it will facilitate project division management in conducting evaluations and providing improvement recommendations according to current project conditions	Training Description Advanced training is the final stage of the Integrated Lean Construction Management. The training is strategic in nature and has reached maturity levels 4 and 5 of WIKA Lean Construction implementation, several references used in this training include Indonesian regulations, FIDIC, and the Society of Construction Law (SCL).

Table 2: LCPD (continued)

Basic Training Project Management (Project Management-1 TW-1)	**Basic Training Lean Construction (Project Management-2 TW-1)**	**Intermediate Lean Construction Training (The Last Planner System, Downtime, A3 Thinking TW-1)**	**Advance Lean Construction Training (Delay Analysis, Claim & Dispute Management TW-4)**
Capability Development Outcome a. Participants understand the integration/ Management knowledge area and its relationship with other processes. b. Participants understand the planning and controlling process of project scope. Participants understand the Breakdown Structure (WBS) based on the disciplines of Engineering, Procurement, Construction & Commissioning.	Capability Development Outcome a. Participants are able to develop productivity standards based on specific project conditions. b. Participants are able to develop pull planning with constructability logic for each project. c. Participants are able to integrate PMS with LPS. Preparation or examples of a project schedule execution plan.	Capability Development Outcome a. Implementation of the Last Planner System. b. Able to understand and measure the types of waste. c. Able to understand the Integrated Dashboard (Project Performance Report). d. Able to provide analysis and corrective actions. Able to perform analysis of potential claims and anti-claims in various management scenarios.	Capability Development Outcome a. Participants are able to conduct delay analysis (Forensic Delay Analysis) and claim / anti-claim management based on standards applicable in the international construction industry. b. Participants are able to establish claim bases such as EOT, change order claims, and disruption claim analysis. Participants are able to develop legal opinion arguments or basic materials to be used as references for mediation with third parties.

As shown in Table 2, LCPD is structured as a progressive learning journey consisting of basic, intermediate, advanced, and coaching stages. The basic training stage is the foundation of integrated project management, where learning is grounded in the knowledge areas shown in Figure 1. At this stage, participants understand the Knowledge area of integration management, which is related to other processes such as scope planning, Work Breakdown Structure (WBS) based on discipline, engineering, source, as well as construction and commissioning. The next basic training stage focuses on creating and analyzing productivity standards for a project that will be entered into the Master Schedule. This process includes logical links, calculation of activity duration, the productivity base, and the logistics plan. The targeted outcomes include the ability to create productivity standards based on project-specific conditions, pull planning with logic and constructability, integrate PMS with the LPS, and create a project Schedule Execution Plan. Subsequently, advanced training is conducted, focusing on technical Lean Implementation Construction at WIKA. There are three tools used at this stage, namely:

6. The Last Planner System (LPS)
7. Waste Production
8. A3 Thinking (Integrated Dashboard)

One example of the three tools used is shown in Figure 3, which relates to waste reporting in ongoing construction projects.

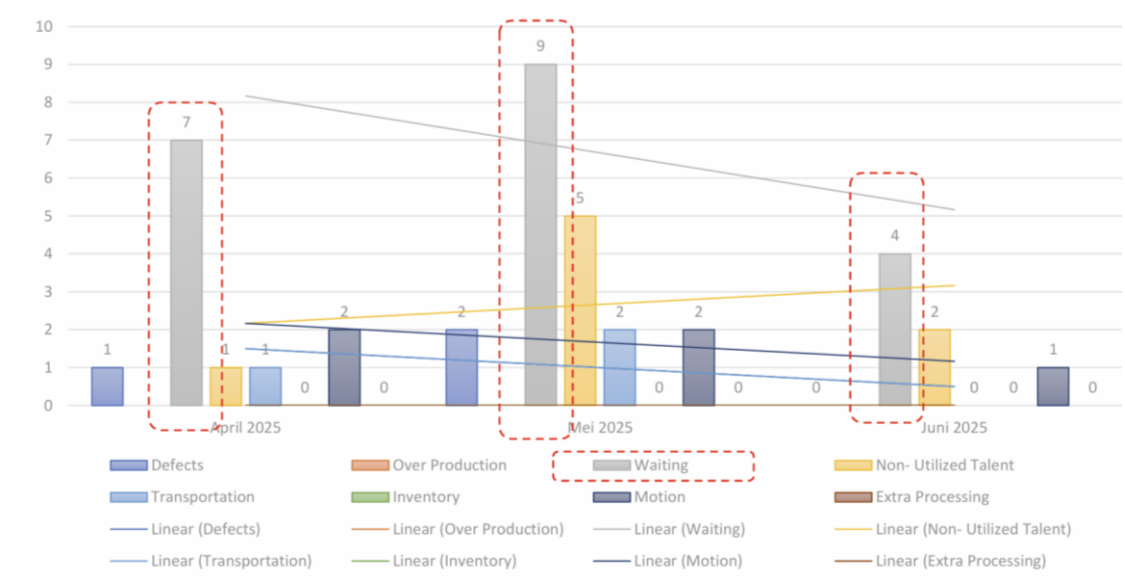

Figure 3: Waste report on construction project WIKA

The final stage of LCPD is the Advanced Training, which consists of a series of integrated sessions under the Integrated Lean Construction Management framework. Specifically, this stage is strategic and has reached Maturity levels 4 and 5 of the implementation process, depending on major references such as Indonesian Law, FIDIC, and Society Construction of Law (SCL). At this stage, participants are expected to conduct Forensic Delay analysis and Claim/Anti-Claim management based on the standards applicable in the International Construction Industry. Additional outcomes include the ability to conduct claim-based analyses, including Extension of Time (EoT), Claim Change Order, and Disruption Claim, alongside the ability to build legal arguments, opinions, or basic materials as a reference for mediation with third parties. The integration of modules with selected ongoing projects is presented in Table 3.

Table 3: Integration of learning with ongoing project

Infra 1 (22 Projects)	Infra 2 & Building (INBD)		EPCC
	13 Projects	5 Projects	4 Projects
1. Patimban P6 2. Japek S 2A Toll 3. Serpan S3 Toll Road 4. Cijurey 3 Dam 5. Semdem 1B Toll Road 6. Kngko Dam 7. HBR 2 8. P4 9. Glass Bridge 10. Rentang Irrigation 11. Lausimeme Simeme Dam 12. Kons Mainroad Serpan 13. Probowangi 3rd Package 14. JSS 2nd Package 15. JSS 3rd Package 16. Lausimeme Simeme Dam Advanced 17. JSS 1st Package 18. Tiga Dihaji Dam 19. Jragung Dam 20. Tenggang Flood 21. Bojongtotor 22. Belimbing Irrigation	1. IKN Toll Road 2. Drdg. Tursina 3. Sei Duri Mpw 4. Jenelata Dam 5. Manikin Dam 6. KIPP Wastewater Treatment Panel IKN 7. Re-MWRD 8. Lingkar Sepaku 4 9. IKN 1B Toll Road 10. Sepaku Water Treatment Installation 11. OIKNG Package 12. D. I Irrigation 13. Kaltara Irrigation	1. Harkit Hospital 2. Hassanudin Hospital 3. Maba Regional General Hospital 4. Mandiri PIK 2 5. Bobong Regional General Hospital	1. 2nd East Java Liquefied Petroleum Gas 2. Manggis Jetty 3. Gospier Jetty 4. TLS 6 & 7

The procedure for the assessment of the integration of learning between the training module and the ongoing project is shown in Figure 4.

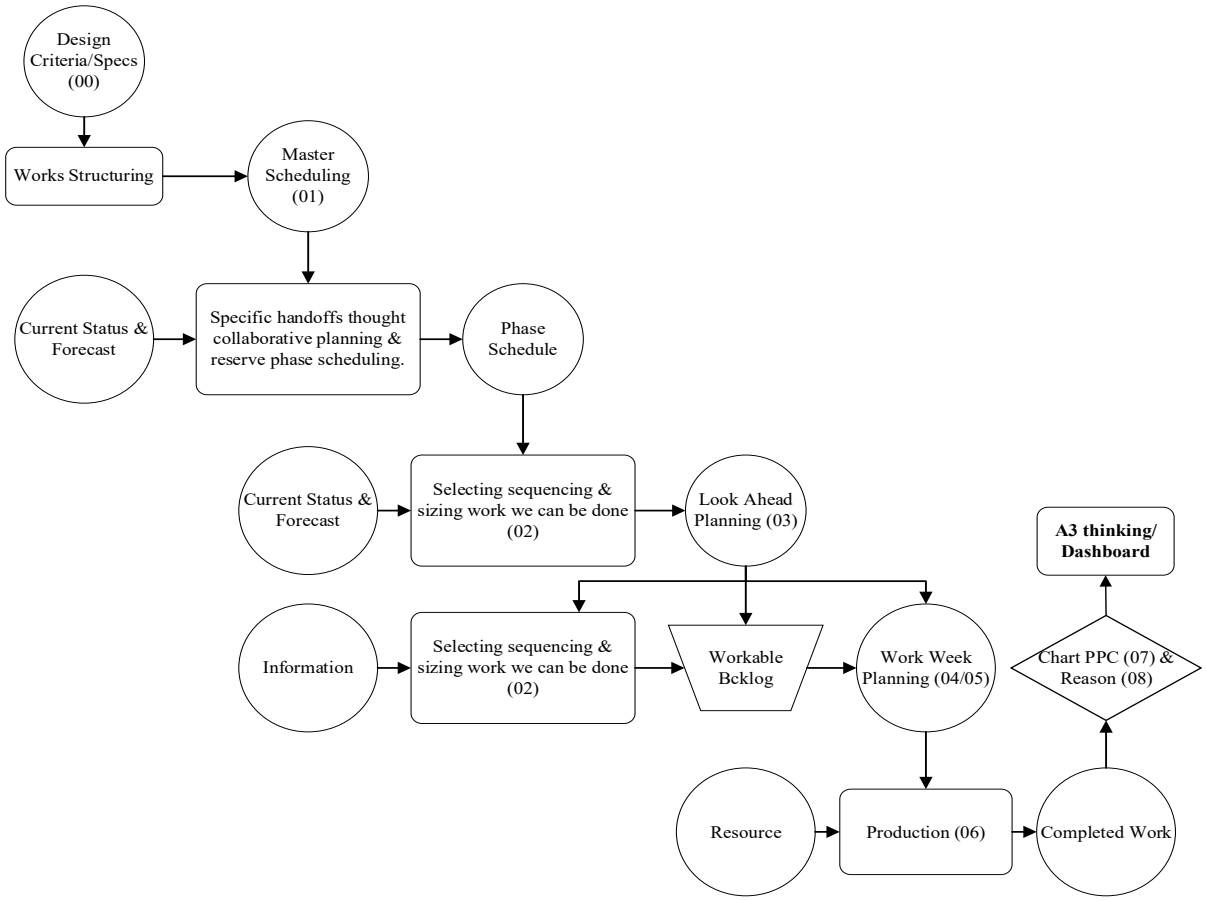

Figure 4: Stages of learning integration assessment between training modules and ongoing projects

The LCPD program introduces the LPS as the core Lean planning framework used in the training. As shown in Figure 4, the planning process progresses from master and stage scheduling to lookahead planning and weekly work planning. The system emphasizes collaborative planning, constraint removal, and workflow reliability to ensure that tasks included in the weekly work plan are ready for execution. Furthermore, planning performance is monitored through PPC and reason analysis, enabling project teams to identify root causes of plan failures and support continuous improvement through A3 thinking. The implementation of Lean Construction is also assessed using MM.

A previous study by Perkins et al (2010) described the development of MM for Lean in the aerospace industry at the Massachusetts Institute of Technology (MIT). This particular assessment tool, the Lean Enterprise Self-Assessment Tool (LESAT), was reported to provide an understanding of the organization's current maturity (Leanness) and guide the transformation towards a leaner company. Similarly, existing studies showed that MM was widely applied across industries to support change management strategies and assess the maturity of discipline or strategy (Huat and Low 1994, Perkins et al. 2010). In this study, maturity was evaluated on a scale from 0 to 5, with a score of 0 (regardless of implementation; 0–0.99), 1 (concerned about implementation, 1–1.99), 2 (learning; 2–2.99), 3 (competent), 4 (teacher), and 5 (innovator in Lean Construction).

The LCPD program enables the direct application of Lean Construction practices in ongoing projects, as participants are personnel responsible for execution. In this study, training impact was monitored through a Maturity Score Level (MSL) dashboard. The results showed that 51 projects were monitored, where 28 achieved the targeted competency level. The maturity trend indicated continuous improvement, with the average score reaching 2.51, which

was close to the competency threshold. The implementation of Lean practices, particularly the LPS, constraint management, and PPC monitoring, improved planning reliability and workflow coordination, contributing to improved Project Time, Output, and Budget (POTOB) performance. Learning was supported through direct application of the LPS, constraint management, and performance control within live projects. In the implementation at WIKA, the LPS was used, and the results were evaluated in the management review, as shown in Figure 5.

Figure 5: Post-implementation management review

RESULTS

Learning outcomes showed an increase in average test scores from 63.33 to 86.84 and achievement of LPS Maturity Level 3. At the organizational level, project portfolio data showed a 9.83% year-on-year improvement in POTOB, with significant reductions in delays and cost overruns. Impact measurement was carried out using EPMO (Enterprise Project Management Office) by comparing the performance of ongoing projects implementing Lean Construction and those under POTOB criteria. The results of the assessment as part of the WIKA performance project are shown in Table 4.

Table 4: Project performance WIKA

Project Status	Up to Nov 2024 (No. of Projects)	Up to Nov 2025 (No. of Projects)	Up to Nov 2024 (%)	Up to Nov 2025 (%)	Deviation (%)
Delay – On Budget	17	10	22.67%	17.24%	-5.43%
Delay – Overbudget	3	5	4.00%	8.62%	4.62%
On Time – On Budget	49	40	65.33%	68.97%	3.64%
On Time – Overbudget	6	3	8.00%	5.17%	-2.83%
Total	75	58	100%	100%	—

An assessment of time and budget was conducted after project implementation. The results shown in Figure 6 indicated that delays still occurred at approximately 25.8%, while the overbudget was 13.79%. This condition showed improvement compared to before the implementation of the principle. Efforts for improvement were also included in the annual report, which could be used for further enhancement.

Figure 6: Assessment of time and budget

CONCLUSIONS

In conclusion, this study confirms that experiential and project-based Lean Construction learning has the potential to effectively bridge theory and practice, leading to measurable performance improvements at both the individual and organizational levels. The application of three key tools, namely the LPS, waste production, and A3 Thinking (Integrated Dashboard), contributes to improving the performance of ongoing projects. The use of these three tools is also influenced by maturity. At WIKA, maturity is assessed as cumulative outcome of the LCPD, carried out in stages from basic, intermediate, and advanced. Therefore, LCPD is a crucial baseline for implementing Lean Construction at WIKA.

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