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# LAST PLANNER® SYSTEM IMPLEMENTATION HEALTH CHECK

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## ABSTRACT

Achieving consistency of Last Planner® System (LPS) implementation is a persistent challenge for owners, contractors, and practitioners alike. This research evaluated the application of all functions of LPS within an Engineering, Procurement, Construction Management and Validation (EPCMV) consultancy and sought to develop a Guideline and Implementation Health Check (IHC) to assist consistent LPS implementation across all company projects. The study adopted a mixed-methods approach utilising case study design and data collected from a literature review, project documentation review, purposeful semi-structured interviews, two pilot implementations, and a focus group workshop conducted within the case company and across two projects.

Findings posit an implementation assessment tool (IHC) should be considered as an aid to sustaining consistent LPS implementation across projects. Construction should strive to standardise its processes (like the IHC introduction) and adopt a 'process improvement' view and mindset. The IHC highlights the critical components of the functions of LPS and allows project teams to check whether each is being utilised effectively. LPS and its functions constitutes a systematic process for construction planning however, best results will only accrue once all components are in place. While the IHC will ensure the physical infrastructure is in place, successful LPS implementation necessitates deeper consideration of how people think, communicate, engage, commit, and collaborate. Successful and sustainable LPS implementations must be founded on a desire and motivation to improve existing delivery processes and necessitate senior management commitment from all stakeholders.

## KEYWORDS

Lean construction, Last Planner® System, collaboration, health check.

## INTRODUCTION & LITERATURE REVIEW

Uncertainty of workflow has blighted construction execution for decades and has been identified as a shortfall in traditional construction management methodologies (Ballard

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and Howell 2003; Mossman 2019). A dedicated tool of Lean Construction (LC), LPS was created in the early 1990s as a suite of complementary functions for controlling and coordinating site production on construction projects (Ballard and Howell 2003; Daniel *et al*. 2015; Hamzeh *et al*. 2016). Ballard and Tommelein (2016 p.59) posit '…the inspiration for LPS was the discovery of chronically low workflow reliability in construction projects. Consequently, the first step in its development was to improve workflow reliability …to learn how to do what we say we're going to do.' While the importance of LPS is highlighted in the literature, there is little practice description of the '*how to do variety'*, as much comment tends to focus on the pitfalls and factors conducive to success. It is this knowledge deficit that has resulted in academics being unable to provide practitioners with the solutions needed to implement the concepts and principles effectively, implying the effort of actually implementing in practice will be even more difficult to achieve.

The core functions of LPS are master / milestone schedule, phase / pull planning, look ahead and make-ready process, commitment / weekly work planning, daily huddles / coordination, and learning and action (Ballard 2000; Daniel *et al*. 2015; Ebbs and Pasquire 2019). Daniel and Pasquire (2017) suggest little attention has been given towards developing a plan or roadmap for integrating LPS into a project. Effective integration is critical as Power *et al*. (2021 p.48) suggest '…rushed implementations of LPS as 'rescue attempts' are doomed to fail as the overburdening of already overloaded teams with new working practices will provoke resistance to the new methodology.'

Several studies (Daniel *et al*. 2016; Daniel *et al*. 2017; Ebbs *et al*. 2018; Power and Taylor 2019; Hackett *et al*. 2019) argue the consistency of implementation of LPS varies. Ballard and Tommelein (2016), with the publication of '*Current Process Benchmark*…' sought to address inconsistent approaches to implementations (Ebbs *et al*. 2017), emphasising the importance of using all functions to ensure PPC and productivity are linked to the overall milestone schedule (Ballard and Howell 2004; Hamzeh *et al.* 2009; Ballard and Tommelein 2016). The adoption of a standard approach is advised by Daniel and Pasquire (2017, p.16) which avoids each project '…reinventing its own wheel every time'. A consistent and standard approach is essential as Ballard and Tommelein (2016, p. 60) posit LPS '…is a series of interconnected parts. Omission of a part destroys the system's ability to accomplish its functions.' Previous assessment tools focused on improving LPS implementations by addressing reasons for non-completion (RNC) of tasks information (Lagos *et al*. 2019), by focusing on organisational, project and external influences (Ebbs *et al*. 2018), with provision of a Facilitator's Guide (Ebbs and Pasquire, 2019), and by utilising lessons learned from cyclical implementations (Hackett *et al*. 2019).

Based on previous studies there is a need to develop a Guideline and IHC to assist consistent LPS implementation across all projects by asking three research questions: 1) How is LPS implemented in projects; 2) How can implementation of LPS be improved; and 3) What are the possible effects of the improvement measures.

## RESEARCH DESIGN

The paper reports on an in-depth case study of an EPCMV consultancy implementing LPS on selected projects since 2015. Inconsistencies pertaining to LPS implementations were observed on recent projects (poor client feedback and lessons learned) and an internal improvement assignment was initiated to develop an understanding of what was required to enable a standardised and consistent LPS implementation across all projects.

This qualitative study utilises a mixed-methods approach with case study design in accordance with Yin (2009). A sequential explanatory approach (Creswell 2009) was adopted, with each stage informing the next phase of the research. Unique sources were purposely sought to increase validity and to provide a wider perspective, as advocated by Yin (2009) and Stake (1995).

Purposefully selected interviewees were familiar with both positive and negative feedback from LPS implementations. These interviews were transcribed and then analysed using a thematic analysis approach and was organised into different themes in accordance with Braun and Clarke (2006); inferences drawn from the emerging themes were checked by triangulation against the literature review findings and against other sources to check their reliability and integrity. An action research approach, in accordance with Eden and Huxham (1996) was taken on one of the pilot implementations (pilot #2) so the effectiveness of interventions could be clearly monitored and measured. Table 1 presents the sources for the research.

Table 1: Research Sequence and Source

| Steps | Source | Project and Participants |
|---|---|---|
| **1** | Integrative Literature Review | Lean, Lean Construction Literature & particular focus on past IGLC contributions |
| **2** | Project Documentation | Owner feedback, lessons learned,12 EPCMV Company LPS Data from 2017 – 2020. Review PPC on 4 'poor feedback' projects. Company's Lean Group (n=4) assessed & analysed implementation of all LPS functions across 12 projects. (n=12) |
| **3** | Purposeful Interviews | Interviews with EPCMV Company members: Ops Director, 2 X Project Manager, 2 X Construction Manager, Last Planner Facilitator. (n=6; all either directly or indirectly involved in the implementation) |
| **4** | Develop Guideline & Health Check | Develop Guideline and Health Check. (4 members of the Lean group referencing sources in table 2) |
| **5** | Health Check Pilots | Roll out Guideline and Health Check training and trial on two projects. (n=2) |
| **6** | Post-pilots Focus Group Workshop | EPCMV Company Members: Ops Director, 2 X Project Manager, Construction Manager, Last Planner Facilitator X 2. (n=6; all either directly or indirectly involved in the implementation) |

An integrative literature review was conducted on Lean and LC literature. Four specific projects had received poor feedback on project performance and LPS implementation – PPC was reviewed on these projects. The research team then analysed 12 projects that utilised LPS to assess effectiveness of implementation of all LPS functions. The projects were measured for compliance with the five core functions of LPS: Milestone Scheduling, Phase Planning, Lookahead Planning, Commitment Planning, and Learning (Ballard 2000; Ballard and Tommelein 2016). The implementations were scored on a range from 0 to 5 with: 0 = 'no existence of the function', 3 = 'Partial existence of the function', and 5 = 'Full existence of the function'.

Next, semi-structured purposeful interviews were conducted with six members of the company project execution team to understand the reasons behind the inconsistency and poor feedback. Referencing LC literature, outlined in table 2, a Guideline and

Implementation Health Check (IHC) was compiled by the company's 'Lean Group' (four persons qualified and experienced in Lean and LPS) to assist project teams with implementation of all functions of LPS.

Table 2: Sources and key points for developing the Guideline & Health Check

| Source | Key Points |
|---|---|
| Ballard and Tommelein (2016, p.61) *'Current Process Benchmark...'* | 'Functions are the proper work of the system, its jobs. 1) Specifying what tasks should be done when and by whom, from milestones to phases between milestones, to processes within phases, to operations within processes, to steps within operations. 2) Making scheduled tasks ready to be performed 3) Replanning/planning to complete, to achieve project objectives 4) Selecting tasks for daily and weekly work plans—deciding what work to do next 5) Making release of work between specialists reliable 6) Making visible the current and future state of the project 7) Measuring planning system performance 8) Learning from plan failures'. |
| Daniel and Pasquire (2017) *'LPS Path Clearing Approach'* | Step Actions at the Project Level.<br>Table 1: Production planning and control practice (Planning Best Practice).<br>Table 2: LPS implementation assessment questions. |
| Ebbs and Pasquire (2019) *'Facilitator's Guide'* | Appendix 3: LPS Facilitator Checklists<br>Appendix 4: Felipe Engineer's LPS Guide<br>Appendix 5: Study Action Team™ Guidance for Facilitators Guide to the Last Planner® System |

Training was delivered on the Guideline, and the IHC was trialled on two projects over a 12-week period. After the trial period a focus group workshop was held to review both pilot implementations and to assess next steps. The IHC weekly scores, plus interventions and their outcomes, were presented to the focus group. Limitations exist due to the research being conducted within a single organisation. Bias was mitigated by two researchers being distanced from the projects and unconnected with the case company.

## FINDINGS

### Research Question 1: How is LPS implemented in projects?

Owner feedback and internal lessons learned sessions suggested haphazard and inconsistent LPS implementation across the case company's projects. Some implementations received plaudits for LPS while others spoke of little, if any, discernible improvement from traditional methodologies. PPC data over 24-week duration from four selected projects (LPS received poor feedback) showed unreliability, unpredictability, and an absence of stability of PPC within the selected projects. PPC generally stayed between 60 and 80 percent, occasionally dropping below 50 percent or rising to over 90 percent. Knowing that PPC is positively correlated to enhanced productivity, this erratic performance is the antithesis of what projects require for enabling smooth and even workflow.

All 12 projects that utilised LPS from 2017 to 2020 were evaluated; mean, median, and lowest scores were calculated; % implementation was attained by calculating the mean values as a % of a perfect score of 5. The summarised findings are presented in table 3.

Table 3: Status of LPS implementation on 12 projects.

| Survey Findings Score from 0-5 (0=no, 5=full) | Milestone Planning | Phase Planning | Lookahead Planning | Commitment Planning | Learning |
|---|---|---|---|---|---|
| Mean Values | 3.7 | 2.1 | 2.8 | 3.7 | 2.2 |
| Median Values | 3.5 | 2 | 2.5 | 4 | 2 |
| Lowest Values | 2 | 0 | 2 | 3 | 0 |
| % Implementation | 73% | 42% | 55% | 73% | 43% |

Table 3 highlights the inconsistency of application of all functions of LPS. Commitment and Milestone Planning were most used functions with Phase Planning, a critical enabling function of the entire LPS system, least used at 42 percent indicating a major weakness in the implementation. Disappointingly, Lookahead Planning at 55 percent and Learning at 43 percent also point to poor and ad hoc use of key functions of the process. Findings from the purposeful interviews are presented in table 4.

Table 4: Interview findings on inconsistency of LPS implementation

| |
|---|
| Unaware of advantages accruing from using all functions |
| LPS support & resource are focused on selected projects (owner mandated) |
| Lack of focus or ownership towards making the process succeed |
| Poor trade partner engagement with LPS process |
| Full implementation not mandated or demanded on all projects |
| Managers selecting individual functions & discarding others |
| Owners offering resistance and not participating |
| Differing interpretations of what LPS is and its benefits |
| Absence of standardised implementation process or procedure |

Interviewees agreed there was an over-reliance on the ‘Lean Team’ supporting LPS on projects; existence of the ‘Lean Team’ removed LPS ownership and accountability from site management and resultingly, trade partners. Additionally, if a budget for ‘Lean Team’ support didn’t exist the site proceeded to use only selected aspects such as a milestone plan and morning huddles. Some owners and managers were more familiar with, and aware of, the advantages of LPS and therefore mandated and supported its use. However, other owners and managers were reluctant to sponsor the implementation. As the company relies on Standard Operating Procedures and Guidelines in its work execution, interviewees suggested the absence of a best-practice Guideline and Implementation Health Check (IHC) was a barrier which, if resolved, could provide an implementation roadmap, consistency, and remove the reliance on the ‘Lean Team’.

## DEVELOPMENT OF GUIDELINE & IHC

### Research Question 2: How can implementation of LPS be improved?

The IHC built on existing research sources as referenced in table 2. The specific aim of the IHC was, along with the Guideline, to ensure consistency of application of LPS and to provide weekly feedback identifying implementation gaps, thus, allowing focused improvement. The IHC consisted of 38 prompts or questions across six areas that when

responding 'Yes' would confirm its application and 'No' would highlight an area for improvement. Table 5 presents the 38 prompts/questions contained in the IHC.

Table 5: Content of IHC per LPS function

| Function | Content |
|---|---|
| Milestone Planning | Physical/virtual space; information accessible; all functions visible; Master Schedule up to date; all team trained & refreshed within past 6 weeks. |
| Phase Planning | Plan developed with all trades within last 3 months; logic and sequence validated; pull from milestone; 6 week lookahead aligns; constraints identified; behaviours; flow walk screening for seven flows. |
| Look Ahead / Make Ready | New week added to lookahead; incomplete tasks brought forward and replanned; constraint log reviewed with lookahead / phase plan; flow walk /new constraints raised; constraints metrics; Tasks Made Ready. |
| Commitment / Week Work Plan | Communication; attendance; all trades contribution; commitments; 'sound' criteria applied; behaviours; agreed plan communicated. |
| Daily Huddle | Communication; engagement; correct mark-up; missed tasks addressed; Unplanned work added & impact assessed; parking lot employed; new constraints addressed; behaviours. |
| Learning & Action / PPC Analysis | PPC visualised & available to all; RNC assessed; recurring RNC root causes; A3 improvement projects enacted. |

## TRIAL OF IHC

### Research Question 3: What are the possible effects of the improvement measures?

The IHC was trialed on two pilot implementations. Pilot #1 was a project involving a single contractor with no handoffs to other contractors. Full LPS training was provided, and the contractor was familiar with the LPS process as they had been participants in the enabling works LPS (run by the case company) for 14 weeks. The contractor implemented LPS with one of the authors attending morning huddles, the weekly coordination meeting, and compiling the weekly PPC and IHC reports. The IHC summary page is shown in figure 1.

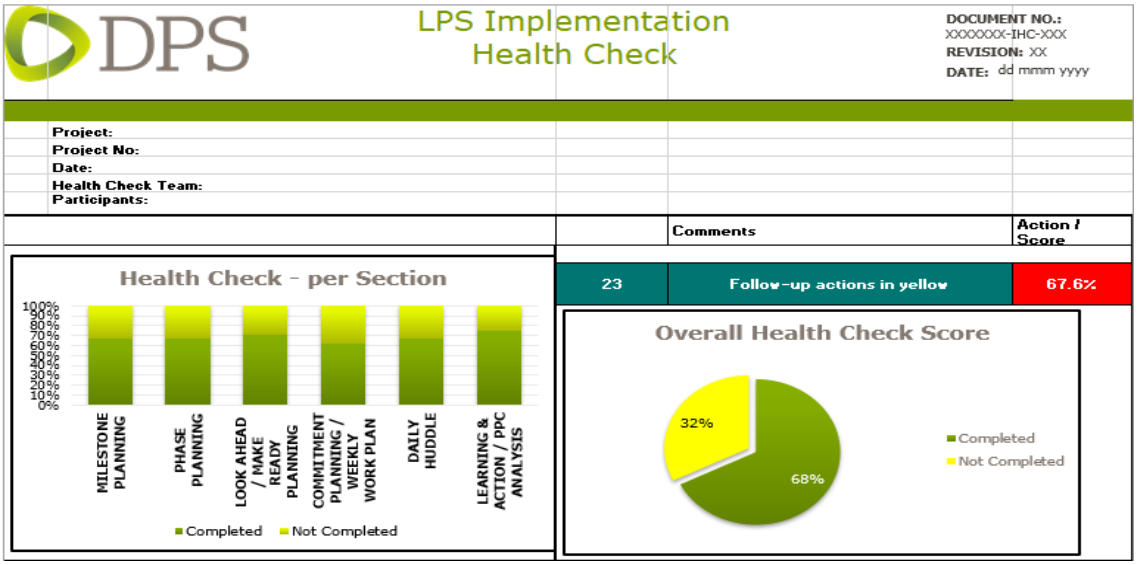


Figure 1: Implementation Health Check summary

The contractor was unwilling to accept the weekly IHC feedback as an improvement opportunity and struggled to understand the value of lookahead planning and constraints identification. A PPC report with detailed reasons for RNC was furnished weekly but the learning and action function of LPS wasn't acted on. Pilot #1 didn't have a collaborative atmosphere; conversations were tense and more adversarial when poor PPC or IHC scores were discussed. LPS was treated as a tool demanded by the owner; the softer social aspects of LPS lay undiscovered as LPS was owned solely by the site manager. A visual correlation between PPC and Health Check is evident in figure 2 (below) and points to PPC performance being influenced by the effectiveness of implementation of all LPS functions, as measured by the IHC. The findings suggest that incomplete implementation (poor IHC score) is constraining PPC achievement.

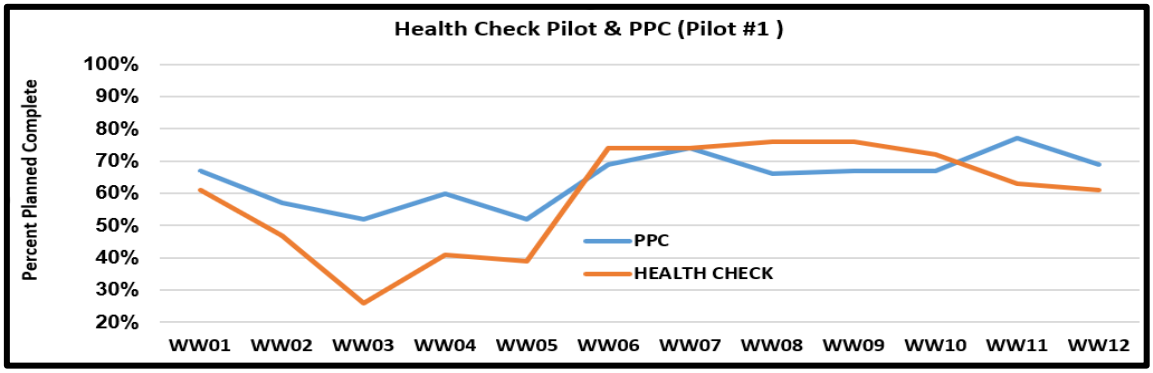


Figure 2: Pilot #1 - PPC & IHC scores.

Pilot #2 was conducted on a warehouse construction project where another author was embedded as a Last Planner Facilitator. The Facilitator had the authority to intervene in the weekly site management and planning process to ensure a full LPS implementation in accordance with the IHC. The EPCMV company's Operations Director was supporting this pilot; this was a key difference from the pilot #1 implementation. Findings from pilot #2 are presented in figure 3.

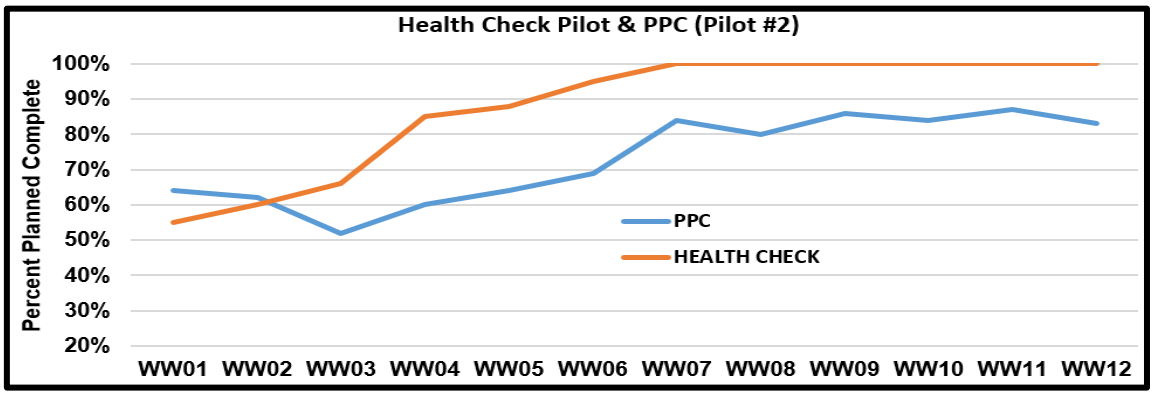


Figure 3: Pilot #2 - Warehouse Project PPC & IHC scores.

Pilot #2 represents how the team (owner, construction management, trade partners) could ensure all functions were implemented. Numerous interventions were applied as improvement opportunities arose when analysing PPC, RNC, and highlighted IHC gaps. Figure 3 presents PPC maintained at over 80 percent when all functions of LPS were implemented and suggests a correlation between a 'full' implementation and higher and more reliable PPC. While both projects are dissimilar in nature, the process of LPS and

IHC should be much easier on pilot #1 (single contractor, minimal design input, sole possession of site and all inputs, low Covid impact) than on pilot #2 (live pharmaceutical facility, owner possession of site, eight trade partners, complex design, international supply chain, high Covid impact as populous site). After the 12-week pilot period expired a focus group workshop was conducted to review the learnings. Table 6 presents the findings.

Table 6: Post-pilot implementation focus group findings

| |
|---|
| There must be a desire and a will to make the implementation succeed. |
| Senior management & site leadership support is critical. |
| Facilitation at early stages is a key enabler. |
| Education and training should be provided to exhibit the benefits & potential of LPS. |
| A longer-term view of LPS implementation should be undertaken; not just to address a crisis. |
| The Health Check is a critical implementation effectiveness measurement tool. |

The summary findings in table 6 posit treating LPS solely as a tool to supplement existing methodologies is insufficient and will not deliver optimal results. Adoption of LPS must be linked to and aligned with a motivation and desire to change from traditional delivery methods. Implementing all LPS functions leads to increased and more reliable PPC; PPC is positively correlated to productivity. The structure introduced by the Facilitator when implementing the IHC on the facilitated pilot #2 brought a coordinated routine that encouraged the trades to participate in the planning of the work; the ensuing positive behavioural change enabled a more collaborative working environment. Early facilitation embeds the routine, practice, and language of LPS from the outset. This common and shared understanding is critical to clarifying the Conditions of Satisfaction for the next customer in line, while also maintaining the implementation process. Standardisation of the process (Guideline and IHC) across all projects will ensure consistency and confidence amongst teams. The IHC identified improvement opportunities on both pilot projects. Critically, it was pilot #2 that addressed the opportunities resulting in higher and sustained PPC.

# DISCUSSION

The IHC, in conjunction with a competent and knowledgeable facilitator, has been found to be a critical enabler of effective LPS implementation. As embedding and sustaining of LPS is often constrained by limited resources, the IHC offers an opportunity to standardise the process and ensuring a step by step ‘check and act’ sequence is part of the kit. Therefore, it is critical that a consistent LPS process, assisted by the IHC, is developed on all construction projects. In pilot #1, the contractor was contractually mandated to utilise LPS on the project. However, they had neither desire nor motivation to use the IHC findings to enhance their weekly planning process. LPS became a tool-focussed ‘tickbox’ exercise ensuring the contractor was contractually compliant. Contractual terms alone will not provide the underlying motivation and determination to meaningfully implement LPS. Also, despite the IHC and the identification of the improvement opportunities, unless the desire to improve the status quo and to overcome past failures exists, the implementation will not reach full potential. Clearly, there must be a desire and a motivation within the company, the project team, and the owner to ensure LPS will succeed and not end up being another ‘fad’ or partial implementation.

The importance of management commitment, leadership, and alignment of strategy in any Lean implementation is emphasised in the literature. Pilot #2 indicates the positive results (PPC and IHC) from a fully supported implementation, where leaders modelled ideal Lean behaviours. Attendance at morning huddles, attending planning workshops, and seeking to be made aware of RNC and process improvement projects are examples of such behaviours. When site leadership support the LPS process, traditional delivery practices are examined, challenged with a Lean mindset, and consideration of customer, next-customer, and 'Value' begin to infiltrate conversations. It is important the 'softer' elements are in place to ensure the IHC contributes fully to the overall LPS process.

Contractors should not wait for the crisis to occur as a reason to introduce LPS on a project. Rather, they should adopt an innovative approach to improve their delivery processes consistently and continuously. This can be achieved by understanding the value of the IHC contribution towards ensuring consistent and effective implementation. Measuring the implementation effectiveness allows continuous incremental process improvement and fosters a continuous improvement mindset and approach; end to end LPS on projects can underpin broader construction delivery improvement extending by consistency and stability across the supply and value chain.

## CONCLUSION AND RECOMMENDATIONS

Diligent implementation of all functions of LPS allied to continuously improving the process delivers better results. This study contributes to academic and practitioner knowledge by presenting how utilising the IHC to improve implementation of all functions of LPS delivers higher and consistent PPC. Construction should strive to standardise its processes (like the IHC introduction) and adopt a 'process improvement' view and mindset. The contribution of this tool is to assist getting the implementation 'effective' from the outset. However, while the IHC will ensure the physical infrastructure is in place (a checklist to ensure compliance with 38 highlighted prompts), successful LPS implementation necessitates deeper consideration of how people think, communicate, engage, commit, and collaborate.

Further research could be utilised to refine, modify, or confirm findings by replicating the study in a larger case population as a means of improving the IHC. Quantitative research could address the measurement of different variables identified in this work.

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