

KHS&S – A CASE STUDY OF LEAN TRAINING FOR TRADE CONTRACTORS

Robert Leicht¹, Blake Tormey², Rob Walter³, and Elnaz Asadian⁴

ABSTRACT

The trade contractor community in the US lags the general contractor community in adopting lean methods. Using a case study, this paper explores trade contractor adoption of lean methods and culture, emphasizing supporting the adoption of lean by field crews. In addition to highlighting the potential value, a case study presenting the training program adopted by KHS&S, a framing and drywall contractor, will demonstrate one example of how the methods can be introduced and supported to support broader field implementation and enhanced construction value for projects. Results highlight the certification process combining classroom learning, observations of the learned methods, and requirements for creating and sharing an improvement that engrains individual learning and supports the lean culture across the company.

KEYWORDS

Craft workers, field personnel, and training

INTRODUCTION

The construction industry still struggles to use the full benefits of lean construction, with past researchers noting the need for increased awareness and better strategies for implementation (Aslam et al., 2020). Despite extensive research into lean construction, previous work has limited its scope to tier 1 or prime contractor adoption. It mostly avoids how lean is supported or adopted by the tier 2 contractors representing the specialty trades (Azevedo et al., 2010). Similarly, the limitation to the general contractor level of adoption leaves a significant gap in potential implications regarding why lean implementation into projects has fallen short thus far. Consequently, the greater study of specialty or trade contractor adoption should be pursued to fill this gap and understand the critical interface of this tier of firms in project organizations linked to production when considering lean adoption. With an itinerant workforce, one of the key considerations for implementing lean is developing and sustaining the understanding of lean across projects. The emphasis becomes the need to train and support field crews in their pursuit. To explore the unique challenges and needs, this research presents some highlights regarding benefits and challenges from interviews about lean adoption by contractors, coupled with studying one leading trade contractor's approach to training field personnel in lean methods.

BACKGROUND

Construction firms face cultural and organizational barriers when implementing lean practices in their operations. Several scholars have studied these barriers and enumerated various factors

1 Professor, Architectural Engineering Department, The Pennsylvania State University USA, rml167@psu.edu, <https://orcid.org/0000-0001-6705-8141>

2 Director, Process and Controls, KHS&S Contractors, Anaheim, CA, USA, blake.tormey@khsswest.com

3 Chief Operating Officer, KHS&S Contractors, Anaheim, CA, USA, rob.walter@khsswest.com

4 DPR Construction, Newport Beach, CA, USA, el.asadian@dpr.com, <https://orcid.org/0000-0002-3146-7725>

affecting lean thinking across the construction industry (Christensen et al., 2020; Maturana et al., 2007; Senior & Rodríguez, 2012). Most research regarding contractor adoption of lean focuses on the construction manager or general contractor, with little consideration for trade contractors. However, trades play a central role in production in several aspects of the construction industry. Thus, their adoption of lean methods and principles offers an incredible opportunity to address waste within the construction industry.

BARRIERS TO LEAN IMPLEMENTATION

In their study of barriers to lean adoption, specific to the UK, ten possible barriers using a survey process were identified (Sarhan and Fox, 2013). Among the leading barriers identified were the scale of subcontracting and corresponding fragmentation, the process for assembling teams (procurement) and the reimbursement terms of their contracts, limited understanding of lean, attitudinal issues, schedule pressure, lack of financial resources, lack of support by management, design and construction division of responsibilities, lack of training and educational, and limitations in the adoption of project management systems. Participants strongly agreed that the most common of these was the limited understanding of lean principles, the limited support from management, and cultural challenges inside firms.

Similarly, Shang and Peng (2014), in their survey of construction industry professionals, sought to understand the limitations of adopting lean practices across China. Participants in the questionnaire rated their agreement across a list of barriers using a 5-point Likert scale. Of the 22 listed barriers, the top three were the "lack of long-term philosophy," "absence of a lean culture in the organizations," and "use of multi-layer subcontracting."

With specific emphasis on using the Last Planner System® (LPS), Brady et al. (2011) sought to develop the primary challenges and success factors of lean projects in the manufacturing sector. The main findings from their research were primarily related to challenges engaging the field workforce, including lack of transparency, poor communication, limited engagement of the field craft workers, limited or no training in LPS, poor definition of roles, limited use of the available information, little to no time spent on implementing identified improvements, and an overall lack of process integration across the participants. The most notable barriers were the lack of teamwork in the LPS implementation, the late engagement of the trades through the subcontracting arrangement, and the limited adoption of lean philosophy. In addition, among all barriers, seven barriers are notably important for trade partners:

- Teamwork,
- Technical capabilities,
- Poor communication,
- Lack of engagement with craft,
- Poor production process integration,
- Poor material quality,
- Workforce turnover, and,
- Lack of jobsite cleanup.

Beyond the studies of lean adoption and the barriers to implementing lean in construction, Christensen et al. (2019) considered the motivation for adopting lean as a factor in successful implementation. While studying the motives among team members on construction projects, they used a questionnaire that considered both the lean methods and the motives of the team members. The findings suggest that the team members focused on quality and process aligned with cost, schedule, and quality motives that were encouraging in support of greater adoption of lean into the project.

CONTRACTOR ADOPTION OF LEAN

Little of the work on lean adoption by contractors has delved into subcontracted work and the implementation by specialty trades. Little published work considers trade contractor use of lean (Asadian et al., 2024; Hamza Khan et al., 2024), and few, if any, have investigated how the trade community and field workforce should be incorporated into the plan, education, or incentives for supporting lean in projects.

Practical training and solid learning regarding the techniques and methods for using Lean are crucial factors for successfully implementing Lean into construction (Shang et al., 2014). An understanding of lean processes among all employees is needed to enable firms to adopt them successfully. To achieve that level of understanding, employees need both conceptual education and method-oriented training to sustain the implementation in an organization (Torp et al., 2018). Training services, using outside facilitators, offering in-house courses, and many other options exist to allow firms to develop or find the best training content and methods to meet their unique needs for learning about lean (Aslam et al., 2020). Training in lean needs to balance technical methods and processes with the principles and concepts that underpin lean (Watfa and Sawalha, 2021), regardless of the methods developed or identified.

In addition to the broad research on lean adoption, there have been some efforts to consider training related to the trade contractor community and field workforce engagement, though in limited areas. In the study of DPR's lean leadership training, Hackler et al. (2019) capture example stories from four diverging business areas within DPR as an organization in their efforts to disseminate lean methods and culture to company leadership. In a more targeted assessment of trade contractor engagement in planning, McConaughy and Shirkey (2013) consider effective Last Planner System implementation, with trade participation emerging as a critical element for successful planning and plan reliability. However, they do not directly delve into the trade field leaders' training methods. In a targeted study of the efforts by a general contractor to further engage lean in their self-perform operations, Tillman et al. (2014) studied two approaches to project training and lean implementation. While their insights and the value of field leader engagement are clear, the broader field training needs and organizational scaling of their insights stop at the project scope.

A comparative analysis of successful lean adopters shows that all successful organizations have established straightforward training portfolios with predefined courses (Asadian et al., 2024). Investing in education and training for workers and other staff is vital in using lean to improve operations. These companies dedicated significant time and resources to employee training, often developing in-house content, incorporating lean principles, technical methods, and internal standards (Asadian et al., 2023). As a result, workforce education is considered crucial for the quality of work and ongoing consistency of operations.

RESEARCH APPROACH

A phenomenological approach was pursued to explore the lean in the trade contractor community, emphasizing field training and adoption, case study research, multiple or single cases in context to understand the real-life processes affecting the phenomenon. In this case, qualitative data serves as the primary source for analysis (Yin, 2003). When considering research regarding the implementation of lean within a trade contractor, the research approach would be practice oriented. Within studies focused on practice, the research focuses on applying theory within a unique context or situation, like lean method implementation. The value of such methods lies in the ability to consider the context and contribution of knowledge from practitioners to enlighten the theory through the evaluation of the practice or intervention (Dul and Hak, 2007).

The case study procedure employed an industry advisory group from the Lean Construction Institute's Trade Task Force. Members helped identify trade contractors who were successful

in their deployment of lean. Following an initial discussion with the firm point of contact, a multi-day visit was scheduled. The visit entailed a series of semi-structured interviews with nine leaders, including the COO, lean champion, trainers, and several project and office leaders, observations of method implementation at multiple construction sites, and a tour of prefabrication facilities and office support infrastructure. The results were captured and organized into a technical memorandum, which the contractor reviewed for accuracy and then reviewed by the trade advisory group to validate value and detail.

RESULTS

Founded in 1996, KHS&S is a specialty contractor focusing on framing, drywall, plaster, and sheathing scopes. It has four offices around the country, generally positioned in the areas that feature its markets, namely entertainment, casino, and related complex architectural work.

KHS&S’s Core Values:

- Direction: Setting their own direction and refuse to be defined by others
- Results: Being solution-oriented and results-driven
- Opportunity: Offering opportunities and recognize performance
- Pride: Taking great pride in who they are and what they do

One of the secrets to the success of KHS&S operations stems from their in-house emphasis on education and training. In addition to the training for management and staff, their field workforce undergoes targeted training in methods they consistently deploy for all KHS&S projects as they transition toward leadership roles. Their training is divided into three certifications, aligning with their Lean House (see Figure 1). The initial target in the training regimen associated with their Bronze certificate involves classroom training in conjunction with the Continuous Improvement Plan (CIP) each employee develops. The plans entail 46 items, including the educational modules covered during the classroom portion of the course that each employee is expected to master. Further, roughly half of the items require future leaders to complete and demonstrate mastery of a series of methods or complete specific tasks to receive their first certificate. While many concepts are covered through the classroom content, they



Figure 1: KHS&S Lean House with corresponding training certification levels.

have to demonstrate their competency by having leaders observe their use of the methods in meetings or appropriate contexts.

To communicate their approach to lean, KHS&S crafted a framework, the Lean House (see Figure 1). The House serves as a fundamental but straightforward tool to communicate the priorities and alignment with the core values of lean to the operations within KHS&S. The lowest level, corresponding to the bronze certification, focuses on practical methods that field workers and staff can use immediately, such as the eight wastes, to enhance field production. Moving up the framework's structure, more complex methods are addressed, such as standard work, that align the higher-order needs of a large organization to sustain production improvements. The movement toward overarching principles, like just-in-time flow, is higher on the structure to show the ongoing pursuit of these ideals. The development of the gold level is ongoing, with concepts like takt time and built-in quality being developed. The elements that follow will focus on the bronze certification, which is emphasized for field leadership.

Using the core values at the foundational level of the house helps support how leadership has embedded lean philosophy with the company values. The culture at KHS&S embeds 'Respect for People' as a core component in all their endeavours. They value having a workforce that feels respected and fully engaged, which is seen through the high level of success they achieve across their portfolio of projects. The empowerment of their field leadership allows them to more easily support craft needs in the field, improve productivity, and identify new or creative solutions to problems using all the knowledge their workforce brings. By aligning their training with this empowerment of workers, they can identify areas for improvement, from small-field adjustments to large-scale prefabrication on projects. Their ongoing efforts to develop and optimize their field resources, such as their custom job boxes for their craft, serve as an excellent example of this support. KHS&S has developed customized job boxes for their different trades; for example, the carpenters have one featuring a saw mounted on top, a power strip inside for charging tools, and storage for tool belts and related framing materials. In an early version, the door location and locking mechanism prohibited a worker from accessing the materials below if a coworker was working atop the box. However, through one of the craft suggestions, by simply changing the closing order of the two doors in the design, other workers can access the tools or materials inside the doors without interrupting the use of the saw on top.

Training for the first level of certification covers six modules, as shown in Table 1. The main content is delivered in courses, with three further areas for reflecting on or applying the content learned. These classes are intentionally done away from the jobsite to create a productive learning environment with minimal distractions. Further, KHS&S has been sharing its culture and training approach with the industry for several years. They describe their journey, share their training program, and expound upon the benefits they have seen from implementing lean in the hopes of advancing the whole industry.

Each of the six courses is structured as a three-hour course. The classes are held once a week for six weeks to accommodate the project needs of the upcoming field leaders while having sufficient time to work on the topics with some depth and application. Each course has content structured to convey the intent, e.g., why the topic of the method is valuable, the application of the method through examples and exercises, and the application to make the students apply the content in the field. The start of each class touches on a brief review of topics from the last class and a short quiz. The end of each class includes a plus/delta review of the content that week, along with time to answer questions from the students.

Table 1: Summary of class modules and learning objectives for KHS&S Bronze Certification

Class 1 Introduction to Lean at KHS&S	<ul style="list-style-type: none"> • Defining lean / tie to KHS&S core values • The tie between lean and safety • Introduction of standard lean methods and techniques • Focus on Last Planner System implementation
Class 2 Stand-Up Board, Teaching vs. Telling, and Reflection	<ul style="list-style-type: none"> • Review Homework (Ohno Circles) and reflection from Class 1 • How to set up the Daily Huddle board and its Function • Stand-up meeting procedures and • Lean thinking examples/videos • Teaching vs. Telling and how to become a better coach and mentor
Class 3 5S and Visual Management (VM)	<ul style="list-style-type: none"> • Detailed overview/application of 5S • Explanation of visualization vs. visual management and examples • Exercises demonstrating both effective 5S and Visual Management • Constraints logs (LPS/WWP)
Class 4 Applying 5S & Visual Management (VM)	<ul style="list-style-type: none"> • Review and reflection from Class 3, Quiz on prior material • Kim's game • How to hold effective meetings & meeting etiquette • Students spend 3-5 minutes teaching a topic of their choice
Class 5 8 Wastes & Weekly Work Planning maps	<ul style="list-style-type: none"> • Application/mastery of the 8 wastes • First run study example • Standard work for leaders • Foreman's (Gemba) Walk • Weekly work plan map • Materials map
Class 6 Stand-up: Bringing it all together	<ul style="list-style-type: none"> • Review and reflection from class 5 • Forms and assessments (completing training) • Forms for stand-up meetings • Video examples • Stand-up meeting practice with each student running a mock daily-huddle and training on lean topics

LPS is implemented at the trade level and is a focal point when implemented to support crew-level planning, resources, and constraints. In addition to introducing the basics of the LPS as a system, the course moves to convey the implementation relative to crew-level concerns. The crew leaders are taught how to read budgets to align field planning tasks, content, and exercises on calculating goals for production for the weekly work plan, as well as a review of an example superintendent weekly work plan and how it is generated for a project. Each plan category is reviewed in detail before moving into a hands-on exercise. In addition, Ohno circles are

introduced to teach about observing work, and a minor ‘homework’ assignment is provided to have each participant conduct a short Ohno Circle observation and report back.

At the start of the second class, there is a review of the homework and previous class topics before the detailed introduction of the KHS&S Stand Up Board (see Figure 2). The placement of each component on the board is reviewed, and the explanation and intent for each piece of information are presented. The information covers LPS tracking, the Weekly Work Plan map project drawings, progress visuals, safety materials specific to current tasks, and the logistics information for material laydown. These are all explained to support visual planning and communication in daily huddles. The content also reviews how the planning process ties the information together for crew-level planning and communication at the site. The material is intermingled with videos and example materials to illustrate effective use.

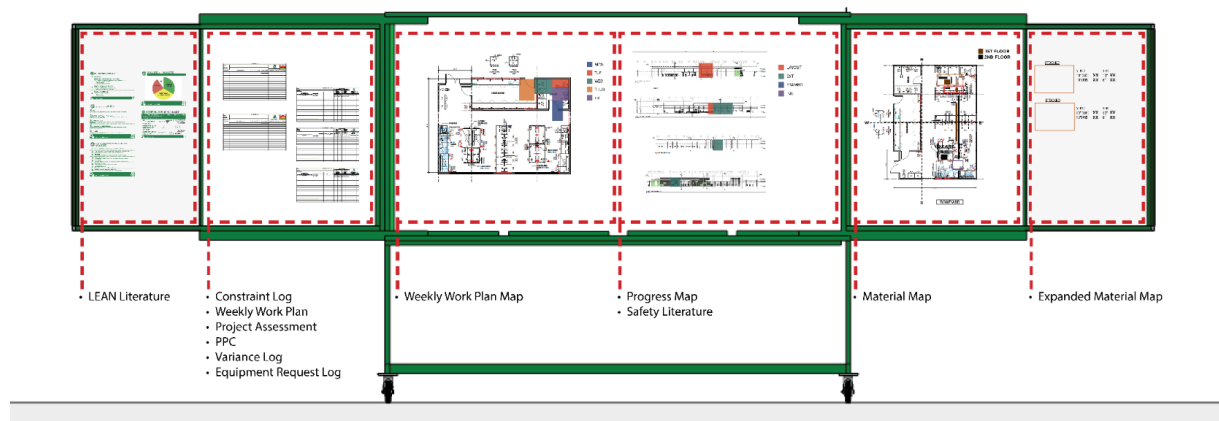


Figure 2: KHS&S Stand Up Board design for daily huddles

The third day of class focuses on introducing 5S, detailing the five steps and how and why the steps are implemented, using examples from practical field contexts, such as crew gang box organization. Other examples from the shop and tool yard, as well as within the office, convey the variety of applications. Building on the 5S, the content shifts to introduce Visual Management. The applications of visual management for inventory control, tool management, and management of material orders are used to support the institutionalization of company systems and tools, in addition to teaching the concepts and application of seeing and knowing through visual control mechanisms. These methods are linked to using the constraints log in developing the LPS Weekly Plan.

In week four, the content from week three is expanded through application and moving into organizing and running meetings using the resources. Kim’s game is used to teach about using memory in a visual context, building from Rudyard Kipling's character from the book Kim (Kipling, 1994), who demonstrates how to enhance observational and memory skills through visual processes. The participants are then trained in holding effective meetings through elements of good action meetings and the different meetings they will participate in, including what, how, and why of effective meeting structures. Participants are then allowed to practice and build their comfort and confidence in public speaking, holding meetings, and delivering lean learning content.

In the fifth class module, students are introduced to the eight wastes. The class is then introduced to methods for applying the principles of 8 wastes on-site, including using first-run studies to identify waste in planned processes, understanding standard work of crew leaders to help reduce waste for craft installing work in the field, performing Gemba walks, and the need for clear weekly work plan maps and materials maps to reduce waste during operations. Class is interwoven with video clips and pictures from construction sites to allow participants to apply the concepts as they learn.

In the course's final week, students are introduced to the CIP form and discuss the scope of work needed to fulfill the bronze-level certification. The participants learn about the forms used to support and document stand-up meetings in the field, including a review of video examples to illustrate the elements of running meetings. Finally, each participant runs a mock daily huddle for a crew. The meeting is based on a plan they have developed as homework. The participants also delivered a lean training topic they prepared to a subset of the class as if they were their crew members.

One of the CIP elements required for them to get certification is observing their field leadership during a meeting outside of the classroom. To complete the CIP, 17 elements must be observed after completing the six-week course to receive certification. The participants need to be observed using all the elements from class, such as using PPC and variance charts in Last Planner updates, documenting the use of 5S for gang boxes over a sustained period, coaching the use of 5S and the eight wastes for their team, as well as implementing an improvement that can be shared. In addition to applying their in-class learning, they must review two books independently and perform two research tasks related to lean and 5S applications. The assessment program uses a scoring rubric to evaluate and provide feedback to the students on how well they use and perform all the skills they are expected to use when running a crew and leading meetings.

Beyond the recognition with the certification, when one of their employees completes training, they receive a special “Bronze” hi-vis vest and jacket and shared recognition through the KHS&S software app announcing their certification to the company.

DISCUSSION

Workers in the construction industry are itinerant. Field workers will have two entirely different teams across similar projects, even for the same firm. The class KHS&S offers is structured as a “Train the Trainer” session. They view their field leaders as trainers who are expected to teach their crews how to plan and facilitate the use of lean within their operations. With specialty contractors, no specific quantity of central resources could train, coach, and mentor the dozens to hundreds of workers that come and go, sometimes daily. Thus, KHS&S has structured its training to give the field leadership the skills to implement their tools through lean and support their transition to becoming lean mentors within their crews. This is needed to address the ongoing shift in field workers, which cannot be avoided. Recognizing the need to be intentional in this adoption allows KHS&S to help sustain its lean culture and approach in the field. To support this, the leaders are empowered to try new processes and methods, allowing them to apply those methods as they deem appropriate.

The consideration of lean as part of the crew activities is embedded into their daily routines. Each morning in the daily huddles, the crews use a standard agenda. The agenda uses the weekly production level of workforce planning from LPS to support field crews in standing up and delivering on the work they have completed and their plan for the day. As part of that discussion, there is a brief discussion of a lean topic, usually only a few minutes, to emphasize lean thinking as a core part of culture and planning. By embedding these small elements, the technical agenda and routines of the daily huddle reinforce both the culture of KHS&S in the field and keep lean and continuous improvement at the forefront of the workers' efforts.

Due to the diversity of scope offerings, labor pools, and technical challenges, KHS&S has intentionally taught lean principles and practical, technical methods for implementing lean. However, KHS&S does not focus on methods at the expense of culture. They used methods to teach processes to their field workforce. The training, in turn, empowers their field leaders as trainers to further educate the crews they lead and to walk the walk of the technical methods while still understanding the intent and principles behind the methods. They have realized that they cannot focus on methods alone and that workers must understand the intent. Also, they

have worked to balance how the methods are trained and implemented to create standard processes while making sure field leaders give their workers the freedom to explore new ideas and find ways to improve the work as an effort at continuous improvement.

In the interviews about the evolution of their training program, it was clear that the training had evolved significantly over the years of pursuing lean. Much of the early efforts focused on project support; however, as one leader commented, “If I visit a job, I may not get back for 3 months. After I taught it on site, it was gone.” They discussed the need to ‘bring the field out of the job’ to get their attention. The leadership characterized the need to turn education into action and evolve it into discipline. They focused on their core planning and areas of influence, weekly work planning, daily stand-up meetings, and the check-in/check-out processes, adding other pieces as they refined the program. Once the program was stable, they added assessments and coaching. They also folded the concepts and lean principles into the company's core values, trying to ‘make it part of their DNA’ as one leader characterized it. The house and the more structured training program presented above evolved over several years. They also worked to develop field lean leaders in each office, rather than solely from the headquarters. However, when discussing the details of the program, they highlighted that construction trades are not like factory workers, there had to be a balance between making the concepts applicable and straightforward while allowing the craft to leverage their skills and knowledge in the nuances of each unique construction project – balancing the teaching of standard methods with understanding of the intent and principles of lean.

In addition, using the CIP for each employee who begins the training embeds the concepts of continuous improvement and empowerment. To complete the certification, a senior leader or trainer must observe the worker, demonstrating that they have learned and can implement the methods as intended. Further, the requirement to implement their continuous improvement to document and share spurs not only instances of improvement but also supports the culture of improvement by making these efforts part of each crew and the overall firm routines.

Three elements stand out regarding their training program, as they relate to the broader needs of the industry. First, they recognize the need to train their field leaders as mentors, recognizing that the needed skills for leading field crews include the ability to support the teaching and coaching of younger crew members. Second, their balance of technical methods with lean principles recognizes the inherent sociotechnical needs of construction training. Crew members contribute as part of a team, and they need to balance the crew level support and planning with the technical requirements of the work. Third, by embedding lean principles into a training curriculum, they engage the cultural change needed by shifting mindsets around production and waste at the crew level in their operations. While the specifics of the training modules can be addressed differently across different organizations and trades, these elements have underpinned the success KHS&S has seen in its training initiative and rollout of the program across the company.

CONCLUSIONS

This research highlights a case study example of how trade contractors can play a pivotal role in advancing Lean Construction principles within the industry, bridging the gap often observed between general contractor adoption and implementation in the field for construction projects. It highlights the challenges of the scale of lean implementation and training needs to support and empower field personnel across the largest population of personnel engaged in construction projects. The case study demonstrates that structured, intentional training programs focused on field crews and leadership offer a unique point of leverage and growth in fostering a sustainable Lean culture. By emphasizing both methods and principles, the example demonstrated by KHS&S has developed an approach that balances standardization with flexibility, empowering teams to adapt Lean practices effectively across diverse projects and challenges.

Key takeaways include embedding Lean into daily routines, such as stand-up meetings, 2–3-minute Lean discussions, and reflective plus/delta processes. Further, their CIP steps and recognition program highlight the effective use of lean in field implementation to encourage adoption. These practices ensure that Lean principles remain at the top of the mind, are integrated into the fabric of operations, and are ingrained into the continuous improvement culture. Furthermore, KHS&S's commitment to sharing knowledge beyond its organization underscores the broader value of collaboration and industry-wide growth in Lean adoption.

The findings affirm that empowering field leadership as mentors and coaches and focusing on culture-driven implementation while considering technical methods and supporting training is essential for overcoming barriers unique to trade contractors. This approach enhances project outcomes and contributes to a more engaged and capable workforce. Future research should explore scaling these practices across different trades and regions to further validate their impact and adaptability.

ACKNOWLEDGMENTS

We thank the Lean Construction Institute, ELECTRI International, the New Horizons Foundation, and the John R. Gentile Foundation, who provided the financial support to develop this research. We also thank the Industry Advisory Group, including Henry Nutt, Greg Stedman, Stephanie Roldan, Cary Norberg, Tom Soles, Sean Graystone, Katie Page, Brian Winningham, Sean Mcguire, Skip Perley, Steve Killius, Scott Teson, Quintin Henry, and Scott Schuenke. Finally, we thank the many industry experts who participated in the data collection procedures and openly shared their insights and experiences.

REFERENCES

- Asadian, E., Leicht, R. M., & Messner, J. (2024). A Comparative Analysis of Lean Approaches Among Trade-Contractors. *Lean Construction Journal*, 41-68. <https://leanconstruction.org/wp-content/uploads/2024/01/LCJ-23-001.pdf>
- Aslam, M., Gao, Z., & Smith, G. (2020). Exploring factors for implementing lean construction for rapid initial successes in construction. *Journal of Cleaner Production*, 277, 123295. <https://doi.org/10.1016/j.jclepro.2020.123295>
- Azevedo, M. J., Nunes, F. R. M., & De Paula Barros Neto, J. (2010). Analysis of strategic aspects in lean construction implementation. In *Challenging Lean Construction Thinking: What Do We Think and What Do We Know? - 18th Annual Conference of the International Group for Lean Construction, IGLC 18* (pp. 386–395). Available at <https://www.iglc.net>
- Brady, Denise Ann, Tzortzopoulos, Patricia and Rooke, John (2011). An examination of the barriers to last planner implementation. In: *19th Annual Conference of the International Group for Lean Construction, (IGLC)*, 13-15th July 2011, Lima, Peru. <https://eprints.hud.ac.uk/id/eprint/21078/>
- Christensen, R., Greenhalgh, S., & Thomassen, A. (2020). When a business case is not enough motivation to work with lean. In the *27th Annual Conference of the International Group for Lean Construction, IGLC 2019* (Vol. 130, pp. 275–286). <https://doi.org/10.24928/2019/0146>
- Dul, J., & Hak, T. (2007). *Case study methodology in business research*. Routledge. <https://doi.org/10.4324/9780080552194>
- Hackler, C., Byse, E., Alves, T.C.L., and Reed, D. (2019). “Building a Lean Culture: Engaging the Value Stream.” In: *Proc. 27th Annual Conference of the International Group for Lean Construction (IGLC)*, Pasquire C. and Hamzeh F.R. (ed.), Dublin, Ireland, pp. 169-178. <https://doi.org/10.24928/2019/0169>.

- Hamza Khan, M. A., Asadian, E., & Leicht, R. M. (2024). Identifying elements for lean construction implementation in trade contractor organizations. In *Construction Research Congress 2024* (pp. 496-506). <https://doi.org/10.1061/9780784485286.050>
- Kipling, Rudyard (1994). *Kim*. Edited by Cedric Watts, Wordsworth Editions.
- Maturana, S., Alarcón, L. F., Gazmuri, P., & Vrsalovic, M. (2007). On-site subcontractor evaluation method based on lean principles and partnering practices. *Journal of Management in Engineering*, 23(2), 67-74. [https://doi.org/10.1061/\(ASCE\)0742-597X\(2007\)23:2\(67\)](https://doi.org/10.1061/(ASCE)0742-597X(2007)23:2(67))
- McConaughy, T. & Shirkey, D. (2013). Subcontractor Collaboration and Breakdowns in Production: The Effects of Varied LPS Implementation, 21st *Annual Conference of the International Group for Lean Construction*, 649-658. Available at <https://www.iglc.net>
- Sarhan, S., & Fox, A. (2013). Barriers to implementing lean construction in the UK construction industry. *The Built & Human Environment Review*, 6, 1–17. Retrieved from <http://www.tbher.org/index.php/tbher/article/view/81>
- Senior, B. A., & Rodríguez, T. A. (2012). Analyzing barriers to construction productivity improvement in the Dominican Republic. In *IGLC 2012 - 20th Annual Conference of the International Group for Lean Construction, (IGLC)* (Vol. 1, p. 970). Available at <https://www.iglc.net>
- Shang, G., & Sui Pheng, L. (2014). Barriers to lean implementation in the construction industry in China. *Journal of Technology Management in China*, 9(2), 155–173. <https://doi.org/10.1108/jtmc-12-2013-0043>.
- Tillmann, P. , Ballard, G. & Tommelein, I. (2014). A Mentoring Approach to Implement Lean Construction, 22nd *Annual Conference of the International Group for Lean Construction*, 1283-1293. Available at <https://www.iglc.net>
- Torp, O., Knudsen, J. B., & Rønneberg, I. (2018). Factors affecting implementation of lean construction. In *Proceedings of the 26th Annual Conference of the International Group for Lean Construction (IGLC)* (Vol. 2, pp. 1261-1271). <https://doi.org/10.24928/2018/0234>
- Wafra, M., & Sawalha, M. (2021). Critical success factors for lean construction: An empirical study in the UAE. *Lean Construction Journal*, 1-17. Available at <https://leanconstruction.org/resources/lean-construction-journal/>
- Yin, R. K. (2003). Design and methods. In *Case study research* (3rd ed., Vol. 9.2). SAGE Publications.