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PDCA FOR TEAM PERFORMANCE MANAGEMENT IN LEAN-IPD

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ABSTRACT

Team performance is critical to the success of Integrated Project Delivery (IPD) projects, yet existing IPD contracts and guidelines offer limited direction on monitoring and managing it. While Lean Construction tools can support collaboration and project delivery, their effectiveness is not guaranteed without a structured implementation approach. This study explores the team performance management approach used during the Detailed Design phase of a Lean-IPD case project through the lens of the Plan-Do-Check-Act (PDCA) cycle, a suitable framework for structuring team performance management practices around continuous improvement. Drawing on the case study results, the research highlights the consequences of insufficient integration between performance monitoring (Check phase) and responsive adjustments (Act phase), where the bi-weekly Percent Plan Complete (PPC) for design tasks fell to just 23%. The results also emphasize the need to monitor broader dimensions of team performance, such as coordination, communication, and collaboration, rather than relying solely on workflow metrics like PPC, in order to support a more holistic understanding of team dynamics. The findings underscore the importance of having a systematic approach to team performance management and offer insights to guide the development of a structured PDCA-based framework for team performance management in Lean-IPD environments.

KEYWORDS

Integrated Project Delivery, Lean construction, team performance, PDCA.

INTRODUCTION

When facing any performance issues, it is critical for construction projects to address them as effectively and promptly as possible. The construction industry continues to face significant challenges, including excessive cost overruns (Aljohani et al., 2017; Tejale et al., 2015), missed schedules (Agarwal et al., 2016; Subramani et al., 2014), and environmental emissions (UNEP, 2009). Addressing these challenges requires a holistic approach that views the project as a whole and employs an integrative, engaging, and value-driven delivery model.

In recent years, Integrated Project Delivery (IPD) has gained traction as an effective project delivery model to mitigate typical industry shortcomings (Allison et al., 2018; Bhonde et al., 2020; Fischer et al., 2017). IPD is defined as a collaborative project delivery model that aligns

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people, systems, business structures, and practices to optimize outcomes, increase value, reduce waste, and maximize efficiency across all phases of design and construction; it establishes contractual agreements that share risks and rewards among the owner, designer, and builder, promoting effective collaboration through transparency and trust and aligning stakeholder success with project success (Allison et al., 2018; The American Institute of Architects, 2007, 2010, 2023). As such, its success is highly reliant on the performance of project teams, making effective team performance monitoring and control essential (Allison et al., 2018; Franz et al., 2017).

Nevertheless, while IPD sets various legal, financial, and operational boundaries as a contractual framework, it does not specify means for effective collaboration, managing team performance, or delivering projects within its scope. Specifically, common North American IPD contract models, such as the CCDC 30 and Hanson Bridgett contracts, and leading IPD guides—such as "*Integrated Project Delivery: A Guide"* by the American Institute of Architects (AIA) and "*Integrated Project Delivery: An Action Guide for Leaders*" by the Integrated Project Delivery Alliance (IPDA)—provide no detailed guidance on implementing team performance monitoring and control methods (Allison et al., 2018; CCDC, 2018; HansonBridgett, 2012; The American Institute of Architects, 2023). Moreover, while Lean construction is considered complementary to IPD, offering project teams practical tools to support collaboration and achieve project goals, the effectiveness of these tools is contingent on their proper selection and implementation, as the tools alone do not inherently guarantee optimal team performance (Bigwanto et al., 2024; Moradi & Sormunen, 2023). Their implementation can be inconsistent and reactive without a structured approach, limiting their effectiveness, as demonstrated in the present case project. Therefore, there remains a need for clear, systematic guidance on integrating team performance monitoring and control into Lean-IPD projects.

The Plan-Do-Check-Act (PDCA) cycle offers a well-established framework suitable for structuring team performance management practices around continuous improvement. However, its use in IPD contexts remains underexplored in the literature, especially in the design phase of a Lean-IPD project, as further detailed in the Background section of this paper. In light of this, the objective of this research is to:

(1) Use the lens of a PDCA cycle to evaluate the team performance management practices implemented in a Lean-IPD project.
(2) Identify the lessons learned to inform future applications of PDCA-based performance management in Lean-IPD projects.

This investigation was conducted through a two-year ethnographic study of a complex Lean-IPD project in its design phase, during which research team members actively participated in project meetings and engaged directly with the project team. Notably, the project team did not deliberately adopt a PDCA-based framework; however, their practices often reflected an incomplete cycle, limited to the Plan, Do, and Check phases, with corrective actions (Act) occurring only after a prolonged decline in team performance reflected through the Percent Plan Complete (PPC). The contribution of this study is twofold: (1) it highlights the practical consequences of operating without a systematic team performance management approach in Lean-IPD settings, and (2) it offers insights to inform the development of a PDCA-based framework for team performance management in Lean-IPD environments, providing a foundation for future refinement and research.

BACKGROUND

LEAN-IPD

Lean Construction practices, rooted in the Lean philosophy of value generation, waste minimization, and continuous improvement (Ballard, 2008; Liker, 2020), could play a vital role in bridging the team performance management gap in IPD projects. The complementary and synergetic nature of Lean and IPD can be an enabler for bridging the performance gaps. IPD establishes a contractual framework that fosters trust and collaboration among project team members, while Lean Construction equips project teams with practical tools to collaborate effectively and achieve project goals (Cheng & Johnson, 2016).

Lean Construction not only aligns with IPD by emphasizing the early involvement of key project stakeholders and aligning their goals and interests, but it also incorporates a variety of tools such as the Last Planner System (LPS), Pull Planning, and Target Value Delivery (TVD) to support effective project implementation, aiming to increase value further and reduce inefficiencies (Ballard, 2008; Ballard & Howell, 2002; Mesa et al., 2019; Umstot & Fauchier, 2017). This synergy has been demonstrated through numerous case studies (Allison & Cheng, 2015; Arar et al., 2022; Chudasma et al., 2019; Tillmann et al., 2012) and is reflected in the emergence of the term LIPD, which stands for Lean Integrated Project Delivery (Chiozzi, 2020; Hettiaarachchige et al., 2022; Sarkar & Mangrola, 2016), and is also sometimes referred to as Lean-IPD (Nanda et al., 2017; Rashidian et al., 2024).

Case studies on Lean-IPD projects (Arar et al., 2022; Chudasma et al., 2019) show that project teams have used certain Lean Construction tools, such as Plus/Delta, to monitor team performance and related aspects. However, these tools are often employed autonomously as monitoring measures intended to inform the project team, particularly the project management team (PMT), to take action when a significant performance drop is observed.

THE PDCA CYCLE

As Lean-IPD emphasizes continuous collaboration and improvement, project planning is iterative. It adapts as the project progresses, as do reviews of the risk register and updates to the cost model. This aligns with the familiar Plan-Do-Check-Act (PDCA) cycle, also known as the Plan-Do-Study-Act (PDSA) cycle. This iterative method has become an essential foundation for implementing the continuous improvement mindset as part of Lean Thinking in general and subsequently in Lean Construction (Moen & Norman, 2009; Umstot & Fauchier, 2017). The PDCA cycle involves: (1) *Plan*: Set a goal, theory, success metrics, and plan; (2) *Do*: Implement the plan; (3) *Check* or *Study*: Evaluate the plan's validity through identifying success or problems and areas for improvement; (4) *Act*: Integrate gained learning to adjust the goal, methods, and/or theory or expand the cycle into a larger implementation plan (The W. Edwards Deming Institute, 2024). In the AEC industry, this typically involves cycles of setting expected outcomes (*Plan*), conducting the necessary tasks (*Do*), measuring the project team's outcomes against the expected outcomes (*Check*), and making necessary adjustments if there is a variance between the expected and actual outcomes (*Act*) (Allison et al., 2018). In this context, the PDCA cycle can provide a structured framework for team performance monitoring and control: the *Check* phase facilitates systematic performance evaluation against established goals, while the *Act* phase enables informed proactive or corrective actions to bring outcomes in line with expectations and sustain continuous improvement.

The application of the PDCA cycle has gained prominence in the construction industry with the growing adoption of Lean Construction practices. For instance, it has been used by foremen to improve daily planning based on actual performance data (Song & Fischer, 2020), integrated with Lean and BIM to enhance production planning and control (Nascimento et al., 2018), applied to prevent safety incidents in plumbing activities (Mosquera et al., 2024), and utilized to implement occupational health and safety management systems (Kunodzia et al., 2024). However, when it comes to IPD projects, its mention is largely limited to brief references or definitions in related contexts or associated with the use of A3 reports (e.g., Gupta et al., 2009; (Allison et al., 2018; Evans & Farrell, 2022; Umstot & Fauchier, 2017).

METHODOLOGY

This study employed a multi-stage qualitative research approach. First, a review of key North American IPD contracts and guides, including the CCDC 30 contract, the Hanson Bridgett IPD agreement, and leading publications by the AIA and IPDA, was conducted to identify existing provisions and recommendations for team performance monitoring and control. This review identified existing provisions and guidelines related to team performance management, thereby capturing the current state of guidance in practice.

This study then drew on a long-term ethnographic investigation of a complex Lean-IPD project, during which research team members were closely engaged with the project team over two years during the Validation and Detailed Design phases. As part of this investigation, research team members participated in and observed over 200 project meetings, during which team performance management emerged as a significant focus during a period of sustained performance challenges. This immersive involvement provided deep insight into project team dynamics, decision-making, and management practices as they unfolded in real-time.

To evaluate team performance management practices through the lens of the PDCA cycle, the research team reviewed and evaluated data collected throughout the ethnographic study. The collected data included meeting notes, more than 40 hours of semi-structured interviews with project stakeholders, and 15 rounds of short surveys. In addition, key project meetings were transcribed to gain deeper insight into the team's response to the sustained performance decline. These transcripts helped capture the rationale behind the team's actions, particularly their use of root cause analysis and subsequent countermeasures. The identified practices were then structured into the phases of the PDCA cycle to demonstrate how the framework was reflected in practice and to assess its suitability for structured team performance management.

Finally, the research team reflected on the documented practices and outcomes to identify shortcomings experienced during the project and to extract lessons that could inform future applications in Lean-IPD projects.

CURRENT STATE OF GUIDANCE IN THE INDUSTRY

As discussed earlier, effective team performance management is critical to the success of IPD projects, yet current industry standards offer limited actionable direction on how to achieve it. For example, common North American IPD contract models, such as the CCDC 30 and Hanson Bridgett contracts, require the PMT in IPD projects to implement “programs” aimed at improving overall project performance (CCDC, 2018; HansonBridgett, 2012). The Hanson Bridgett contract also provides a brief description of the objectives of such “programs,” embedded in PMT’s tasks, as follows (HansonBridgett, 2012): (1) Developing management protocols and monitoring compliance with these protocols; (2) Evaluating progress toward achieving the project objective. However, neither contract provides detail on what these programs should entail or how to monitor and control team performance effectively.

A similar lack of specificity is evident in leading IPD guides. “*Integrated Project Delivery: A Guide”* and “*Integrated Project Delivery: An Action Guide for Leaders*”, published by the American Institute of Architects (AIA) and the Integrated Project Delivery Alliance (IPDA), respectively, provide no detailed guidance on implementing team performance monitoring and Control methods (AIA, 2023; Allison et al., 2018). The IPDA highlights the importance of project teams' self-awareness and their reflection on performance with a mindset geared towards continuous improvement as a key condition for successful team collaboration (Allison et al., 2018). However, while it briefly introduces Lean Construction tools, it lacks guidance on integrating them into a cohesive performance management system. As a result, selecting and implementing appropriate performance monitoring and control methods are primarily left to the discretion of IPD teams.

OVERVIEW OF CASE PROJECTS AND PRACTICES EMPLOYED

Over two years, the research team was actively involved in the Validation and Detailed Design phase of a highly complex Lean-IPD project. This project involved a two-storey healthcare facility topped by two small residential towers and was further complicated by having three different public owners. These factors made Lean-IPD an attractive delivery model, and a variety of Lean Construction practices were adopted despite most project team members having limited familiarity with Lean-IPD concepts and practices. Adding to these challenges, the COVID-19 outbreak occurred during the Detailed Design phase, forcing the team to transition all collaborative activities to an online environment. Then, a notable drop in team performance prompted adopting a team management approach involving root cause analysis and countermeasures, which inadvertently mirrored the PDCA cycle. The following provides brief overviews of the prominent methods adopted by the project team:

- The Last Planner System (LPS): A production planning and control system that improves workflow reliability and efficiency, enhances project performance, and fosters stakeholder collaboration (Ballard, 1999, 2000). LPS has also been successfully applied during the design phase of construction projects, where it has been shown to improve team alignment, task clarity, task sequencing, and process transparency (Fosse & Ballard, 2016).
- Pull Planning: A collaborative process within LPS used to plan workflows. It starts with a defined goal or milestone and works backward to identify the tasks needed to achieve it. It engages those directly responsible for the work and key decision-makers to create realistic and achievable task sequences that promote reliable project delivery (Ballard et al., 2020).
- Percent Plan Complete (PPC): A performance metric measuring the percentage of planned tasks completed out of the total number of commitments made over a given period. It reflects the extent to which the team’s commitments were realized and indicates workflow reliability and short-term execution performance (Ballard, 1999, 2000; Pérez et al., 2022).
- Scrum: An Agile project management framework that structures work into short, time-boxed iterations, called sprints, during which cross-functional teams collaborate to execute tasks, monitor progress, and adjust plans to achieve defined goals (Sutherland, 2014).
- Five Whys (5-Whys): A problem-solving tool used to incrementally identify the root causes of project issues by repeatedly asking “why” until the underlying cause is revealed (Liker, 2020).

The implementation of these practices for managing team performance in the Lean-IPD case project is outlined in the following section.

CASE PROJECT TEAM PERFORMANCE MONITORING AND CONTROL THROUGH THE PDCA LENS

This section describes the practices implemented to manage team performance in the case project, framed through the PDCA lens.

Plan and Do Phases

Following the methods of LPS and SCRUM, the team employed Pull-Planning techniques to divide the Detailed Design phase into two-week Sprints. The Pull-Plan was organized into "Swim-lanes," each assigned to a specialty discipline called the Project Implementation Team (PIT). These Swim-lanes contained the deliverables or commitments of each PIT (Figure 1). Each PIT further broke down the deliverables into specific activities using a Sprint Board (Figure 2).

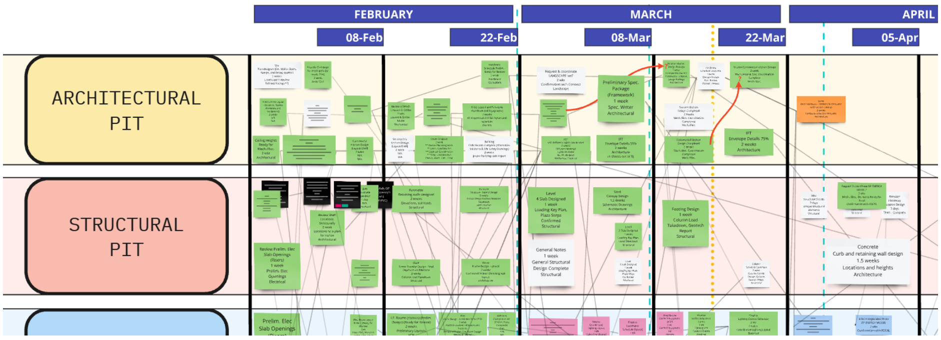

Figure 1: A section of the Virtual Project Pull-Plan

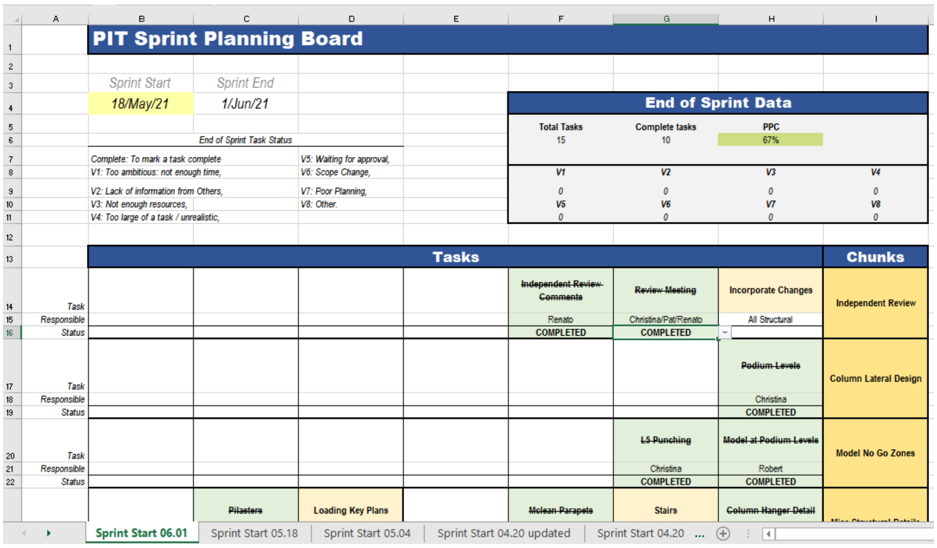

Figure 2: Two-week Sprint Board for the Structural PIT

The typical two-week agenda followed a consistent structure. On Mondays, the PMT met to coordinate management tasks, including reviewing the risk register, setting agendas for the upcoming sessions, and managing project team interactions with external parties outside the Lean-IPD framework. The entire project team gathered virtually on Tuesdays and Thursdays, starting with a Big Room session to address topics relevant to most participants. These sessions typically occupied the first half of the morning, followed by PIT Work Time dedicated to coordinating and executing tasks specific to each specialty team. Afternoons mirrored this structure, concluding with a Plus/Delta session for the entire team. Since “design” and “design coordination” were the essence of this phase, it was observed that the PIT Work Time was frequently replaced with multiple PITs coming together to collaborate on a certain design matter. The described pattern was followed for two weeks, with a “Sprint Report Out” session held at the first Big Room meeting of the following Sprint wherein the PIT members would inform the entire project team of their progress.

CHECK PHASE

PPC was used as the main performance monitoring tool in this project. As Figure 2 shows, the virtual Sprint Boards in Excel were programmed so that the PPC for each PIT for each Sprint was calculated automatically. Sprint Boards were allocated to separate Excel tabs, which made it possible to develop PPC trends for each PIT and closely monitor their progress or lack thereof. Figure 3 shows the PPC trend for the entire project team throughout the Detailed Design phase.

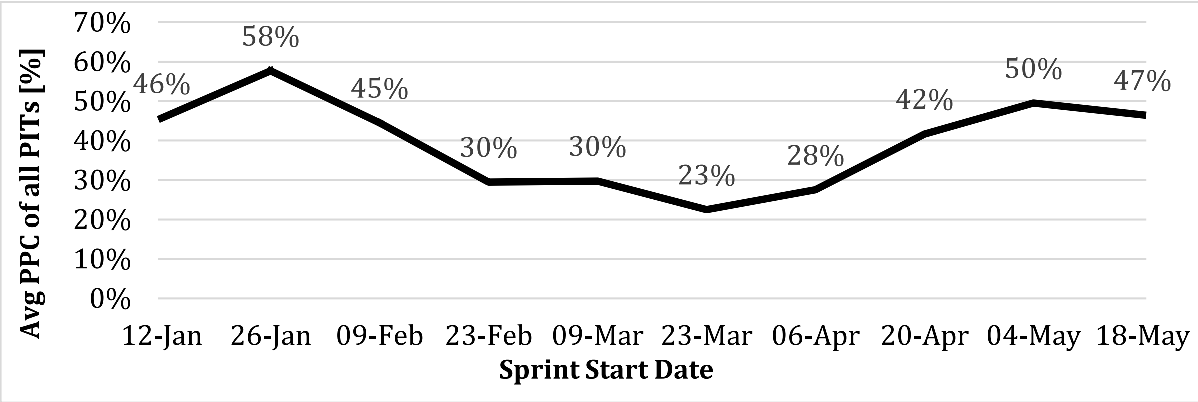

Figure 3: PPC Trend for the Entire Project Team

Plus/Delta sessions were also held in Big Room meetings at the end of every project day. The Deltas were discussed in the same session, and potential improvements were suggested. However, it was notable that there was no systematic method for following up on these items or finding their way to the PMT meeting agenda. This resulted in significant issues being flagged by the project team at the beginning of the daily Big Room sessions, which could sometimes become disruptive to the previously set agenda and create additional inefficiencies.

As the Detailed Design phase progressed, a downward trend in the PPC of most PITs became evident (Figure 3). In addition, most individual PPCs consistently remained low over several months (January to April 2021), ultimately prompting the PMT to trigger an intervention in April 2021. This intervention is detailed in the following subsection.

ACT PHASE

During the Detailed Design phase of the case study, no Lean Construction tools for root-cause analysis and adjustment were frequently used. Minor adjustments concerning topics like schedule, design, and budget were discussed informally during Big Room or PMT sessions without employing specific Lean Construction tools, likely because issue flagging was handled informally in these settings. However, it is challenging to critique this practice, as none of the minor adjustments caused major issues throughout the phase.

On the other hand, when the PMT decided that a major adjustment was needed to address the steady low PPC rates, they invited external facilitators to conduct a root-cause analysis session. This was mostly due to the lack of experience of the PMT with Lean Construction root cause analysis methods. As such, a Five-Whys session was held in April, starting with a presentation to familiarize the team with the concept behind this tool. Then, the concept of Gemba, well known from Toyota Thinking, was introduced by the IPD facilitator to initiate the root cause analysis: *"Even though this is a manufacturing example of how Toyota uses this with rigor, we can still do that here [in the construction context]. So, the idea is that we take the data that we have and look at some of those instances, using the 5 Whys technique to really ground our root causes in facts" – Facilitator of the Five-Whys Session*

The Gemba exercise quickly led the team to acknowledge: "*We have experienced challenges in meeting our commitments.*" The team then applied the Five-Whys technique to investigate: "*Why have we experienced challenges in meeting our commitments?*" Two responses were identified by the team: "*1) We ran out of time, and 2) we were waiting for information from others.*"

The team then moved to an individual level, with each participant applying the Five-Whys technique to these two responses on their own. They then shared their final conclusions, their identified root causes, with the rest of the group, where each was discussed in detail. With the facilitator's guidance, the team ultimately narrowed down the root cause to "a lack of clarity regarding expected deliverables." For example, team members were uncertain about what exactly was required to reach milestones such as "30% construction documents" for each discipline.

As a primary countermeasure, the team decided to restructure its design coordination approach by having all PITs collaboratively focus on one building section at a time, referred to as "Quadrants", rather than having each PIT work independently toward discipline-specific design milestones. This shift aimed to foster deeper collaboration among related PITs by encouraging them to jointly develop design solutions within defined spatial zones, promoting integration over isolated progress. The following quote reflects some of the discussions leading to this decision: *"For me, break the building down into, let's say **Quadrants**, and let's take this part of the building and let's focus on X, Y and Z. That allows us to get into the stage of collaborating, having a discussion, going back into your position, getting the design pieces done, then coming back to the table with any questions and comments. But it's like **a systematic process** where we're taking it **one piece at a time** because that's kind of at the point where we're at now is making sure that we're finalizing design, but we're integrating it together so that it is a collaborative design. We don't want teams to go into their own **silos** and just complete the design. We want that to be **a team design**." – Project Manager in the Five-Whys Session*

As shown in Figure 3, PPC began to improve after this intervention and corrective measurements. However, this upward trend plateaued after a few additional sprints, indicating that further root cause analyses may have been necessary to achieve greater efficiency. However, with only two months remaining to conclude the Detailed Design phase, the team hesitated to stop the work and undergo another intervention.

REFLECTION AND LESSONS LEARNED

This case study highlights three key insights into the application of team performance management practices during the Detailed Design phase of the Lean-IPD project

First, the findings have shown that while the Lean-IPD team adopted core Lean tools (e.g., Pull Planning, Plus/Delta sessions, Five Whys), their effectiveness was limited by the absence of a timely link between performance monitoring (Check) and proactive adjustments (Act), as reflected in the continued decline of PPC, which dropped to as low as 23%. Specifically, performance issues emerged and persisted over several months, yet no immediate corrective action was taken. The project team continued working without adjusting its design approach until PPC reached a critical low and the Project Management Team (PMT) determined that intervention was necessary. While this late-stage response did lead to improvements, overall performance only partially recovered and quickly plateaued at around 50%. This suggests that further gains in team performance could have potentially been achieved through a more continuous improvement process, enabled by repeated and complete PDCA cycles. The absence of such cycles limited the team's ability to refine processes and sustain higher levels of performance over time. This highlights the importance of implementing structured performance management practices that not only support early detection of underperformance but also foster ongoing learning and iterative improvement through proactive and consistent use of the full PDCA cycle.

Second, the case study revealed that the scope of the Check phase was too narrow to fully capture the factors affecting team performance, as it relied solely on PPC as the primary monitoring metric. While PPC proved effective for tracking workflow reliability and the realization of planned commitments, it did not offer insight into the quality of coordination, communication effectiveness, and collaboration between disciplines—all of which are critical dimensions of team performance, especially in IPD environments. This limitation was evident during the root cause analysis session, which identified lack of clarity and insufficient collaboration and coordination between PITs as major performance barriers. In response, the team restructured design coordination around shared building sections ("Quadrants"), shifting the focus from individual PIT outputs to collaborative efforts within defined spatial zones. This change was aimed at enhancing cross-disciplinary interaction, an effort that PPC alone could not have captured or assessed. To address this, teams could consider integrating complementary assessment tools that reflect the broader dimensions of team performance. For example, Durugbo et al. (2011) propose a network-based modelling approach to analyse how individuals collaborate toward shared goals, offering a way to visualize and understand interaction patterns that PPC cannot reveal. Such examples highlight the potential for more robust and multi-dimensional approaches to team performance monitoring, supporting a more comprehensive Check phase.

A final reflection from this case study is the value of pausing project work to address persistent performance issues, a practice that aligns with the Jidoka Lean principle of stopping production when abnormalities are detected and solving problems at the source (Ohno, 1988). Although stopping progress can feel counterproductive in fast-paced environments, the case project demonstrated that taking time to investigate root causes and implement corrective actions can ultimately restore team performance.

CONCLUSION AND OUTLOOK

This study has explored team performance management in a Lean-IPD project through the lens of the PDCA cycle, highlighting both the potential and limitations of current practices. While Lean Construction tools like PPC, Pull Planning, and Five Whys were utilized to varying degrees, their effectiveness was constrained by the lack of a structured and comprehensive continuous improvement process.

Three key insights were drawn from the case study. First, it is essential to close the PDCA loop by linking performance monitoring (Check) with timely responses (Act). Without this connection, performance issues may persist or worsen before appropriate interventions are made, limiting the potential for sustained improvement. Second, incorporating monitoring methods that capture multiple dimensions of team performance, such as coordination, collaboration, and communication, alongside workflow metrics like PPC can provide a more holistic understanding of team dynamics, supporting earlier detection of performance barriers and more targeted interventions. Third, the study highlighted the value of adopting a Jidoka mindset, pausing work when problems arise, to prevent performance issues from persisting and worsening over time.

While the findings offer valuable insights, there are several limitations to consider. First, the study is based on a single Lean-IPD project, which limits the extent to which the results can be generalized to other projects. In addition, the project team did not deliberately adopt the PDCA cycle as a guiding framework. As a result, the study does not capture the effectiveness of a fully implemented PDCA cycle but rather evaluates practices that only partially reflected its structure. Finally, the research team's involvement concluded at the end of the Detailed Design phase, which constrained the analysis to this phase and limited the ability to assess how performance management practices evolved during construction or in later stages of the project.

As IPD gains momentum in complex projects, future work should focus on formalizing PDCA-based performance management frameworks that integrate indicators of the various dimensions of team performance. Building on this study, the research team plans to examine additional Lean-IPD projects where PDCA is deliberately applied, to evaluate its effectiveness and enhance the generalizability of the findings.

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