Lujan, G. P., & Engineer-Manriquez, F. (2026). Integrating SCRUM with the last planner system: an AI-enhanced framework. In F. Hamzeh, M. Poshdar, N. P. Garcia-Lopez, & V. Gan (Eds.), *Proceedings of the 34th Annual Conference of the International Group for Lean Construction* (IGLC34) (pp. 1725–1736). https://doi.org/10.24928/2026/0271

INTEGRATING SCRUM WITH THE LAST PLANNER SYSTEM: AN AI-ENHANCED FRAMEWORK

Guillermo Prado Lujan[1] & Felipe Engineer-Manriquez[2]

ABSTRACT

While both the Last Planner System (LPS) and SCRUM have demonstrated benefits independently, existing research lacks a practitioner-grounded framework that integrates these approaches across planning horizons. Grounded in a shared epistemological foundation of empiricism (where planning is continuously adjusted through feedback and learning) this study adopts an inductive, case-based approach to develop an initial framework outline. This research consists of a comparative analysis of LPS and SCRUM across six key dimensions, the synthesis of an integrated framework with AI as an augmentation layer, and an illustrative case study of a complex construction project. Results indicate that LPS provides stability through multi-horizon planning and commitment management, while SCRUM enhances short-cycle coordination, learning, and role clarity. AI further supports these processes by improving information synthesis, visibility, and anticipatory decision-making, while maintaining a human-in-the-loop approach. This study contributes a structured, practitioner-informed starting point for integrating Lean, Agile, and AI in construction, highlighting the need for further validation and development through future research.

KEYWORDS

Last Planner System, SCRUM, Lean Construction, Integration, Artificial Intelligence

INTRODUCTION

The construction industry continues to experience persistent project delivery problems (i.e., schedule delays, coordination failures, and unreliable workflow) despite decades of improvement efforts considering methodological and technological advancements. Research in Lean Construction and related project management practices attributes these outcomes to the limitations of deterministic, command-and-control planning approaches when applied to complex, interdependent, and highly variable production environments, among other reasons (Koskela & Howell, 2002a; Owen et al., 2006; Engineer-Manriquez, 2021; Prado, 2022). In response, Lean Construction and Agile methods have been increasingly explored as complementary paradigms capable of improving planning reliability, learning, and value delivery under uncertainty (Owen et al., 2006; Power et al., 2022; Power & Sinnott, 2025).

Within Lean Construction, the Last Planner System (LPS) has emerged as a widely adopted production planning and control system designed initially for construction activities (Ballard, 2000; Ballard & Tommelein, 2021). Through its five planning conversations, LPS emphasizes, LPS emphasizes collaborative planning, constraint removal through make-ready processes, and

[1] Production Manager, Project Delivery Services, The Boldt Company, San Francisco, California, USA, guillermo.prado@boldt.com, orcid.org/0000-0002-5325-1132

[2] Project Delivery Services Director, Project Delivery Services, The Boldt Company, San Francisco, California, USA, Nick.Loughrin@boldt.com,

commitment-based weekly planning supported by learning metrics such as Percent Plan Complete (PPC) and reasons for variance (Ballard, 2000; Power et al., 2022). In parallel, within the agile methods, SCRUM—originated in software development—has been introduced as a construction project management method that structures work through iterative cycles, frequent inspection and adaptation, and clearly defined events such as daily standups, sprint reviews, and retrospectives that lead to improved performance (Owen et al., 2006; Streule et al., 2016; Engineer-Manriquez, 2021). Previous research has shown that SCRUM is particularly effective in design and engineering phases, where iterative problem-solving and information flow dominate and decisions are interdependent among disciplines (Power et al., 2022; Power & Sinnott, 2025).

Both methods (LPS and SCRUM) have been implemented in construction projects and case studies are part of numerous papers in the construction project management body of knowledge, showing their applicability in different scenarios and specific uses in the industry. Although LPS and SCRUM share conceptual foundations in empirical process control, continuous learning, and collaborative coordination (Koskela & Howell, 2002a; Owen et al., 2006) they differ in ways that are critical for construction common practice. LPS provides a structured, multi-horizon planning system that stabilizes production and aligns multiple trades through reliable commitments and constraint management (Ballard, 2000; Power et al., 2022). On the other hand, SCRUM enables high-frequency coordination, rapid feedback, and adaptability through short-cycle routines and self-organizing teams (Owen et al., 2006; Power et al., 2022). These complementary strengths suggest that integration is not only possible but necessary, particularly in project environments characterized by high variability, late-stage disruption, and intense coordination demands, where project teams can emphasize SCRUM during the design phase and LPS during the construction phase.

Empirical studies provide increasing evidence that SCRUM can complement LPS in construction projects. A case study reported that implementing SCRUM routines alongside an existing LPS system improved crew-level communication and was associated with an approximately 11% increase in PPC by reducing missed handoffs and improving bottlenecks removals (Power et al., 2022). Comparative analyses also map correspondences between LPS and SCRUM planning artifacts and suggest adjustments to better align the methods (e.g., backlogs and planning levels), reinforcing the logic of integration (Poudel et al., 2020; Power et al., 2022). While existing contributions tend to remain conceptual, comparative, or limited to isolated implementations (Owen et al., 2006; Poudel et al., 2020), current practices suggest an increasing practitioners' need for an LPS-SCRUM integration, leaving a gap in a practitioner-grounded framework that integrates both approaches across planning horizons.

At the same time, advances in artificial intelligence (AI), particularly in generative AI/Large Language Models (LLMs), show new opportunities to improve planning and control processes in construction. Recent studies suggest that AI can support functions such as information synthesis, pattern recognition in production data, and alignment between planning levels (Amer et al., 2021; Ganji Rad & Ilbeigi, 2025). Despite this, current construction research emphasizes that the effectiveness of AI depends on its integration within existing human-focused systems, where trust and transparency are critical, and where decision-making remains grounded in collaborative, commitment-based practices (Schia et al., 2019). Consequently, AI is not a replacement for existing planning systems, but it could be used as an augmentation layer that can enhance visibility, learning, and decision support within LPS and SCRUM practices.

Accordingly, the research gap addressed in this paper is that despite growing theoretical alignment and empirical evidence supporting the integration of LPS and SCRUM, there remains a lack of a practitioner-grounded framework that operationalizes this integration across planning horizons and project conditions. In this study, SCRUM–LPS integration is defined as the alignment of selected SCRUM roles, events, and artifacts with the planning and control

structure of the LPS, particularly at the short-cycle coordination level. This integration does not imply full SCRUM implementation, but rather the adaptation of SCRUM principles based on the project needs while implementing LPS. Therefore, the objective of this paper, which is theoretical in nature, is to present an outline of a potential LPS-SCRUM integrated framework (with AI positioned as an augmentation layer to support planning and control) based on observed implementation practices to inform future research efforts in developing a comprehensive integrated LPS-SCRUM framework.

LITERATURE REVIEW

ORIGINS AND COMMON GROUNDS OF LPS AND SCRUM

Lean Construction and Agile methods developed as responses to the limitations of traditional project management tools in construction. Both paradigms shift emphasis from deterministic planning methods to empirical control, the incorporation of feedback loops as learning mechanisms to inform the plan, and the central role of people doing the work. Koskela and Howell (2002a) stated these approaches as departures from conventional project management tools, advocating for "management-as-organizing" supported by feedback loops, decentralized decision-making, and continuous learning. Similarly, Owen et al. (2006) distinguish Lean and Agile as complementary approaches: Lean focuses on stability, flow, and waste reduction, while Agile emphasizes adaptability, responsiveness, and iterative value delivery.

Within this context, the LPS and SCRUM represent two prominent frameworks embodying these paradigms. Both LPS and SCRUM are grounded in the principle of empirical process control, where planning and execution are continuously adjusted based on observed performance. In LPS, this is operationalized through commitment-based planning, 5 conversations, metrics such as PPC, and systematic analysis of reasons for non-completion, which enable teams to learn from execution and improve reliability over time (Ballard, 2000; Koskela & Howell, 2002a). Similarly, SCRUM defines itself as an empirical framework, relying on short iterative cycles (sprints), daily inspection, and structured reflection (retrospectives) to continuously adapt plans based on real outcomes (Schwaber, 2004; Sutherland, 2014).

While these mechanisms differ in structure and application, both frameworks share a common epistemological foundation in empiricism, emphasizing feedback, transparency, and learning as the basis for effective planning and control. Recent research reinforces this convergence. Power et al. (2022) and Power and Sinnott (2025) highlight the alignment between the broader concepts of Lean and Agile thinking in construction, particularly in environments characterized by uncertainty and interdependence. Similarly, Poudel et al. (2020) demonstrate conceptual alignment between LPS and SCRUM planning logics, suggesting that both can be understood as complementary methods for empirical production control.

INDIVIDUAL FRAMEWORKS FOR LPS AND SCRUM IN CONSTRUCTION

LPS is widely recognized and used as a structured production planning and control system designed for construction. Its core contribution lies in aligning what should be done, can be done, and will be done in the project through collaborative planning, constraint removal, and commitment-based coordination (Ballard, 2000; Ballard & Tommelein, 2021). Operationally, LPS is implemented through interconnected planning levels, including phase (pull) planning, lookahead planning (make-ready), weekly work planning, and learning through metrics such as PPC and Reasons for Non-Completion (RNC). Case studies consistently show that LPS improves workflow reliability by enabling superintendents' input in the planning effort and strengthening feedback loops (Power et al., 2022; Ballard & Tommelein, 2021). Despite its proven effectiveness in improving workflow reliability, LPS faces limitations in contemporary

construction projects. These include challenges in supporting highly iterative design processes, weak structuring of short-cycle coordination, inconsistent implementation maturity, and difficulty sustaining commitment-based behaviours in fragmented project environments (Ballard & Tommelein, 2021).

SCRUM is an Agile framework that structures work into time-boxed iterations (sprints), supported by defined roles, events, and artifacts that enable frequent synchronization, rapid issue escalation, and continuous improvement (Schwaber, 2004; Sutherland, 2014). In construction, SCRUM has been increasingly applied to design and engineering activities, where iterative development, interdisciplinary coordination, and evolving requirements are prevalent (Streule et al., 2016; Engineer-Manriquez, 2021; Power & Sinnott, 2025). Recent studies further highlight both the applicability and challenges of SCRUM in construction. While its emphasis on adaptability and rapid feedback aligns with Lean principles, challenges arise when applying SCRUM to construction execution due to contractual constraints, fragmented project organizations, and the need for multi-party coordination (Owen et al., 2006; Power et al., 2022). These challenges suggest that neither framework alone fully addresses the combined need for multi-horizon production stability and short-cycle adaptability.

EMPIRICAL STUDIES OF LPS AND SCRUM INTEGRATION

Currently, a growing body of literature explores the integration of LPS and SCRUM through case studies, comparative analyses, and potential hybrid frameworks. Among others, Power et al. (2022) report a field implementation in which SCRUM routines were introduced alongside an existing LPS system, resulting in improved crew-level communication, faster issue resolution, and an approximate 11% increase in PPC. Power et al. (2024) analyse the role of SCRUM-specific functions, such as defined facilitation roles, in complementing LPS and takt planning implementations, demonstrating how role clarity can strengthen planning reliability and learning processes. Similarly, Power and Sinnott (2025) propose a Hybrid Agile Lean (HAL) production planning and control system based on 11 case studies, reinforcing the feasibility of integrating Agile and Lean practices in construction environments.

Comparative work by Poudel et al. (2020) systematically maps LPS and SCRUM across multiple dimensions and concludes that many SCRUM elements already exist within LPS (despite their origins in different industries), while identifying opportunities for targeted improvements such as clearer role definitions and structured facilitation mechanisms. Furthermore, practitioner-centred contributions continue to shape implementation approaches. Engineer-Manriquez (2021) presents a structured adaptation of SCRUM for construction teams which also includes LPS components, but it mainly focuses on showing the usage of SCRUM in construction, while Poudel et al. (2020) synthesize synergies between LPS and SCRUM, highlighting alignment in transparency, collaboration, and iterative planning.

Additionally, recent efforts attempt to integrate Lean, Agile, and advanced production analyses tools. For example, Power et al. (2024) propose combining LPS, SCRUM, and Takt planning to enhance project delivery. While these contributions represent important advances, they remain largely exploratory and context-specific, providing remarkable insights but limited standardized, operational guidance for broader application across projects and different contexts. There is clearly an opportunity for the integration of LPS and SCRUM and the previous articles were a part of the literature relevant to the purpose of this paper.

CURRENT USE OF AI IN LPS AND SCRUM IMPLEMENTATIONS

Alongside LPS-SCRUM integration, there is growing interest in the application of AI to support planning and control processes in construction projects. Recent studies demonstrate that AI, particularly machine learning and natural language processing techniques, can enhance functions such as schedule optimization (through multiple alternatives evaluation), data

analysis, and information synthesis (Amer et al., 2021; Ganji Rad & Ilbeigi, 2025). Among others, Amer et al. (2021) show that language models can support alignment between long-term and short-term planning, enabling to overcome a key challenge found in LPS. Similarly, Ganji Rad and Ilbeigi (2025) identify a rapidly expanding set of AI applications in Lean Construction, including planning, safety, risk management, and collaboration, but also highlighting limitations such as data quality, access to these tools, interpretability, and reliability.

At the same time, emerging paradigms such as Lean 5.0 further extend this discussion by proposing human-centered integration of AI within Lean tools and methods. Among others, Khoshkonesh et al. (2025) argue that AI can support and enhance decision-making, predictive capabilities, and workflow optimization, while emphasizing that human oversight, ethical considerations, and transparency remain essential. Consistent with these findings, research emphasizes that AI must be integrated within human-centred planning systems. For example, Schia et al. (2019) demonstrate that trust, transparency, and user understanding are critical for effective AI adoption in construction. Therefore, AI is increasingly positioned not as a replacement for planning systems, but as an augmentation layer that can support information processing, learning, and decision-making within LPS and SCRUM practices, ideally in an integrated and practical fashion with people in the project.

RESEARCH GAP

Collectively, the literature demonstrates a strong theoretical connection between LPS and SCRUM, supported by shared principles of empirical control, transparency, and continuous learning. Furthermore, they share a common epistemological foundation in empiricism, aiming for effective planning and control. It also provides growing empirical evidence that SCRUM can improve LPS, particularly in improving coordination, communication, and responsiveness in construction projects, mostly in the design phase. Additionally, recent studies propose hybrid Lean–Agile systems and explore the integration of SCRUM roles, routines, and planning logic within LPS implementation (Power et al., 2022; Power et al., 2024; Power & Sinnott, 2025). Nonetheless, despite these relevant pieces of literature, these studies have a conceptual or comparative nature, are limited to single or small sets of case studies, and present exploratory hybrid frameworks without standardized implementation guidance.

Even recent efforts combining LPS, SCRUM, and Takt planning (Power et al., 2024) provide valuable insights but do not yet offer a practitioner-grounded framework that can be consistently applied across planning horizons and project contexts. Furthermore, while AI applications in construction are rapidly expanding, there is limited research on how AI can be effectively integrated within LPS-SCRUM planning systems without undermining key principles such as commitment-based planning and respect for people. This gap highlights the need for a practitioner-grounded approach that bridges theory and practice, providing clear operational guidance on how LPS and SCRUM can be integrated and how AI can support, rather than replace, human-centred planning systems in construction.

METHOD

This study follows an inductive, case-based approach (Eisenhardt, 1989) as the initial step toward developing an initial outline of an integrated LPS–SCRUM framework for construction planning and control. Consistent with prior research in Lean Construction and Agile methods that investigates emerging hybrid practices, the purpose of this study is not to test hypotheses but to provide a structured point of departure for future research through a practitioner-grounded conceptual contribution. Given the nature of this paper, this research leverages the authors' professional experience as a point of departure for theory exploration. The study also directly examines one case study that was used as a starting point for the explanation of this integrated framework. The study employs the Observation-Participation method that

researchers actively participate in the daily activities of the studied scope, enabling context-rich insights that support theory development (Rischmoller, 2005). Data collection included four-six informal semi-structured interviews with the project superintendent, project managers, site engineers, lean lead, and owner representative, complemented by direct observation of weekly planning meetings, PPC values, constraint logs, and retrospective sessions. Qualitative findings were analysed through thematic synthesis focused on coordination issues, planning reliability, and learning routines. The authors possess multiple years of experience in construction management and have established working relationships with the observed project as case study.

The research was conducted in three sequential steps. First, a structured comparative analysis of the LPS and SCRUM was performed to identify opportunities for integration. This comparison focused on key dimensions previously discussed in the literature: planning horizons and cadence, commitment and plan reliability mechanisms, roles and facilitation structures, visual management practices, learning and feedback cycles, and constraint management processes. Each dimension was analysed to identify complementarities between both methods, with particular attention to areas where one method could address limitations of the other.

Second, based on the insights derived from this comparative analysis, an integrated LPS–SCRUM framework was developed. LPS was used as the baseline system, given its established application in construction projects, while selected SCRUM practices were incorporated to enhance short-cycle coordination, role clarity, and learning processes. In addition, AI was introduced as an *exploratory* augmentation layer to support information processing, alignment between planning horizons, and repetitive tasks. The resulting framework represents an initial outline that integrates AI with a Lean and Agile framework while maintaining a human-centred, commitment-based planning approach.

Third, a case study was used to display how the proposed outline was originated from practice. The case is based on project documentation and reflective practitioner experience from one of the authors, who participated in a complex construction project where LPS was implemented as the primary planning system and SCRUM practices were selectively introduced during periods of high coordination demand and schedule pressure. Following established case study research guidance (Yin, 2009), the purpose of the case is not to provide statistical generalization but to illustrate the feasibility of the proposed framework. The linkage between these steps ensures that the framework is both theoretically informed and empirically grounded through observed practice. Overall, the main outcome of this study is the development of an initial, practitioner-grounded outline of an AI-enhanced LPS–SCRUM framework, informed by both comparative analysis and empirical observations.

RESULTS

COMPARATIVE ANALYSIS OF LPS AND SCRUM

This section presents the results following the three-step approach described in the method. The results are grounded in the authors' professional practice, supported by literature, and informed by observations from the case study. A structured comparison of LPS and SCRUM was conducted across key dimensions identified in the method. Table 1 summarizes the results of this analysis. This table represents an original synthesis developed from the literature review and practitioner observations.

The comparison confirms that LPS and SCRUM share conceptual foundations in empirical control, commitment-based planning, and continuous learning. Simultaneously, several elements already overlap between both systems, as identified in prior literature. Therefore, the integration builds upon existing common areas while organizing these relationships into a structured, practitioner-oriented framework. The identified interactions represent opportunities for improvement but also introduce implementation challenges depending on project conditions,

team maturity, and organizational context, which will be part of the discussion but also the starting point for this baseline of LPS and SCRUM integration.

Table 1: Comparison of LPS and SCRUM practices across six dimensions

Dimension	LPS	SCRUM	Integration Opportunity & Challenges
Planning Horizon & Cadence	5 levels: Milestone to Weekly	Sprint (1-4 weeks)	Alignment of sprints with lookahead and weekly planning can improve flow, but misalignment across teams may create coordination complexity
Commitment & Plan Reliability	Weekly commitments (Last Planners)	Sprint Backlog items	Dual commitment layers can strengthen reliability, but risk overcommitment if not coordinated properly
Roles & Facilitation	Informal roles	SCRUM Master, Product Owner	Clear facilitation and prioritization roles can enhance coordination, but role overlap may generate confusion
Visual Management	Big Room, physical/digital boards	SCRUM boards	Integrated visual systems improve transparency, though duplication of tools may increase complexity
Learning & Feedback Cycles	PPC, Variance analysis, RNC tracking	Velocity, Sprint Retrospective	Combined learning loops strengthen continuous improvement, but require discipline and cultural maturity
Constraint Management	Make-ready process	Impediment removal	Daily escalation of constraints improves responsiveness, but depends on team readiness and engagement

OUTLINE OF A LPS AND SCRUM FRAMEWORK WITH AI SUPPORT

Based on the comparative analysis, an initial outline of an integrated LPS–SCRUM framework was developed. Table 2 presents how SCRUM practices and AI capabilities can enhance specific LPS planning levels. This framework positions LPS as the backbone of production planning and control, while SCRUM enhances short-cycle coordination and learning processes. AI is introduced as an augmentation layer that supports information processing and decision-making without replacing human judgment. Consistent with Lean principles, AI remains human-in-the-loop, requiring interpretation and validation by practitioners. The framework represents an initial outline, derived from practitioner experience and exploratory analysis, rather than a validated or standardized model.

Table 2: Outline of Integrated LPS–SCRUM Framework with AI Support

LPS Planning level	SCRUM Integration	AI Support (Enhancer)	Expected Benefits & Challenges
Milestone Planning	Alignment with backlog priorities	Scenario analysis, data synthesis	Improves strategic alignment but depends on data availability and quality
Phase Pull Planning	Product Owner participation	Pattern recognition in sequencing	Enhances prioritization and coordination, though role integration may be challenging
Lookahead Planning	Sprint planning & backlog refinement	Constraint identification support	Improves readiness and flow but may create reliance on AI outputs
Weekly Work Planning	Sprint commitments aligned with weekly plans	Automated tracking of commitments	Increases reliability (PPC), though requires consistent data inputs
Daily Huddles & Coordination	Daily SCRUM meetings	Meeting summaries, issue tracking	Accelerates issue resolution but may increase coordination load
Learning & Improvement	Retrospectives/Velocity + PPC/RNC analysis	Trend analysis, lessons learned capture	Strengthens learning loops, though adoption depends on team discipline

CASE STUDY: RELIGIOUS FACILITY PROJECT

The proposed LPS–SCRUM framework outline was illustrated on The Shrine Project, a $50M multi-program religious facility delivered from Fall 2019 to Winter 2022, including a 2,000-seat sanctuary, chapel, visitor centre, museum, and sacred mound. These site features and conditions created high coordination demand, strict quality expectations, and complex sequencing. The "lean team" joined during the final four months before completion, when schedule pressure and coordination intensity were at their peak.

Integration of SCRUM within LPS Planning Levels

LPS served as the primary planning and control method. SCRUM elements were selectively embedded to strengthen short-cycle coordination. A project-wide goal (substantial completion by October 31, 2022) was clearly defined and communicated across all stakeholders, functioning similarly to a Sprint Goal and aligning decision-making across trades. A combined visual management system was implemented using a To Do / Doing / Done board, updated weekly. Additionally, 5-day cycles were introduced and communicated as Takt time, creating a predictable rhythm for planning and execution. A targeted retrospective conducted after two weeks with the site contractor served as a critical turning point. Observable improvements in coordination and predictability led to voluntary adoption of these practices across other trades.

Partial Adoption of SCRUM Practices

SCRUM was not fully implemented. Formal roles such as Scrum Master or Product Owner were not assigned, and no structured backlog refinement process was used. Daily stand-up meetings were not implemented, as weekly coordination cycles and visual management were considered sufficient. Sprint reviews were conducted only twice with the owner's representative at key milestones rather than at the end of each cycle and retrospectives were used when needed. This partial adoption reflects the need to adapt SCRUM to construction contexts and reinforces that integration depends on selecting practices that the project needed.

AI as an Augmentation Layer

AI was utilized as a practical support tool during the project's final phase, primarily through Large Language Models (LLMs) based on GPT-3/3.5 applications. AI-supported analyses were used in an exploratory manner. For example, PPC data were processed to identify trends and recurring causes of plan failure, while constraint logs were summarized to highlight frequently occurring bottlenecks. It also assisted in summarizing coordination meetings and tracking commitments. AI functioned strictly as decision support. All AI outputs were interpreted by practitioners, and no autonomous decision-making was implemented. AI was observed to support planning visibility and anticipatory discussions, although its direct causal effect on project performance was not quantitatively validated within this study.

Lessons Learned and Contribution to the Framework Outline

Significant resistance emerged from the existing project management team, who initially preferred overtime-based recovery strategies over process changes. The late-stage context further limited tolerance for new methods. Adoption was achieved not through top-down mandates but through a pilot implementation with a single trade, followed by a retrospective that provided measurable benefits. This evidence-based approach enabled broader team buy-in and highlights the importance of incremental adoption and internal champions. This case study served as the initial empirical basis for the proposed LPS–SCRUM framework. The observed interactions between LPS and SCRUM informed the structure presented in Tables 1 and 2, while lessons learned (particularly regarding selective adoption, role clarity, and implementation challenges) led to refinements and additions to the framework outline.

DISCUSSION

These findings reinforce prior literature that identifies conceptual overlap and integration potential between LPS and SCRUM, particularly their shared grounding in empiricism, where planning and control are adjusted based on observed performance, feedback, and learning (Koskela & Howell, 2002a; Owen et al., 2006; Poudel et al., 2020; Power et al., 2022). This study extends previous work by operationalizing these similarities into a practitioner-oriented outline that connects SCRUM practices to the LPS planning levels. The case study further demonstrates that integration does not require full adoption of SCRUM, but rather selective implementation of high-impact elements such as goal alignment, visual management, time-boxing, and targeted retrospectives. This supports prior findings that SCRUM components already overlap with LPS practices (Poudel et al., 2020), while also showing that their explicit structuring can strengthen coordination, transparency, and learning loops in practice.

The results also highlight that integration is context-dependent and influenced by project phase and conditions. Consistent with previous studies, SCRUM appears particularly effective in design and high-uncertainty environments requiring rapid feedback and iteration (Streule et al., 2016; Power & Sinnott, 2025), whereas LPS provides the necessary structure for multi-party coordination, constraint management, and workflow reliability during construction (Ballard, 2000; Ballard & Tommelein, 2021). The case study illustrates that even in late-stage

construction, selected SCRUM practices can enhance LPS when introduced through targeted pilots. This finding complements existing literature that often questions the applicability of Agile methods in construction execution (Owen et al., 2006), suggesting instead that integration should be adaptive and situational rather than prescriptive.

The role of AI in this study provides exploratory evidence as an augmentation layer within planning systems. AI-supported tools enhanced information processing, visibility, and early detection of performance patterns, aligning with recent research on AI-enabled decision support in construction (Amer et al., 2021; Ganji Rad & Ilbeigi, 2025; Khoshkonesh et al., 2025). However, consistent with socio-technical perspectives, effective use depended on maintaining human-in-the-loop decision-making, where AI outputs were interpreted by practitioners (Schia et al., 2019). The case study suggests that AI has the potential to support planning visibility, improving situational awareness and learning cycles within the LPS-SCRUM implementation.

This study is subject to several limitations. It is based on a single case study and the authors' professional experience, and the proposed framework represents an initial outline rather than a validation. The application of AI was exploratory and limited to practical use cases, without quantitative evaluation of its impact on performance, reflecting current challenges related to data quality and interpretability (Ganji Rad & Ilbeigi, 2025). Given its exploratory and practitioner-grounded nature, this study does not provide statistical validation of the proposed framework. Instead, it offers an initial conceptual foundation that requires further research.

CONCLUSION

This paper aimed to develop an initial, practitioner-grounded outline of an integrated LPS–SCRUM framework for construction planning and control, and to identify how artificial intelligence (AI) can support this integration without undermining Lean principles. This aim was achieved through a structured comparative analysis of LPS and SCRUM, the development of an integrated framework outline grounded in their shared empirical foundations, and the illustration of its application through a case study that informed and refined the proposed framework.

The results demonstrate that LPS and SCRUM are not only conceptually aligned through empiricism, but also operationally complementary when applied in a context-sensitive manner. LPS provides a robust, multi-horizon system for production planning, constraint management, and commitment reliability, while SCRUM strengthens short-cycle coordination, structured learning, and transparency through selected practices such as goal alignment, visual management, and time-boxing. The case study shows that integration does not require full SCRUM adoption, but rather the selective implementation of practices that address specific project needs, particularly under high-pressure conditions. This reinforces prior findings on Lean–Agile integration while extending them through a practitioner-grounded, phase-aware perspective. Within this integrated system, AI acts as an augmentation layer that enhances information processing, visibility, and anticipatory decision-making, reinforcing empirical learning cycles while maintaining a human-in-the-loop approach consistent with Lean principles.

The main contribution of this paper is the development of an initial outline of an AI-enhanced LPS–SCRUM framework grounded in both literature and practitioner experience. While this outline is not yet fully validated, it provides a structured starting point for integrating Lean, Agile, and AI in construction planning and control. Future research should focus on validating this framework across multiple project contexts, quantifying its impact on planning performance metrics, and further exploring the role of AI through rigorous evaluation of its effectiveness, reliability, and integration within human-centered planning systems. These efforts are necessary to transition from exploratory, experience-based integration toward validated and scalable implementation in practice.

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