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CONTINOUS IMPROVEMENT OF THE DIGITAL LAST PLANNER SYSTEM WHITEBOARD

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ABSTRACT

The first paper on this iterative action research was published in 2022, describing the digital Last Planner System (LPS) whiteboard concept and prototype development, and evaluation. The aim of this subsequent research iteration is the continuous improvement of the implementation of the proposed digital LPS whiteboard for design process planning and control. Using the action research methodology in collaboration with Estonian design firms, challenges were identified through the observation of two design projects, and solutions were proposed, implemented and evaluated within a third project. Nine problems were identified in managing design processes and in utilizing the digital LPS whiteboard. They fall into three areas: (1) individuals and motivation, (2) process and time management, and (3) the digital LPS's collaboration board. Four improvements were suggested, implemented and evaluated: (1) a standardized process for digital LPS implementation; (2) identifying causes of design task delays; (3) designer specific KanBan view; and (4) automating the preparation of meeting minutes, which provide information on project status, decisions, and visual performance metrics. The results indicate that these improvements increase the reliability of collaborative design planning and control.

KEYWORDS

Lean design management, Last Planner System, digital Last Planner System whiteboard, continuous improvement.

INTRODUCTION

Lean design management, (digital) collaboration and novel design tools have emerged as solutions to improve design project delivery and its outcomes (Bølviken et al., 2010; Koskela et al., 1997; Sacks et al., 2018). While collaboration in building design is important, the traditional methods have failed in promoting effective communication, knowledge integration, and interdisciplinary cooperation (Kleinsmann, 2006). Recent research has emphasized the importance of integrating both technical and social aspects of design management, leveraging the Last Planner System (LPS) and digital means to improve design process management and reliability (Pedó et al., 2023; Pikas et al., 2020, 2022).

The digital LPS whiteboard began to be used due to the COVID-19 pandemic (Pedó et al., 2020; Pikas et al., 2022), enabled by platforms like Miro (2025). Users have found whiteboards useful in the context of remote work due to its affinity to the traditional LPS, ease of use, ability to support meeting organization, participant engagement, and information visualization (Conte et al., 2022; Pedó et al., 2020). However, the implementation of digital LPS requires

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commitment, and training. Digital LPS whiteboard based planning and control can be time-consuming, especially considering its generic nature and the low level of automation for design process management, e.g., no integration of different levels of planning (Conte et al., 2022; Pikas et al., 2022). This study addresses these barriers through action research and systematic improvements to achieve a more reliable design process.

The study aims for continuous improvement in the implementation of the digital LPS whiteboard for design process planning and control. Specifically, this action research explored the implementation problems through two design projects to suggest actionable solutions and tested solutions on the third design project. By integrating lean principles and design management with the digital collaboration, this study seeks to provide practical recommendations for improving design process management. The structure of the paper is as follows. First, the research methodology is described. Then, the results of the action research, and main lessons learned and conclusions are presented.

RESEARCH METHODODOLOGY

This study is the second iteration of the action research aimed at the continuous improvement of the implementation of the digital LPS whiteboard (Pikas et al., 2022). Action research is suitable for developing practically useful and theoretically relevant research (McKay & Marshall, 2001), and for studying the adaptation of novel practices in new contexts (Altrichter et al., 2002). This study was organized into five phases (Susman & Evered, 1978): (1) problem diagnosing, (2) action and solution planning, (3) solution and action implementation, (4) solution evaluation, and (5) lessons learned.

Problem diagnosis involved a literature review and empirical investigation of two Estonian design projects (Tallinn Central Market, 18 weeks; Park Tondi, 15 weeks). These projects were selected, because these implemented the digital LPS system. Data were collected through weekly hybrid planning meetings, Miro task boards, maintaining a research diary, and, in one project, daily communication monitoring. Observations focused on task statuses, deadlines, planning, communication, and collaboration practices, along with performance metrics and reasons for task delays. A workshop with project managers followed to review findings and co-develop improvement proposals.

Based on the literature review, the observations of design projects, and workshop results, improvements were developed, implemented and evaluated over four weeks in the third selected design project. Participants, except project managers, were unfamiliar with the enhancements. This evaluation began with an introduction of improvements and discussions of the proposed improvements, followed by monitoring the implementation of improvements and feedback. A final evaluation workshop was held with design managers to present results, discuss improvements and opportunities for further refinement. Finally, the impact was assessed to draw conclusions.

BUILDING DESIGN PROJECTS

Three building design projects were selected (**Table 1**), utilizing a digital LPS whiteboard. The first two design projects were used to observe and identify problems, and the third was used to evaluate improvements. The Preliminary Design phase of Tallinn Central Market project was observed, involving the market building and five residential buildings. Design team included 20 participants, most new to the digital LPS whiteboard. The second project, the Design Development phase of an office building at Park Tondi, involved 15 participants, many with prior experience using the digital LPS whiteboard. The third project, the Tehvandi Sports Center, was used to evaluate improvements over a four-week period during the Schematic and Preliminary Design phases. Evaluation involved eight participants and focused on five key stakeholders due to the project's early stage.

Table 1: An overview of three cases.

Characteristics	Tallinn Central Market	Park Tondi	Tehvandi Sports Center
Design Project Purpose	Observe and identify problems	Observe and identify problems	Evaluate improvements
Image			
Building Use Type	Commercial, service, and office building; apartment buildings	Office Building	Sports Facility
Project Type	New build	Renovation	New build
Building Footprint	Above-ground10866 m2 Underground 16210 m2	954 m2	2744 m2
Net Building Area	Above-ground 34093 m2 Underground 30776 m2	1282 m2	4055 m2
Design Phase	Preliminary Design	Design Development	Schematic and Preliminary Design Phase
Observation Duration	5 Months	4,5 Months	4 Months

RESULTS OF ACTION RESEARCH

PROBLEM DIAGNOSING

On the Tallinn Central Market, the implementation of the digital LPS was new for most design team members. Several problems related to planning, communication, and meetings were observed. Due to the large scope of the project, the planning whiteboard was divided into three segments by building types: the market hall, apartment buildings, and office. However, it proved ineffective as 80% of resources were concentrated on the market hall building, and other segments were given less attention. This was also observed in meetings, where most meeting time was allocated to the market hall. The absence of scheduling across segments, where segments could have been addressed sequentially, increased problems. Project managers highlighted five critical tasks to counter these issues, marking them in red on the digital LPS whiteboard. This proved effective and ensured focus during meetings and timely execution of high priority activities.

Project team used the Fleep (2025) platform for communication, which included structured chatrooms for discipline and task-specific discussions. The project manager implemented weekly reminders to support awareness of tasks and deadlines. The meetings were well structured to allow participants to attend only the segments relevant to them. While this improved meeting efficiency, not enough attention was given to upcoming tasks and their prerequisites – an area essential to the LPS methodology (Ballard, 2000).

Several other problems emerged. Task granularity varied, with some tasks spanning 42 days, while others were disproportionately detailed. Recurring tasks, such as modelling, model reviews, and specifications were defined ambiguously, hindering clarity and progress tracking. Furthermore, the digital LPS whiteboard became overloaded with information, which made the environment slow.

The Park Tondi project benefited from design team members with prior experience in the LPS, which resulted in a disciplined application of planning and task management. However, the project faced delays, partly due to the client's overdue design briefing. Delayed briefing led to hesitancy among designers to proceed with tasks that might later require rework. Additionally, this project was complicated by an extended decision-making chain and uncooperative design team members, who postponed their involvement until others had completed their design work.

Project managers established critical milestones to address uncooperative design team members, including, for example, the completion of demolition plans, finalization of

architectural designs, and preparation of detailed construction drawings. These milestones motivated participants to adhere to the plan and facilitated progress tracking. Unfortunately, issues with model alignment and file management caused delays and necessitated rework, such as correcting architectural models due to misaligned axes.

The Park Tondi project demonstrated effective communication strategies. Email and Miro's commenting functionality were used extensively for task-specific clarifications. Weekly planning meetings, on average 45 minutes in length, focused on reviewing completed tasks and the identification of prerequisites for upcoming tasks. Two project managers were employed in the meetings: one for leading the discussions and another updating the plan in real-time. This division of work minimized meeting duration.

In Park Tondi, design team members and managers followed best practices for the LPS. Tasks were updated, and incomplete or ongoing items were rescheduled properly. The visual sticky notes, used to represent tasks on the Miro board, were well organized, featured concise descriptions, distinct colours, and consistent application of abbreviations. However, the Miro board became overloaded with information in the later project stages.

These projects revealed differences in the implementation of the digital LPS. Tallinn Central Market excelled in communication and management of design meetings, while Park Tondi demonstrated good practices in the LPS implementation. A workshop was conducted after the observation period. The project manager for the Tallinn Central Market expressed satisfaction with the overall design project process and highlighted that digital LPS helped to manage the project's complexity. Critical tasks were identified and adjusted early, which was effective. Problems included the manual nature of the Miro environment, and that it became overloaded as the project advanced. The Park Tondi benefitted from the participants' prior experience with digital LPS. Delays arose due to lengthy approval processes and the need to coordinate diverse stakeholder priorities.

Altogether, nine problems were identified, based on prior (Pikas et al., 2022) and this research. They were in three categories (**Table 2**): individuals and motivation, process and time management, and the digital LPS whiteboard. Addressing these problems potentially improves collaboration, improves innovation attitude, and facilitates better understanding of the design process. Despite problems, both design projects showed separately that when done properly, the digital LPS has great potential in supporting collaborative design workflows.

Table 1. Summary of problems by category.

Category	Problems
Individuals and Motivation	Understanding the design process
	Attitudes toward innovation and collaboration
Process and Time Management	Organizing and managing meetings
	Ensuring effective communication
	Adhering to schedules
	Choosing appropriate methods and tools
Digital LPS	Collecting, using, and interpreting statistics
	Automation and integration limitations
	Meeting visual management criteria

ACTION AND SOLUTION PLANNING

For developing and implementing improvements, researchers collaborated with project managers from the first workshop, while also considering insights from the literature review and case studies. Based on literature (Ballard & Tommelein, 2021; Pikas et al., 2022), two design projects, and workshops, four proposals for improvement were made (**Table 3**). To support adoption and implementation, the focus was on suggesting practical improvements, which project managers and design team members would find valuable. The intention was that

these would adhere to the visual management criteria (Pedó et al., 2022): simplicity, standardization, accessibility, flexibility, and traceability.

Table 3: Relation between proposals and problems.

Category	Problems	Standardized Process for Digital LPS Implementation	Identifying Causes of Design Task Delays	Designer Specific KanBan View	Automating Meeting Minutes
Individuals and Motivation	Understanding the design process	X	X	X	
	Attitudes toward innovation and collaboration	X	X	X	X
Process and Time Management	Organizing and managing meetings	X	X	X	X
	Ensuring effective communication			X	X
	Adhering to schedules	X	X	X	X
	Choosing appropriate methods and tools	X			X
Digital LPS	Collecting, using, and interpreting statistics	X	X		X
	Automation and integration limitations	X	X	X	X
	Meeting visual management criteria	X	X	X	X

The proposed improvements are explained as follows:

1. **Standardized Process for Digital LPS Implementation**: Observations highlighted the need for best practices, including compiling guidelines and recommendations to support process and time management, and to align with visual management criteria. This improvement suggested the standardization of the digital LPS implementation, combining different best practices.
2. **Identifying Causes of Design Task Delays**: This assumed that better understanding of causes for delay can support project managers to make more informed decisions. The improvement stemmed from the observation that unmet deadlines often result from insufficient design task inflows (Bølviken et al., 2010). It involved developing practices to monitor delays and identifying causes and improvement opportunities.
3. **Designer Specific KanBan View:** The discipline-specific KanBan view of tasks improvement idea was identified at the workshop. It aimed for improving the usability of the digital LPS collaboration whiteboard.
4. **Automating Meeting Minutes**: This improvement is suggested to reduce the administrative work needed for creating meeting minutes. It could be automated based on information from digital LPS whiteboard. These meeting minutes can provide real-time updates on project status, decisions, and visual performance metrics.

SOLUTION AND ACTION IMPLEMENTATION

Another workshop was held to discuss these improvement suggestions. Given that several suggestions require the creation of an entirely new project management software application, the problem was “how to properly evaluate these suggestions for improvements”. In this study, focus was on developing and implementing low fidelity prototypes to demonstrate and evaluate solutions.

Standardized Process for Digital LPS Implementation

For the standardization, a list of categorized improvements was developed together with design managers and designers, dividing best practices into five key areas, prioritized by importance (**Table 4**). The improvements should be implemented in the recommended sequence, indicated

with the position number. For example, motivation and preparation need to be implemented before best practices and guidelines.

Table 4: Proposed guideline for improving the standardized digital LPS implementation.

#	Category	Guidelines
1	Motivation and Preparation	a. Continuously motivate and instruct design team to use the digital LPS. Practice has shown that the more thoroughly the system is used, the greater its benefits. b. Set goals and deadlines. Decide on the planning cycle duration, such as one design stage. At the end of the planning cycle, conduct a comprehensive planning review meeting. c. Hold an introductory meeting for team members who are new to the digital Last Planner System, explain its principles and provide guidance on using the digital environment. The more aware participants are of the system and its benefits, the more effectively it will be used. d. Prepare a project collaboration whiteboard with a separate row for each stakeholder. Use different colored sticky notes for each participant. It is recommended to add rows for meetings and decisions made. Deadlines and milestones should be visually represented on the board.
2	Best Practices and Guidelines	a. Be precise and concise in planning and executing tasks. Use appropriate wording and level of detail. The plan should remain visual and easy to understand. For large projects, use separate whiteboards for different design project delivery stages. b. Use bold text for task descriptions and for prerequisites start with the stakeholder's abbreviation (e.g., AR, EK, VK) to indicate who needs to provide input. c. Not completed or unfinished tasks should be moved to the week when they will be executed by the project manager. This keeps the plan aligned with reality and helps make necessary adjustments. d. For re-entrant tasks (e.g., specifications, model checks), break them into smaller units and plan these as recurring tasks. Such tasks often evolve throughout the project, but this approach allows for better control.
3	Kickoff Meeting	a. Each participant must prepare for the kickoff meeting by placing their tasks and inputs in the plan. The number of tasks should be sufficient to achieve the stage goals. b. During the first phase planning meeting, tasks are adjusted collectively in the plan to ensure that all prerequisites and stage goals are met. c. At the end of the meeting, once the initial plan is set, review the planning cycle process together. Identify approximately five critical tasks essential for achieving stage goals. Mark these tasks in red and give them special attention.
4	Regular Meetings	a. The recommended meeting time is at the beginning or end of the week to allow focus on the previous and upcoming weeks. Experience shows that mid-week meetings cover a 1.5-week period, which is too long and ineffective due to the weekend break. b. Meetings should have a structured agenda. If a technical discussion follows a planning meeting, create a meeting schedule and adhere to it. Ensure that stakeholders only participate in relevant discussions. c. Meetings must be actively managed. Planning meetings should focus on planning rather than technical design discussions. d. Planning meetings should be structured per stakeholder in the following order: previous week's tasks, current week's tasks, and next week's tasks. For upcoming tasks, focus on prerequisites and the feasibility of meeting deadlines. e. For not completed or unfinished tasks, identify the reasons. This helps ensure stakeholders reflect on their work and allows systematic responses to process issues. f. Participants must prepare for each meeting by: 1. Updating the status of the previous week's tasks and explaining any not completed work. Sticky notes should not be moved by participants—this is done by the project manager to stay informed of changes. 2. Reviewing the upcoming weeks' tasks and preparing any clarifications needed during the meeting. 3. Informing the project manager of topics requiring discussion to facilitate effective meeting management. 4. Scheduling additional meetings with other stakeholders if needed. g. Meeting minutes should be compiled, summarizing key decisions, project status, and reminders for each stakeholder.
5	Lessons Learned and Continuous Improvement	a. At the end of each planning cycle, review the process with project stakeholders and identify improvements for the next cycle. b. At the end of each project, conduct a workshop to analyze the entire process and identify enhancements for future projects.

Identifying Causes of Design Task Delays

Together with project managers and the work by Hamzeh et al. (2009), the method for identifying causes of not completed tasks was developed. Based on the feedback from project managers, it was agreed that predefined options would streamline the process and facilitate meaningful analysis. Drawing from the observation of practices and literature (Pikas et al., 2022), the following categories were suggested: (a) prerequisites were not met on time; (b) prerequisites were inadequate in quality or content; (c) the time required for the task was

underestimated; (d) the responsible party did not complete the task on time; and (e) other reasons.

Designer Specific KanBan View

Regarding the stakeholder-specific Kanban view, improvement development was limited due to existing functionalities within the Miro environment. Miro currently lacks the capability to synchronize Kanban boards with project plans. To evaluate this improvement and potential automation, the researcher manually synchronized the overall Miro-based phase plan and Kanban view. The visual representation for tasks on the Kanban view was developed, also incorporating tags to simplify monitoring prerequisites. These tags indicated for different stakeholders whose input was required for tasks, matching the colours of the stakeholders' sticky notes on the collaboration board. This improvement proposal is visualized in **Figure 1**.

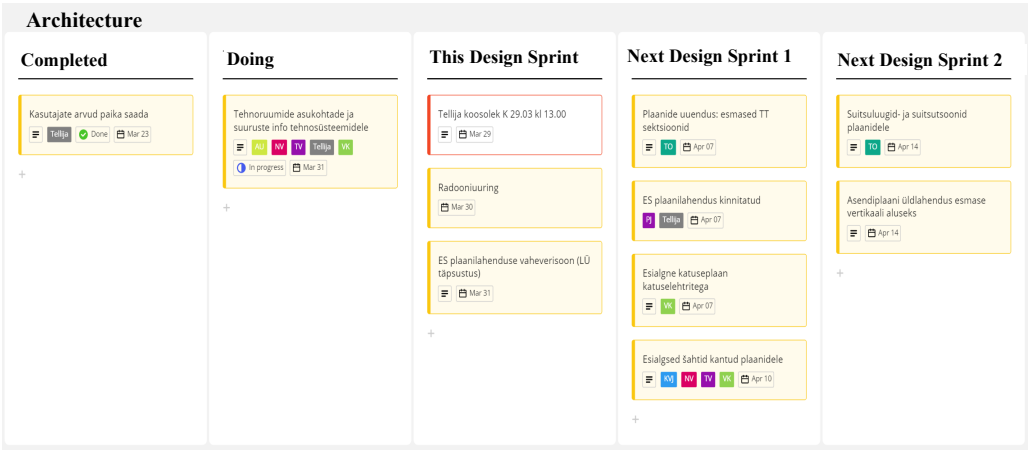

Figure 1: A stakeholder-specific Kanban view.

Automating Meeting Minutes

To support project managers in meeting documentation, an automated meeting minutes creation was piloted. An example of the automated meeting minutes form and its content is showed in **Figure 2**. The piloting was done manually but it was designed to suit future automation, utilizing data from the digital LPS whiteboard. For this purpose, a dedicated row for decisions was added to the board. This allows entries to be organized by week and records the timing of decisions. The initial prototype was developed in Excel, emphasizing visual management principles, focusing on simplicity, standardization, and clear visuals. This prototype went through several revisions based on feedback from project managers. The project statistics content was reduced, because the Tehvandi Sports Center project was in the early stages, making some metrics less relevant. Additionally, a file for comments by project managers were added for each topic to annotate generated information, such as statistics or individual stakeholder activities. The proposed meeting minutes are structured into four main sections:

1. **Current Project Status**: The project manager provides an assessment of the project's status. First section also includes statistics on the causes of not completed tasks from the previous week, accompanied by comments.
2. **Key Decisions**: Decisions made during the meeting, listed by stakeholder.
3. **Upcoming Meetings**: An overview of agreed upcoming meetings.
4. **Task Reminders by Designer**: A list of tasks assigned to each designer with current statuses.

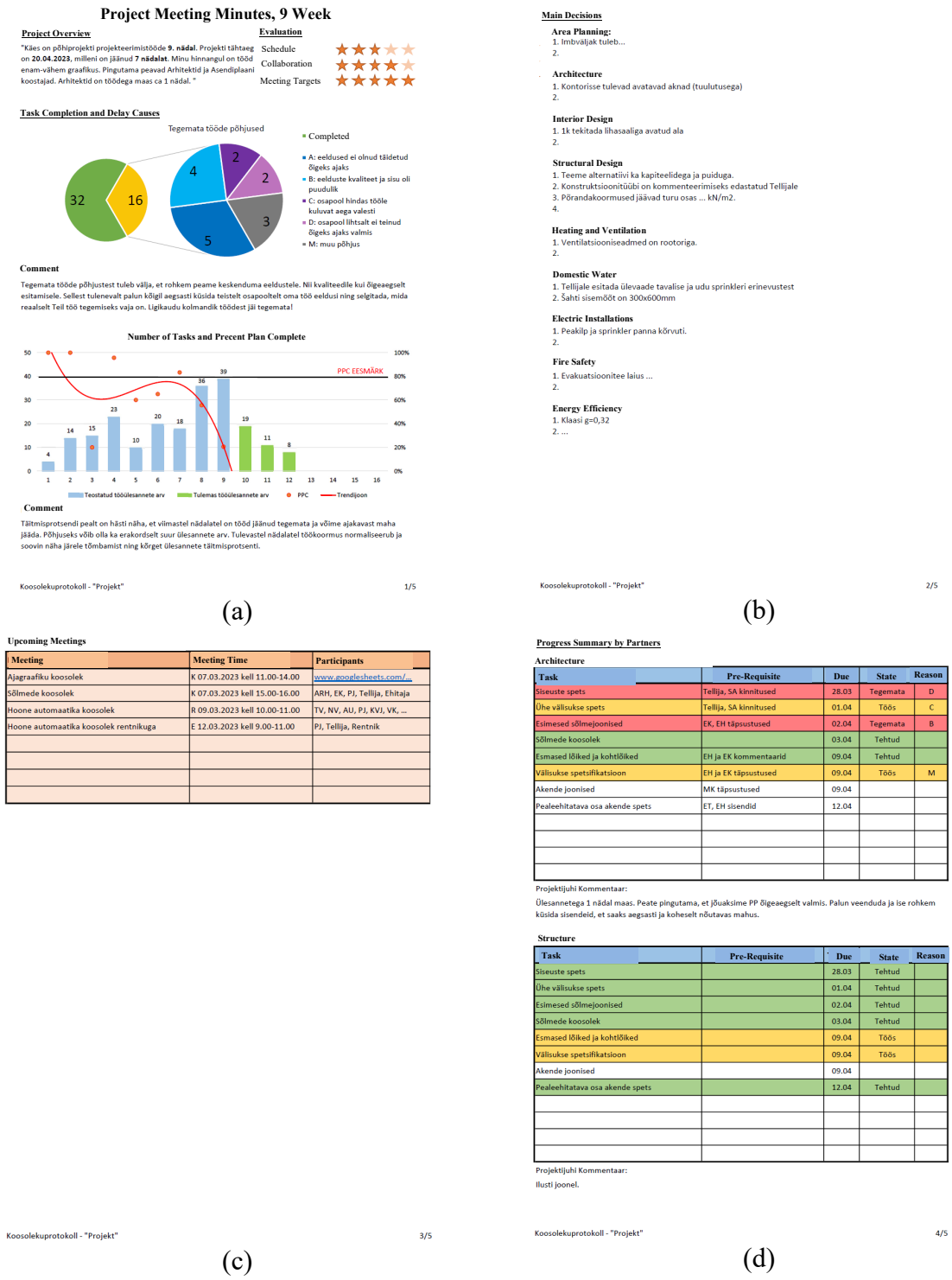

Figure 2: (a) Current project statuses; (b) key decisions made during meetings; (c) upcoming meetings; and (d) task reminders by designer.

SOLUTION EVALUATION AND LESSONS LEARNED

Improvements were evaluated over four weeks in the context of Tehvandi Sports Centre project, starting with the Schematic Design phase, and led by the Park Tondi project manager. The suggested improvements were novel to all designers as they were all new. A limitation for evaluation was the project's early stage as many design disciplines had not yet started the design work. All project members were introduced to the improvements. Evaluation involved observing designers' behaviour, utilization of improvements, and gathering feedback from the

architect, structural engineer, water supply and sewerage engineer, HVAC engineer, and electrical engineer. After four weeks, another workshop was held to present evaluation results to design managers and to discuss and refine improvement proposals. Table 5 summarizes the pluses and deltas per improvement. Important limitation in the evaluation of improvements is the limited observation period. However, despite this, some lessons learned were observed, which are useful for the following iterations.

Table 5: Summary of pluses and deltas by improvement.

Improvement	Plus	Delta
Standardized Process for Digital LPS Implementation	• Project managers better adhering to meeting structures • Improved planning practices • Design managers and designers became to value process planning activities	• Lack of prior benchmark or a longer evaluation duration made it difficult to assess design team behavior changes • While most design team members prepared for meetings, some did not
Identifying Causes of Design Task Delays	• Explicitly addressing each not completed or "in progress" task in meetings facilitated issue resolution, improving design process management • This practice helped project managers and designers have a better awareness of roles and responsibilities, increasing motivation	• Further improvements to engage all designers are needed as some designers were still not proactive • Long-term effectiveness in sustaining behavioral improvements remains uncertain
Designer Specific KanBan View	• Provided a structured overview of design specific tasks aligned with the digital LPS board's plan	• No stakeholders used the KanBan view during the evaluation period, stating that in that early stage it did not make sense to use it
Automating Meeting Minutes	• Planning meeting minutes were prepared weekly by the researcher. Its structure and content were well-received by design managers and designer, particularly the section on reasons for not completed tasks • Project managers appreciated the overview and automation, which saved time	• Two design team members never reviewed meeting minutes, two skimmed them only once, and only one reviewed these weekly • Reasons included the project's early stage, making the meeting minutes of limited additional value • The commenting feature was not use, as the project initiation was smooth

Additional observations were made. Due to limited usage of some improvement (e.g., KanBan View), design managers and designers were asked about their frequency of Miro usage and alternative task management tools. Two out of five accessed Miro as needed to view their tasks, while three recorded tasks elsewhere after planning meetings. That is, they used Miro only once a week, during planning meetings. This was due to the use of other software within their respective organizations for task management.

DISCUSSION AND CONCLUSIONS

This study identified nine problems related to process and time management, motivation, and the digital LPS implementation. Four improvements were suggested, implemented and evaluated. Three, including the standardization of the digital LPS practices, automating meeting minutes, and clarifying why tasks are delayed, proved successful. Although the designer-specific KanBan view had minimal impact, the overall aim of improving the digital LPS implementation was successfully achieved.

Findings also suggest that improvements should be implemented gradually, allowing users to adapt and contribute to the refinement of emerging best practices. Although the automated

meeting minutes saved time for project managers, it received limited enthusiasm from designers, highlighting the need for broader and longer-term evaluation. In contrast, explicitly addressing the causes for not completed or "in progress" tasks earned support and delivered benefits, such as improved motivation and focus. This area presents also further opportunities for improvement, including the potential automation of schedule adjustments based on task status updates.

When compared with the traditional project management methods, such as the Critical Path Method (CPM), the digital LPS whiteboard approach is a shift from hierarchical, contract-driven control to collaborative, adaptive planning. As highlighted by Koskela et al. (2014), historically CPM has been in practice used for contract enforcement rather than for enabling reliable process management. In contrast, the digital LPS is focused on collaboration, transparency, and continuous learning. As such, it facilitates the early identification of design task delays and fosters shared ownership of planning that is especially valuable in complex, iterative building design projects.

Future research should extend the evaluation of improvements across multiple projects and over longer time. Furthermore, as digital technologies continue to evolve, attention should be on the future trajectory of digital LPS whiteboards, including integration with Building Information Modelling (BIM), cross-platform data interoperability, and emerging capabilities such as AI-assisted planning and analytics. These could enhance both the effectiveness and efficiency of collaborative planning environments to support more adaptive and reliable design management practices.

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