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BRIDGING PROBLEM AND SOLUTION SPACES: DEVELOPING AN INNOVATION FRAMEWORK WITH LEAN AND AGILE METHODS IN CONSTRUCTION

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ABSTRACT

This research addresses the challenges of innovation and productivity in the construction industry by leveraging the Problem-Space Framework (PSF) and the Solution-Space Framework (SSF). The Problem-Space Framework (PSF) identifies and prioritizes organizational pain points, while the Solution-Space Framework (SSF) focuses on iterative solution development. These frameworks integrate Lean Construction and Agile methodologies to identify, prioritize, and address organizational pain points systematically. A previous paper Etges ten Caten (2023) had already developed the understanding of the PSF and the pain-point identification. Initially, the PSF focused on diagnosing and defining challenges through workshops, data collection, and prioritization, providing companies with a structured approach to innovation. Subsequent refinements incorporated Lean Construction maturity assessments, improved prioritization tools, and greater involvement of site teams, enhancing the PSF's effectiveness. The second phase of the study introduced the SSF, which emphasizes solution development through iterative cycles. This research aims to develop and validate an innovation framework that integrates the PSF and SSF with Lean and Agile methods to improve innovation and productivity in the construction industry. Agile methodologies structured the process, ensuring adaptability and collaboration. The phased implementation of pilots enabled incremental testing and refinement of solutions. In the third phase, the Innovation Framework was applied in Company R, incorporating lessons learned from Company M and further aligning the framework with industry needs. Tailored workshops and Lean maturity assessments enhanced its adaptability and impact. The framework results highlight the potential of integrating Lean and Agile practices to foster systematic innovation in construction, bridging the gap between identifying challenges and implementing effective solutions. The quantified results are under evaluation as it is ongoing research.

KEYWORDS

Lean construction, innovation, pain-points, agile methods, Solution-Space-Framework, Innovation Framework

INTRODUCTION

The construction industry faces increasing complexity and demands for innovation. Recognizing these issues, Etges and ten Caten (2023) introduced the Problem-Space

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Framework (PSF), which leverages Lean principles to identify and prioritize pain-points as the a starting point for the process of innovation. This framework highlights the critical need for systematic identification and management of challenges to foster meaningful advancements. However, as the complexity of construction projects increases, addressing these pain-points demands methodologies that are flexible, collaborative, and iterative.

Innovation in the construction industry encompasses multiple dimensions, such as new materials, advanced construction systems, and cutting-edge design tools (Dallasega, Rauch, & Linder, 2018b; Hampson & Sanchez, 2014; Oesterreich & Teuteberg, 2019). Despite its potential, the sector struggles with fragmented innovation efforts due to integration challenges and a lack of structured management practices (Pellicer et al., 2017). Recent studies emphasize that collaboration within stakeholders, including clients, contractors, and suppliers, is essential for fostering technology diffusion and knowledge sharing (Pellicer et al., 2017; Larsen, 2015). These insights align with Lean principles, which promote waste reduction, transparency, and continuous improvement as core drivers of organizational innovation (Ghezzi & Cavallo, 2020; Reinertsen & Shaeffer, 2005). From this perspective emerge a knowledge gap that refers to the disconnect between identifying challenges and implementing effective solutions: resulting from knowledge fragmentation, lack of integration between theory and practice, and the absence of structured methods to translate insights into applied innovation and real results.

To bridge the gap between identifying problems and implementing solutions, the Solution Space Framework incorporates Agile methodologies. Agile practices offer structured, iterative processes that enable construction teams to transform pain-points into actionable solutions while maintaining adaptability to emerging challenges. Scrum's focus on collaboration and stakeholder engagement complements Lean principles, creating a robust foundation for innovation. Empirical studies conducted in Company M, a large-scale residential developer, and Company R a medium-sized residential company, demonstrate the effectiveness of this integrated approach in improving productivity, cost management, and stakeholder alignment (Sutherland & Schwaber, 2017; Moe et al., 2010).

This integration of Lean and Agile methodologies represents a significant advancement in addressing operational challenges in the construction sector. Recent literature highlights the potential of frameworks like Lean Construction 4.0, which combines Lean principles with Industry 4.0 technologies to enhance performance and innovation (Hamzeh et al., 2021; González et al., 2023). This paper aims to advance the integration of Lean and Agile methodologies within the Innovation Framework, focusing on bridging the Problem-Space and Solution-Space phases and bringing real solution through effective implementation. By addressing key pain points and fostering iterative improvements, the framework seeks to enhance innovation processes in construction.

LITERATURE REVIEW

The Lean philosophy has proven effective in streamlining processes, integrating technological advancements, and enhancing organizational adaptability. Kolberg and Zühlke (2015) and Tortorella et al. (2019) demonstrate how Lean principles, such as value stream mapping and Kaizen, have been adapted to address challenges in construction and R&D settings. Furthermore, the integration of Lean principles with Industry 4.0 technologies has shown promise in fostering interdisciplinary collaboration and enhancing operational performance (Tortorella & Fettermann, 2018; Gutierrez et al., 2022). By coupling Lean methodologies with innovative tools, the construction sector can better manage complexity and drive systemic improvements.

In recent years, the adoption of Agile methodologies in construction has gained traction as a complementary approach to Lean. Agile practices, particularly Scrum, excel in breaking down complex problems into manageable components and fostering incremental improvements

(Serrador & Pinto, 2015). Moe et al. (2010) highlight how Agile frameworks create environments conducive to iterative testing and continuous learning, ensuring alignment with project objectives. Sutherland and Schwaber (2017) emphasize the role of Scrum in promoting collaboration and adaptability through structured processes like sprints and retrospectives.

Notably, the integration of Agile methodologies with Lean Construction, as explored by Hamerski et al. (2019), provides a practical framework for addressing the multifaceted challenges of construction projects. Hamerski et al. (2019) proposed a hierarchical planning and control model combining elements of the Last Planner System (LPS) and Scrum, addressing multi-project environments with shared resources and dependencies. Their model emphasizes long-term planning (master plans), medium-term planning (stage gates), and short-term planning (commitment levels), offering flexibility and structure to manage complexity. Moreover, performance indicators such as Percent Plan Complete (PPC) serve as valuable tools for monitoring progress and ensuring continuous improvement within Agile and Lean-integrated frameworks.

The use of Agile methods in IGLC Community has been recognized as an effective approach to managing complexity, uncertainty, and the need for adaptability in projects. Owen et al. (2006) highlight that Agile Project Management offers flexibility and collaboration, enabling construction teams to respond quickly to changing project conditions. They also highlighted that agile methods revolves around the embracing of change as an opportunity for improved, early and sustained value delivery Owen et al. (2006). The ability to incorporate continuous feedback and promote stakeholder interaction aligns with the demands of a traditionally fragmented and complex sector. Complementing this perspective, Chen et al. (2007) emphasize the role of Interface Management as a facilitator for integrating Lean and Agile practices, suggesting that effective interface management can minimize conflicts and enhance workflow efficiency. Hamerski et al. (2019) explored combining Scrum with the LPS to optimize planning, control, and project delivery, demonstrating clear benefits in coordination and task prioritization. Lima et al. (2024) propose the Agile Ramp-Up method, which integrates Lean tools, such as the LPS, with Agile principles to reduce risks associated with premature construction starts. Those papers reinforces the importance of robust preparation and structured iterations to improve performance and predictability in construction projects.

Lean and Agile play distinct roles in addressing challenges in the construction industry. Studies by Chen et al. (2007), Court et al. (2006), and Hamerski et al. (2023) demonstrate that LPS and Interface Management improve communication and minimize waste, enhancing project resilience. Similarly, Naim et al. (1999) highlight Lean's role in optimizing supply chains by reducing waste and improving coordination before inefficiencies impact construction processes. On the other hand, Agile is more effective in solution development, enabling continuous adaptation to evolving project conditions. Owen et al. (2006) emphasize its flexibility and iterative feedback loops, contrasting with Lean's structured planning approach. Studies on the integration of Lean and Agile, such as the "leagility" concept presented by Court et al. (2006) and Naim et al. (1999), suggest that Lean enhances problem understanding and structured planning, while Agile fosters incremental and adaptable solution implementation. Thus, combining Lean and Agile offers a comprehensive approach, integrating thorough problem analysis, Lean, with dynamic, iterative solution development, Agile. However, considering the knowledge gap, no research connects both methodologies, agile and lean, for the development of innovative projects or solutions.

By aligning Agile practices with Lean principles in the Problem-Space Framework, this paper outlines a cohesive approach to systematically address challenges and foster sustainable innovation in the construction industry.

RESEARCH METHOD

The current paper is part of a broader research activity for a doctoral thesis by the first author. The stage described in this article covers the validation of the first construct within a broader methodological approach of Design Science Research (DSR). The aim of DSR is to create outputs that serve human purposes (March; Smith, 1995), and the critical point is to design a system that will address new challenges (Kasanen et al., 1993) and create new perspectives for the current time (Lukka, 2003). DSR seeks to devise solution concepts, and, at provide a theoretical contribution to the field of knowledge (Kasanen et al., 1993). The Figure 1 brings the complete Research Design undergoing on the doctoral thesis. The previous paper (Etges, ten Caten; 2023) described the first phase illustrated on Figure 1, presenting a framework for the Problem-Space analysis on Innovation Process for Construction Industry.

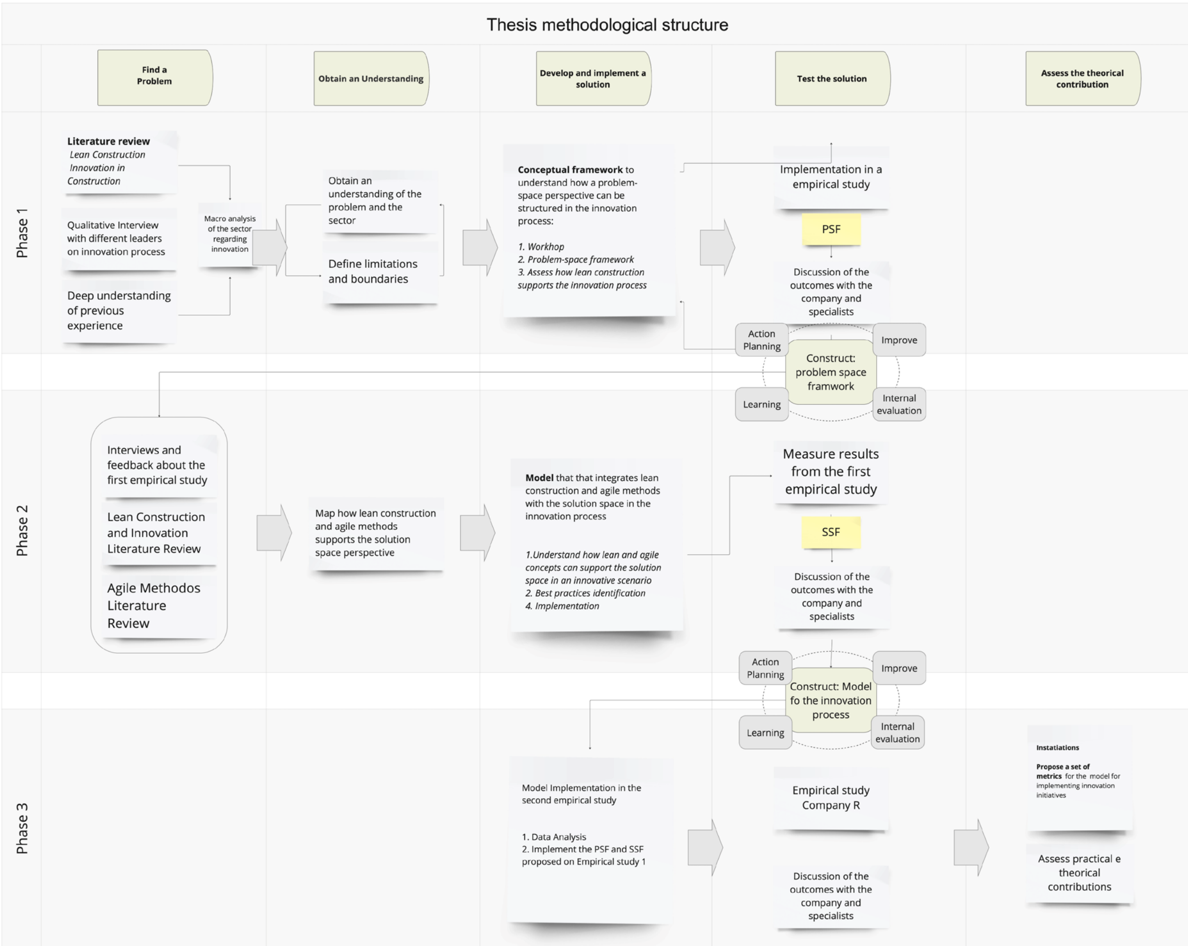

Figure 1 Research Design

As illustrated in the research design, the investigation was divided into three phases, with three different empirical studies. As this is an ongoing study, the Phase 1 was presented on Etges ten Caten (2023) and brings an understanding of the current situation from literature review, a qualitative study with specialists in innovation in the construction industry. Empirical studies were conduced in two real state developer and construction companies: Company M and Company R. Companies were chosen regarding the following criteria: (a) previous knowledge and application of lean construction; (b) multiple sites under construction; (c) approach to innovate means that the Company are interested and investing resources on understand and implement innovative concepts on their process; and (d) main product focused on the construction of housing projects. A Empirical study was conduced with on Company M to (a) carry out a workshop to understand the main pain points influencing the creation of innovative solutions in the following years, (b) develop and implement the PSF and (c) assess the perception and feedback from the participants. The more detailed phases and outcome of this study was presented by Etges and ten Caten (2023) and is shown on Figure 2. The Problem Space Framework as presented by Etges and ten Caten (2023) structured the innovation process into two distinct spaces: the Problem Space, focused on discovering and defining challenges, and the Solution Space, aimed at developing and delivering solutions. The Problem Space followed the principles of the Double Diamond Diagram (Design Council, 2016), with phases for data collection, workshops to validate pain-points, prioritization of issues, and the formation of project groups.

Phase 2 and part of the Phase 3 of the DSR are subject of the current study. The second phase of the study began following a descriptive analysis of the results generated by the PSF, which served as an artifact in the current thesis. This phase involved an improvement cycle developed in collaboration with the pilot study innovation team, focusing on four key activities: (a) internal evaluation of the framework outcomes, (b) learning sessions to analyze workshop and framework outputs, (c) defining an action plan, and (d) constructing an improvement roadmap. Those steps were conduced within the pilot study innovation team in four brainstorming and feedback meetings (60 to 120 minutes) and a full day validation workshop with IT team and the Company board members. PSF provided a structured sequence of stages that enabled real estate construction companies to identify and address critical pain points in their innovation processes. To ensure the effective implementation of the second round of PSF workshops, additional refinements were incorporated based on a deeper understanding of the challenges and metrics identified through a literature review. The pilot study team suggested that Lean Construction principles and Agile methods could play a significant role in supporting the development of the innovation process, particularly within the Solution Space. Consequently, the second phase integrated Lean Construction and Agile Methods to structure a comprehensive model encompassing both the Problem Space and the Solution Space.

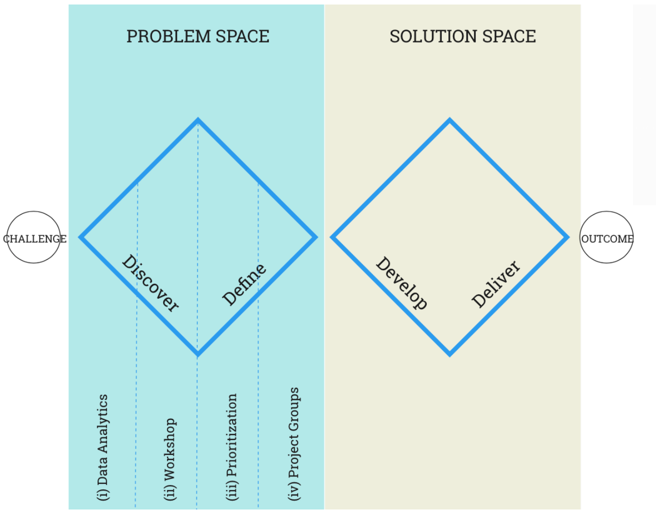

Figure 2: Double Diamond Framework adapted to the current research - Problem-space-framework (PSF)

The empirical study conducted at Company M represented a important step in advancing the Solution Space. This phase involved a structured process comprising four brainstorming and prioritization sessions, which were instrumental in shaping the methodological approach for its development. Based on these sessions, working groups were formed and incorporated into the proposed framework to tackle the identified pain points collaboratively. At the end of the phase, the following actions were implemented: (i) conducting learning sessions using the proposed model, (ii) defining a new action plan, and (iii) identifying improvement gaps to refine the model further. These steps aimed to optimize the methodological approach and enhance its applicability of the PSF for the second empirical study.

The third phase focused on improving the model developed during the empirical study at Company M and subsequently applying an integrated PSF and SSF at Company R.

This application included enhancements based on lessons learned from the initial study. As part of this phase, a Lean Maturity Assessment was conducted at Company R (Reck, 2010), enabling a comprehensive evaluation of the organization's innovation initiatives and production deviations. The first stage involved diagnosing key innovation challenges and deviations in production processes. A workshop was then organized to validate the identified problems and pain points, ensuring alignment between the framework and organizational needs.

Following the validation workshop at Company R, the identified pain points were assigned to dedicated working groups for monitoring and implementing solutions using Agile methodologies. These groups operated iteratively, ensuring that solutions were continuously adapted and improved to address the company's specific challenges. By incorporating Lean Construction principles and Agile practices, the integrated model effectively bridged the Problem Space and Solution Space, providing a dynamic framework for fostering innovation and operational efficiency in construction companies. Table 1 represents the summary of Meetings, Workshop, Surveys and Agile Cycles that were implemented in each Empirical study for PSF and SSF. Until now, the effectiveness and results of each Work Group have not been measurable in Company M and Company R. In Company R The SSF, which began in January 2025, is not expected to yield results at this stage.

Table 1: Summary of the PSF and SSF implementation in both empirical studies

RESULTS

IMPROVING THE PSF

Considering the stages of the DSR methodology, an analysis of the outputs from the initial implementation of the PSF was conducted. To achieve this, a structured brainstorming session and a detailed evaluation of the work were organized with a dedicated task force. The group comprised two Production Directors, the Innovation Director, the Innovation Coordinator, and two site engineers. The analysis focused on the following dimensions: (a) preparation, (b) workshop phases, (c) quality of prioritized pain points, (d) strengths, and (e) areas for improvement. The results of the analysis highlighted the following points:

- (a) Preparation Quality: Relevant data for understanding the company's current situation were analyzed and structured effectively. However, it was suggested to reduce the number of meetings, particularly those involving the IT team, and to expand data collection by including a larger number of site engineering teams.

- (b) Workshop Phases: While the workshop phases were well-structured, the second round of prioritization yielded less effective results. Improvements were suggested for the effort-impact analysis to enhance its effectiveness.
- (c) Quality of Prioritized Pain Points: The quality of the identified and grouped pain points was significantly strengthened. This aspect emerged as one of the key strengths and benefits of the PSF, as it allowed the organization to focus its project initiatives, which had previously been highly dispersed. By providing a comprehensive understanding of pain points and aligning them with multi-collaborative workshop phases, PSF introduces an innovative approach to driving the innovation process in the construction industry.
- (d) Areas for Improvement: Suggestions included gaining a deeper understanding of the level of Lean implementation on construction sites and leveraging medium- and short-term indicators to identify the most significant production challenges. Additionally, involving a larger number of site engineers in the workshop was recommended to enrich the analysis and solutions.

Based on these findings, four key improvements were proposed for the PSF: (a) conduct a pre-analysis of the level of Lean implementation on construction sites; (b) direct the preparation phases toward involving site teams, ensuring their participation in the workshop; (c) reduce the involvement of IT teams in the pain-point identification phase; and (d) enhance the prioritization matrix used during the first round of workshop prioritization.

DEVELOPING THE SOLUTION-SPACE-FRAMEWORK

As the study advanced into the Solution Development phase, the group that participated in the PSF analysis suggested revisiting methodologies previously implemented at Company M. They emphasized the company's successful track record with Agile methodologies, particularly in developing internal applications and enhancing software systems. This prior experience demonstrated the effectiveness of Agile practices within the organization and their potential to be adapted to drive innovation and improve processes in the Solution Space.

Given the significance of the identified pain points and the urgency for Company M to address these needs, the working groups were organized into a cross-functional structure under a focused governance model called the Production Journey. These groups, referred to as Squads, were each led by a dedicated Project Owner (PO) responsible for the Squad's activities. Following Agile methodology, the solution development process was structured into iterative cycles across three horizons: (a) defining target goals and deliverables in monthly cycles, (b) tracking progress through weekly meetings, and (c) monitoring action plans and tasks via daily stand-ups (Dailys). Figure 3 presents the PSF and SSF. The governance of the Production Journey involved, in each squad, representatives from the production team, IT, and Strategic Planning, in addition to the areas related to each identified pain-point.

Following the definition phase for implementing the proposed changes, phased pilot schedules were established to guide the rollout of the solutions. Given the scale of Company M, with approximately 200 active construction sites, the pilots were strategically deployed in a staggered manner across major geographic macro-regions. This phased approach ensured that the solution could be tested, evaluated, and refined incrementally, aligning with the Agile methodology's iterative principles. This strategy reinforced the adaptability and scalability of the SSF.

The detailed development of solutions for the prioritized pain points was conducted within the Agile framework presented by the SSF over a period of 10 to 12 months. To manage the cycles and ensure the timely delivery of each iteration, a specific project management software tailored for squad-based operations was utilized. During this period, a critical need emerged:

the definition of control indicators to monitor the benefits and value that the proposed improvements and innovations would bring to Company M.

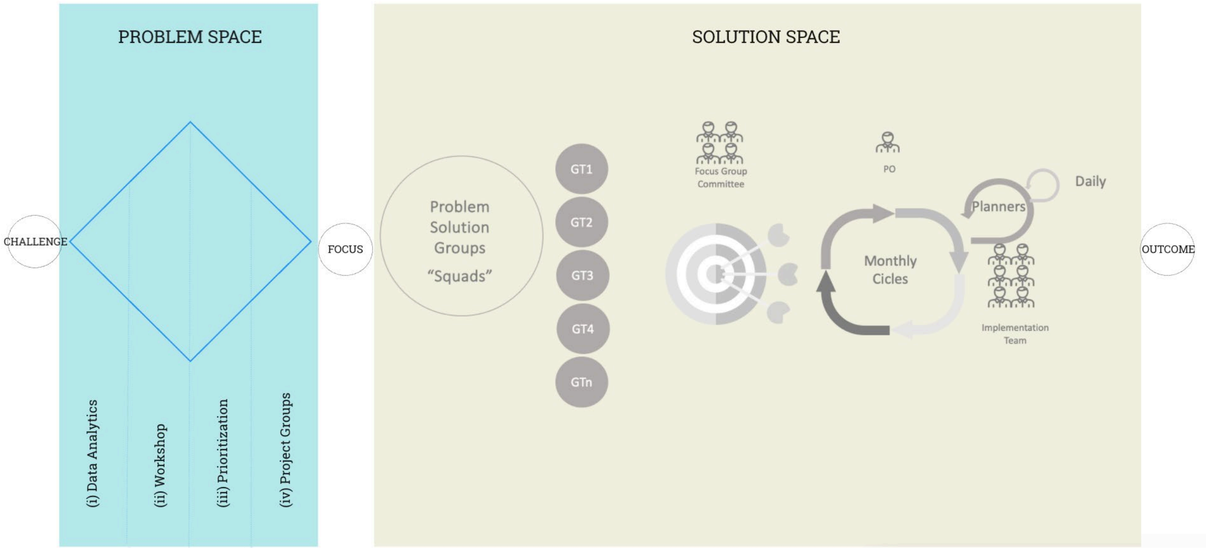

Figure 3: Problem-Space-Framework and Solution-Space-Framework

Currently, the seven squads are in the pilot implementation phase, each focused on addressing a specific area of improvement: (a) Corporate Planning, (b) Project Enhancements, (c) Data Management and Analysis, (d) Cost Accuracy, (e) Efficient Planning, (f) Construction Site Logistics, and (g) Productivity Improvement and Worker Satisfaction. All of then are running into pilot study and measure the accuracy towards the target goals defined. This structured and collaborative approach ensures that the implemented solutions are aligned with the company's strategic goals and fosters a culture of continuous improvement and innovation across its operations

APPLYING THE INNOVATION FRAMEWORK IN THE SECOND EMPIRICAL STUDY

Entering the third phase of the present research, the objective is to apply the identified improvements to the Innovation Framework in a second empirical study. This phase is still ongoing, and therefore, the final discussion regarding the model's applicability and utility has not yet been concluded.

For the new application of the Innovation Framework, references from the literature were sought regarding maturity assessment models for Lean Construction at construction sites. To address this need, the Innovation Framework was enhanced with the assessment system developed by Reck (2010) focused on the Last Planner System maturity level. Figure 4 illustrates the Innovation Framework applied in the second empirical study, highlighting the integration of these improvements and their alignment with the broader innovation objectives of the construction sector.

Company R is a construction and real estate development firm. It manages approximately 20 projects under execution, divided into housing and mid-range product lines. Similar to Company M, Company R also possesses knowledge of and applies Lean Construction principles in its projects. For this empirical study, the full implementation of the Innovation Framework was proposed, encompassing: (a) Lean Maturity Assessment; (b) Problem Space Framework; and (c) Solution Space Framework.

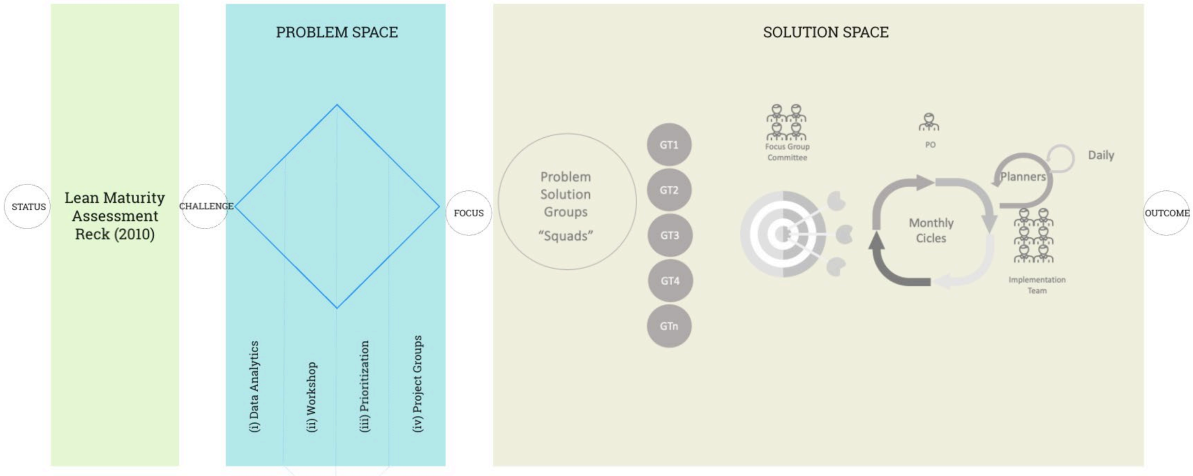

Figure 4: Innovation Framework

All improvements identified in Empirical Study 1 regarding the PSF were applied: (a) optimization of the number of preparation meetings; (b) increased involvement of the production team in the preparation stages and the workshop; (c) enhancement of the proposed prioritization tools; and (d) incorporation of Lean understanding and alignment with Kaizen routines already practiced on-site. For the latter, mapping medium-term constraints and formalizing and analyzing short-term issues became a key source of potential production pain points.

The workshop identified 40 pain points, of which 11 underwent at least one cycle of prioritization rounds. However, through groupings and discussions with the executive board, four pain points were selected, each linked to a corresponding working group: (a) lack of standardization in real estate products and project designs; (b) challenges in controlling the procurement and application of materials; (c) shortage of qualified labor and high turnover in the construction sector; and (d) subcontractors providing low-quality labor.

Project Owners have already been assigned, and the follow-up model has been established based on the Agile approach of the PSS) Initial rounds began in January 2025. An interesting aspect of Empirical Study 2 is that the governance of the Working Groups is managed by two corporate areas: Digital Transformation and Quality & Excellence.

DISCUSSION AND CONCLUSIONS

The findings of this study demonstrate the significant impact of integrating Lean Construction and Agile methodologies within the Innovation Framework. The framework addresses frequent challenges in the construction industry in recognizing and bringing results through innovation. These findings also address a critical gap in current construction management literature by providing a structured approach to integrating Lean and Agile methodologies towards innovation. By refining the PSF and introducing the SSF, the research highlights the importance of systematic processes for identifying, prioritizing, and solving pain points (Etges and ten Caten, 2023). The application in two empirical studies, Companies M and Company R, confirmed the frameworks' adaptability and efficacy in enhancing production efficiency, team engagement, and the alignment of solutions with strategic objectives. The iterative cycles within the SSF ensured continuous improvement, fostering a culture of innovation and collaboration (Serrador and Pinto, 2015; Sutherland and Schwaber, 2017).

A key observation is the importance of governance structures within the SSF, particularly the formation of cross-functional squads involving production, IT, and strategic planning teams. This governance model enhances interdisciplinary collaboration and ensures that innovation efforts remain practically viable and site-specific. However, leadership roles within the SSF were focused on members from production or engineering, ensuring that solutions were grounded in practical, site-specific challenges and priorities. This balance between technical support and production-led leadership highlights the framework's alignment with Lean principles of decentralizing decision-making to those closest to the process (Hamzeh et al., 2021; Tortorella and Fettermann, 2018). Additionally, the cross-functional squads fostered a collaborative environment, bridging expertise from diverse areas to address complex challenges (Moe et al., 2010). Unlike traditional rigid planning cycles, the structured Scrum-based approach fosters a dynamic response to emerging challenges while maintaining a clear strategic direction.

Considering that results and effectiveness have not yet been fully measured, a key conclusion of the method development and implementation is that the understanding of pain points has been maintained, while solution development continues to progress across the seven Work Groups in Company M and the seven Work Groups in Company R. This reinforces the agile principle of involving people to enhance development and enable early value delivery (Owen et al., 2006).

Future research should explore the scalability and adaptability of the Innovation Framework in different organizational contexts. Future steps aim to validate the results from the work groups considering an analysis of the new status of performace. Company M, due the number of construction sites, will probably be evaluated by an ANOVA analysis. Additionally, the integration of Industry 4.0 technologies could further enhance the agility and precision of the SSF (Hamzeh et al., 2021; Oesterreich and Teuteberg, 2019). Investigating the long-term impact of Lean and Agile integration on organizational culture and performance will provide valuable insights into sustaining innovation in the construction industry as a organizational value. Additionally, exploring the long-term cultural and organizational impact of integrating Lean and Agile will provide valuable insights into sustaining innovation as a core capability within construction firms. By addressing these aspects, the framework can be further refined and positioned as a scalable and robust solution for fostering systematic and sustainable innovation in the construction industry.

LIMITATIONS

Due the current stage of the ongoing PhD thesis, the effectiveness and results of each Work Group of the empirical studies could not be measured. This results and statistical analysis will be described in future steps of the research.

REFERENCES

Chen, Y., Reichard, G., & Beliveau, Y. (2007). Interface Management—A Facilitator of Lean Construction and Agile Project Management. Proc. 15th Annual Conf. of the International Group for Lean Construction (IGLC-15).

Court, P., Pasquire, C., Gibb, A., & Bower, D. (2006). Design of a lean and agile construction system for a large and complex mechanical and electrical project. Proceedings of the 14th Annual Conference of the International Group for Lean Construction (IGLC-14), Santiago, Chile.

Dallasega, P., Rauch, E., & Linder, C. (2018). Industry 4.0 as an enabler of proximity for construction supply chains: A systematic literature review. Computers in Industry, 99, 205-225. https://doi.org/10.1016/j.compind.2018.03.039

Design Council (England). A study of the design process. Available at: <http://www.designcouncil.org.uk/sites/default/files/asset/document/ElevenLessons_Design_Council (2).>. Accessed on: 07 set. 2016.

Etges, V., & ten Caten, C. S. (2023). Structuring the Innovation Process in Construction: Problem-Space Framework. Proc. 31st Annual Conf. of the International Group for Lean Construction (IGLC31). https://doi.org/10.24928/2023/0100

Ghezzi, A., & Cavallo, A. (2020). Agile Business Model Innovation in Digital Entrepreneurship: Lean Startup Approaches. Journal of Business Research, 110, 519-537. 10.1016/j.jbusres.2018.06.013

González, V. A., Alarcón, L. F., & Mundaca, F. (2023). Lean Construction 4.0: Transforming the AEC Industry Through Digitalization and Lean Principles. Proc. 30th Annual Conf. of the International Group for Lean Construction (IGLC30).

Gutierrez, L. et al. (2022). Beyond efficiency: the role of lean practices and cultures in developing dynamic capabilities microfoundations. International Journal of Operations and Production Management, v. 42, n. 13, p. 506–536. https://doi.org/10.1108/IJOPM-02-2022-0086

Hamerski, F., Müller, D., & Schuch, L. (). Combining Scrum and Last Planner System in Multi-Project Environments. Proc. 27th Annual Conf. of the International Group for Lean Construction (IGLC27).

Hamerski, D. C., Saurin, T. A., Formoso, C. T., & Isatto, E. L. (2023). The contributions of the Last Planner System to resilient performance in construction projects. Construction Management and Economics. https://doi.org/10.1080/01446193.2023.2262622

Hamzeh, F., González, V. A., Alarcon, L. F., and Khalife, S. (2021). “Lean Construction 4.0: Exploring the Challenges of Development in the AEC Industry.” Proc. 29th Annual Conference of the International Group for Lean Construction (IGLC29)

Kasanen, E.; Lukka, K.; Siitonen, A. (1993). The Constructive Approach in Management Accounting Research. Journal of Management Accounting Research, v. 5, p. 243–264

Kolberg, D., & Zühlke, D. (2015). Lean automation enabled by Industry 4.0 technologies: A case study on cyber-physical production systems. International Journal of Advanced Manufacturing Technology, 79, 917-925. https://doi.org/10.1007/s00170-014-6034-7

Larsen, G. D. (2015). Innovation Diffusion Across Firms. Construction Innovation, First Edition. Edited by Finn Orstavik, Andrew Dainty and Carl Abbott, pp. 103- 116. https://doi.org/10.1002/9781118655689.ch8

Lima, C. M. , Fireman, M. C. T. , Nascimento, L. H. , Etges, B. M. B. S. , Antonini, B. G. , Bluhm, B. B. , Silva, D. P. & Rocha, F. C. O. (2024). Agile Ramp-Up: A Method to Reduce Premature Construction Start, Proceedings of the 32nd Annual Conference of the International Group for Lean Construction (IGLC 32) , 478-489. doi.org/10.24928/2024/0212

Lukka, K. (2003). The Constructive Research Approach. Em: OJALA, L.; HILMOLA, O.-P. (Ed.). Case study research in logistics. Publications of the Turku School of Eco-nomics and Business Administration: Publications of the Turku School of Economics and Business Administration

March, S. T.; Smith, G. F. (1995). Design and natural science research on information technology. Decision Support Systems, v. 15, n. 4, p. 251–266.

Moe, N. B., Dingsøyr, T., & Dybå, T. (2010). A Teamwork Model for Understanding an Agile Team: A Case Study of a Scrum Project. Information and Software Technology, 52(5), 480-491. https://doi.org/10.1016/j.infsof.2009.11.004

Naim, M., Naylor, J., & Barlow, J. (1999). Developing lean and agile supply chains in the UK housebuilding industry. Proceedings of the 7th Annual Conference of the International Group for Lean Construction (IGLC-7), Berkeley, CA, USA.

Oesterreich, T. D., & Teuteberg, F. (2019). Understanding the implications of digitization and automation in the context of Industry 4.0 for construction supply chains. Computers in Industry, 83, 121-139. https://doi.org/10.1016/j.compind.2016.09.002

Owen, R. , Koskela, L. , Henrich, G. & Codinhoto, R. (2006). Is Agile Project Management Applicable to Construction?, 14th Annual Conference of the International Group for Lean Construction , 51-66.

Pellicer, E., Yepes, V., Correa, C. L., Alarcón, L. F., (2017). The Dilemma of Innovation in the Construction Company: A Decade of Lessons Learned, Project Management and Engineering Research, Springer International Publishing AG DOI 10.1007/978-3-319-51859-6_2

Reck, R. (2010). Assessing Lean Maturity in Construction: A Guide to the Last Planner System. Lean Construction Journal, 7(2), 15-24.

Reinertsen, D. G., & Shaeffer, R. (2005). Lean Product Development: How to Minimize Waste and Maximize Innovation. Harvard Business Review Press.

Serrador, P., & Pinto, J. K. (2015). Does Agile Work? A Quantitative Analysis of Agile Project Success. International Journal of Project Management, 33(5), 1040-1051. https://doi.org/10.1016/j.ijproman.2015.01.006

Sutherland, J., & Schwaber, K. (2017). The Scrum Guide. Scrum Alliance. https://www.scrumguides.org/

Tortorella, G. L., & Fettermann, D. C. (2018). Implementation of Lean Manufacturing and Industry 4.0: A Multiple Case Study. Journal of Manufacturing Systems, 45, 135-148. https://doi.org/10.1016/j.jmsy.2017.12.001

Tortorella, G. L.; Giglio, R.; Van Dun, D. H. (2019). Industry 4.0 adoption as a moderator of the impact of lean production practices on operational performance improvement. International Journal of Operations and Production Management, v. 39, p. 860–886. https://doi.org/10.1108/IJOPM-01-2019-0005