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THE IMPACT OF LEAN TRAINING PROGRAMS ON BEHAVIOR AND ORGANIZATIONAL PERFORMANCE

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ABSTRACT

Training and education are critical enablers of lean implementation. However, many organizations still face challenges in assessing the impact of training on individual behaviors and overall organizational performance. This challenge is exacerbated by a lack of robust research and well-defined frameworks for systematically assessing the effectiveness of lean training programs. This study addresses this gap through a case study examining the influence of a training program on participants' engagement with lean principles and the adoption of practices into their daily business and operations. Data was collected from 99 construction professionals using a post-training survey to measure lean implementation levels. Results indicate that 80% of participants adopted lean tools and methods after completing the training. Evidence from various lean implementations carried out by participants after the training covered a wide range of business scenarios, resulting in both qualitative and quantitative benefits. These include reduced process lead times, increased production capacity, and improved communication efficiency. These findings offer empirical evidence of the effectiveness of lean training, contributing to academic discussion while providing actionable insights for designing training programs that deliver measurable and sustainable improvements.

KEYWORDS

Lean Training, Lean thinking, Training and education, Lean Training Impact, Organizational Performance.

INTRODUCTION

Adequate training and education play a critical role in any process supporting an organization's growth and development (Netland, 2016). This statement is particularly true in the context of lean construction, where training serves as a cornerstone for equipping individuals with the knowledge, skills, and mindset required to successfully integrate lean principles into organizational practices (Sarhan and Fox, 2013; Watfa and Sawalha, 2021).

Despite training's critical role, organizations—both within and beyond the construction sector—frequently struggle to assess its effects on people's behavior and business performance (Aragón-Sánchez et al., 2003). In many cases, training evaluation is either conducted inadequately or entirely absent. This lack of systematic assessment prevents organizations from

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demonstrating the value of training or justifying its continued implementation (Davidove and Schroeder, 1992).

Lean construction training literature also mirrors this gap. A targeted search in the IGLC proceedings database identifies 112 papers mentioning "training." For instance, Tsao et al. (2012) explore various approaches to teaching Lean Construction (LC) in university settings, drawing from the authors' experiences in the United States and Brazil. The study highlights the integration of diverse instructional methods, including readings, lectures, discussions, simulation exercises, team projects, field trips, and guest speakers, to blend theoretical knowledge with practical application. Alves et al. (2016) investigate Lean Construction skills and qualifications required by contractors. The authors analyzed job descriptions from Lean Construction Institute (LCI) member companies, focusing on roles such as project engineers, assistant project managers, project managers, schedulers, and superintendents. The findings highlight that employers prioritize competencies in the Last Planner System™ and Pull Planning techniques. The study recommends that university curricula incorporate these Lean methodologies to better prepare graduates for industry demands. Outside IGLC proceedings, Alarcón et al. (2006) examine the process of preparing contractor organizations for Lean Construction (LC) implementation, emphasizing the role of training and education in fostering organizational readiness. The study identifies key barriers to LC adoption, including resistance to change, lack of awareness, and insufficient managerial commitment. The authors highlight the importance of structured training programs, which equip personnel with Lean principles and methodologies to drive cultural and operational transformation. With the advancement of technology, some authors have also explored additional challenges that go beyond the technical aspects of Lean and Industry 4.0 (Forcael et al., 2023).

While the existing literature on lean construction training is rich and varied, it primarily focuses on the design and delivery of training programs within formal educational and professional settings. However, studies do not explicitly assess the tangible impact of such training on individual skills or organizational performance. This lack of focus on evaluating training outcomes is a significant shortcoming and highlights the need for research that links training initiatives to tangible improvements in practice and performance. Given the substantial investment that organizations typically make in such programs, the lack of rigorous evaluation not only hinders theoretical advances but also undermines the industry's ability to make evidence-based decisions and optimize training strategies for greater effectiveness.

This paper seeks to contribute to addressing this gap by investigating the impact of a lean training program on participants' behavior and performance outcomes. This study expands on the research conducted by Martinez et al. (2024) by incorporating a post-training survey to examine how a structured lean training program influences employees' engagement with lean principles and the adoption of lean practices into their daily business and operations. By providing empirical insights into the effectiveness of lean training, this study advances academic understanding and offers actionable recommendations for designing and implementing more effective training programs with measurable results.

RESEARCH DESIGN

The research is guided by the following question (RQ): How do training programs facilitate the integration of lean practices into participants' daily activities and operations?

We address this question through case study research. According to Yin (2014), case study research is appropriate when examining contemporary phenomena within real-life contexts, mainly when the boundaries between the phenomenon and its context are not evident. This definition aligns well with the aim and context of this research, as the training program's impact is closely linked to the organizational environment in which it was implemented.

Building upon the previous work of Martinez et al. (2024), this case study uses multiple data sources to provide a comprehensive analysis. These include insights into the training program's development and design processes, as well as additional data collected through a post-training survey conducted two years after the program's implementation. Integrating the post-training survey enables a deeper understanding of how participants apply (or do not apply) lean practices over time, offering a richer perspective on the program's effectiveness and its influence on operations.

The training program evaluation process is framed using the Kirkpatrick model. The Kirkpatrick model is a widely used framework for evaluating training effectiveness, consisting of four progressive levels (Alsalamah and Callinan, 2022).

- **Level 1** - Reaction: Evaluating participants' initial responses helps trainers determine if the content aligns with attendees' expectations and effectively conveys the intended message.
- **Level 2** - Learning: Assessing the knowledge gained and skills improved during the training program provides a precise measure of its effectiveness by comparing pre- and post-training performance.
- **Level 3** - Behavior: Observing how participants incorporate newly acquired skills into their daily activities helps determine whether the training has influenced their behaviors as intended.
- **Level 4** - Results: Analysing the training's impact on metrics such as productivity, quality, efficiency, and customer satisfaction provides insight into whether the learning has delivered measurable benefits to the organization.

These levels provide a comprehensive approach to understanding and improving the effectiveness of training programs. Levels 1 and 2 are addressed in related research (Martinez et al., 2024). This study specifically focuses on levels 3 and 4, examining whether the training led to adopting lean practices and evaluating its influence on trainees to drive organizational improvements.

The post-training survey was distributed two years after the program's initiation and the design of the questions was tailored to match the context of the case study. In the survey design (Figure 1), participants responded to the key question, *"Have you been able to implement the learnings from the Lean Expert Program[4] in your project or business context?"* Based on their answers, they were directed to different sections to provide detailed insights on either the successful implementation of lean practices (yes) or the reasons for non-implementation (no).

In the details for implementation section (yes), survey participants were offered a list to provide inputs about the different lean tools and methods they could implement after the training program via multi-selection. Furthermore, they were also asked to provide additional details about the implementation and provide insights into any qualitative and/or quantitative outcomes derived from such implementation.

In the details for no-implementation section (no), participants were asked to provide insights about the main barriers they found to implementation. This procedure was intended to create an understanding of those barriers and derive potential actions to address them. At the end of the survey, both groups merge into a section where they can provide additional feedback to improve the future cohorts of the training program.

Administered in August 2024, the survey included two cohorts, totaling 99 trainees. Of these, 60 participants responded, with a 61% response rate. The data collected from post-training surveys was consolidated and analyzed. The analysis focused on identifying recurring patterns,

[4] "Lean Expert Program" is the internal name given to the training program in the organization

insights, and themes related to the program's impact on knowledge acquisition, behavioral change, and practical implementation of lean principles.

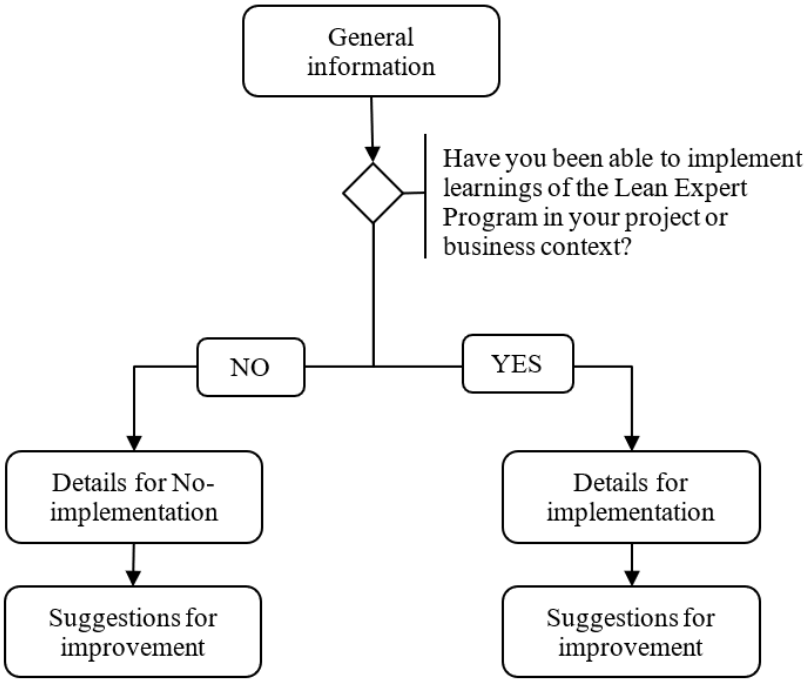

Figure 1: Survey design

CASE STUDY BACKGROUND

The case study involves a major construction services provider headquartered in Central Europe. The organization implements Lean Construction as a strategic initiative to achieve operational excellence. In 2022, the organization launched a customized lean training program designed to equip employees with the knowledge and skills necessary to implement lean construction principles, tools, and methods across diverse business units. The program also aims to develop a network of lean advocates within the organization, fostering a sustainable integration of lean principles into its culture and operational practices. To provide context, Figure 2 illustrates the timeline of the training cohorts, highlighting the specific point at which the survey was distributed.

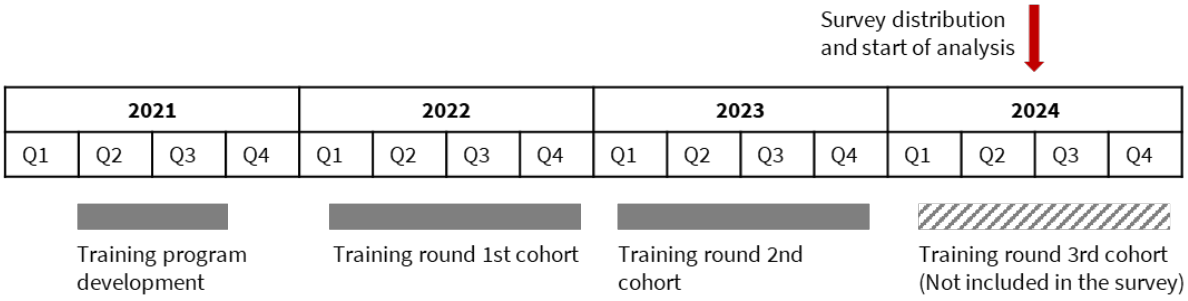

Figure 2: Training cohorts timeline

LEAN TRAINING PROGRAM STRUCTURE

The training program is based on a global framework that can be adapted according to the particularities of different businesses and country contexts. The program was developed in collaboration with operational units to ensure that the global framework meets the requirements

of different local contexts, providing relevant content that addresses the key operational challenges faced by construction teams in their projects. The program framework includes the following elements (Figure 3):

- **Nomination**: in collaboration with the local management teams, interested individuals with a suitable profile are evaluated and nominated for the training program.
- **Onboarding**: initial basic training in Lean construction takes place. Lean principles are taught in greater depth.
- **Lean training**: training takes place in a 3–4-days distributed over the year. Training focuses on selected lean tools and methods, each adapted to the needs of the business unit.
- **Live case implementation**: as part of the program, participants complete a "live case" where they can implement learnings in a real operational scenario. These practical implementations are summarized in an executive A3 report.
- **Training completion**: trainees are officially certified after finalizing training and the completion of the live case. A certificate is granted after proving knowledge via an online test/quiz.
- **Continuous network involvement**: after certification, trainees remain active in the network. This step includes involvement in further community activities and supporting new colleagues joining the program.

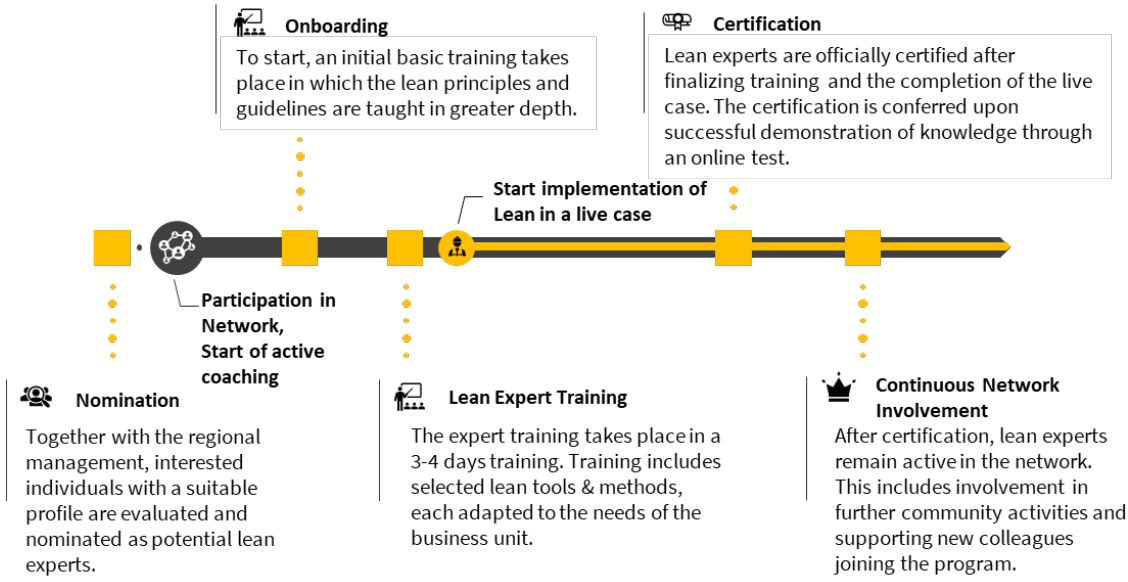

Figure 3: Lean training program design (Martinez et al., 2024)

Training sessions are delivered locally across multiple regions, using a blend of workshops, simulations, project site visits, and hands-on group work to foster collaboration, knowledge exchange, and network building among participants. The program's practice-oriented modules address various aspects of project execution, including continuous improvement, pull planning, the Last Planner System® (LPS), takt planning, value stream mapping (VSM), shop floor management, 5s (five s), go to Gemba, supply chain management, and logistics. As of 2024, the program has successfully trained 113 employees across multiple countries. Of these, 14 have since left the organization, resulting in a current total of 99 people included in the survey: Switzerland (43), Germany (40), Austria (4), Sweden (1), Norway (19), and France (16). Further details of the program and learnings from implementation can be found in Martinez et al. (2024).

SURVEY RESULTS

EVIDENCE ON BEHAVIOR

In response to the question, *"Have you been able to implement learnings from the Lean Expert Program in your project or business context?"*, 80% of respondents (48 out of 60) confirmed applying various lean tools and methods acquired during the program to their work or projects.

Participants who provided a positive response were subsequently asked, *"What specific method(s) or tool(s) have you been able to implement?"* They were allowed to select multiple options from a list representing the training modules delivered in the program. Among the responses (Figure 4), the LPS emerged as the most frequently mentioned tool, followed by Continuous Improvement tools such as A3 problem-solving and the PDCA cycle. Other widely adopted practices included go to Gemba and Shop Floor Management. In the "Other" category, some respondents highlighted the use of methods not covered explicitly in the program, such as Kata, or the integration of process improvement through digital tools. These insights suggest that while the program successfully fostered the application of its core methodologies, participants also sought complementary approaches to enhance their lean practices further.

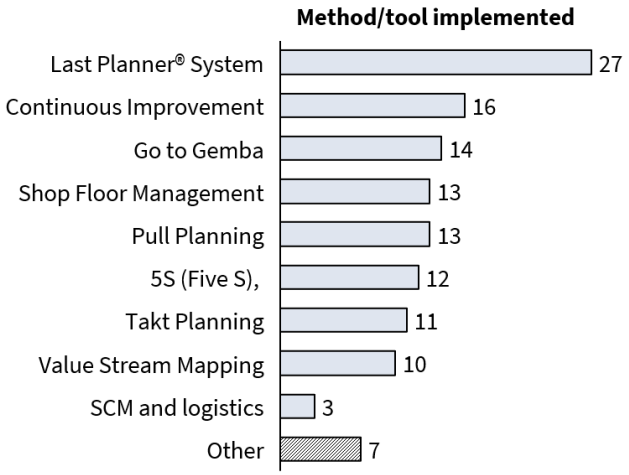

Figure 4: Number of mentions of methods and tools used

To gather deeper insights into the implementation of lean practices, survey participants were asked: *"Could you briefly describe the scope of the implementation?"* The responses revealed varying levels of application across projects and operational contexts. Several participants highlighted the integration of different levels of collaborative planning practices within their projects. Other applications included improvements in project steering and communication practices, such as using cycle meetings and establishing shop floor management systems. Some implementations extended beyond project execution. For instance, some participants reported improvements in the handover process from bidding to execution, leveraging VSM to better understand the flow of information inputs and outputs during the bidding phase. Others noted the use of Plan-Do-Check-Act (PDCA) cycles for various improvement initiatives, including visualizing information flows, optimizing processes, and implementing 5S management on construction sites. The level of implementation varied across different phases of the project life cycle and operational contexts. This variation can also be attributed to the diverse mix of professionals involved in the program, representing distinct business units with unique operational priorities and technical expertise.

EVIDENCE ON ORGANIZATIONAL PERFORMANCE

To assess the business impact of these practices, participants were also asked: *"Were you able to quantify the impact of this implementation?"* Respondents provided a range of estimates detailing both quantitative and qualitative outcomes. A selection of reported benefits includes:

- Process lead time reductions, such as a two-hour improvement per cycle in machine maintenance.
- Enhanced communication efficiency, with standardized practices yielding cost savings in reporting processes.
- Production capacity improvements exemplified by a twofold increase in concrete mixing output.
- Efficiency gains in running team meetings and exchanges, with participants estimating time savings of two to three days per month.
- Streamlined workflows, leading to decreased waiting times across various operations.

Although these figures demonstrate a measurable impact of lean practices on business performance, only about half of the participants who reported implementing lean practices could articulate clear, measurable benefits derived from these initiatives. This inconsistency underscores the inherent difficulty of isolating and quantifying the effects of improvement efforts within complex operational environments and project setups. Overall, the responses suggest a positive correlation between the training program and the subsequent adoption of lean practices. However, it is important to acknowledge that the reported benefits are based on participants' self-assessments, lacking standardized methodologies for validation. This limitation highlights the need for more robust evaluation frameworks to measure and substantiate the outcomes of lean training initiatives accurately.

OPPORTUNITIES FOR IMPROVEMENT

In cases where the training program did not result in effective implementation, participants were invited to share feedback through the survey, identifying barriers and suggesting ways to facilitate lean implementation. A recurring theme in these responses was the significant challenge posed by time constraints and the lack of adequate support, which emerged as key barrier to implementation. One participant concisely highlighted this issue, stating:

"[Implementing lean] …requires more attention and commitment at the beginning than is available 'on the side.' For myself, I always manage to implement learnings, but on a small scale."

This reflection reveals the difficulty of initiating lean practices within competing operational demands, especially without sufficient organizational or resource backing. It suggests that while individuals may recognize the value of lean principles and attempt small-scale adoption, the absence of structured support inhibits broader, more impactful implementation.

At the conclusion of the survey, participants from both survey groups were asked to provide additional suggestions for facilitating the implementation of lean construction. The most prominent recommendation centered on adopting a more integrated approach emphasizing group collaboration to address common challenges. One participant adequately summarized this need:

"Many projects have similar problems. Consolidate problems and develop integral solutions – too many people working on the same challenges at the same time."

Similarly, another participant emphasized the importance of collaboration, stating:

"Promote joining forces where similar roles work on similar problems."

These insights highlight the potential of collective problem-solving to minimize duplication of effort and improve project efficiency. They also stress the persistent issue of project-by-project fragmentation and the challenges in the construction industry in scaling improvements across projects—an area that could serve as a foundation for future research. Another critical suggestion focused on strengthening both managerial support and practical coaching to facilitate lean implementation. For example, one participant noted:

"For new projects, motivate the management level to apply lean methods in all areas (operational and technical office staff) at an early stage."

In addition to managerial endorsement, the importance of hands-on, practical support was emphasized. One participant suggested on-site team training as a valuable resource:

"Where possible, on-site team training would probably also be useful. Many people still tend to see lean as 'I already do it anyway.' I doubt whether this can be changed within a training course, but perhaps a specific problem could be tackled as an example and ideally solved together."

To further enhance lean construction implementation, participants proposed additional measures such as fostering continued exchanges among current and former participants of lean training programs and incorporating new training modules to expand competencies. These strategies represent valuable opportunities to overcome existing barriers and strengthen the integration of lean practices within the construction industry.

DISCUSSION

In response to the RQ, *"How do training programs facilitate the integration of lean practices into participants' daily activities and operations?"*, evidence from this case study suggests that lean training programs positively influence the adoption and implementation of lean practices. Participants reported integrating the program's learnings into their daily business and operational activities to varying degrees. The implementation encompassed a diverse range of lean tools and methods, including widely adopted practices such as the LPS and Takt Planning, alongside shop floor management, VSM, and various continuous improvement initiatives. These findings demonstrate the program's effectiveness in equipping participants with practical skills to drive operational excellence across different operational contexts.

A key observation is that people not responding to the survey might reasonably be classified under the "no implementation" category. If this hypothesis is valid, it would mean that 48 out of 99 participants (48.5%) effectively implemented lean practices after the training. Another important consideration is the reliability of self-reported data. To minimize the risk of over-reporting, the survey was conducted anonymously, ensuring that respondents were not identified or evaluated based on the quality of their reported work. Furthermore, a carefully worded introduction of the survey was considered to reduce biases when answering following guidelines from Mayer (2021), which have been also used in similar surveys in the construction industry (e.g., Cisterna et al. 2024). Additionally, there was no additional incentive to provide biased responses; the purpose of the survey was to consolidate information for analyzing the program's impact and guiding future improvements.

How should these figures be interpreted—positive or negative? Whether using 80% (based solely on survey respondents) or 48.5% (considering the entire group) as the baseline, the lack of benchmarks in the literature makes it difficult to assess these results. Although extensive research on lean emphasizes training as a critical success factor for implementation (Dinis-Carvalho, 2021; Paneerselvam et al., 2024; Yamchello et al., 2014), to the best of the authors' knowledge, no studies provide tangible metrics to support these assumptions or establish a baseline for comparison. This gap underscores the need for further research into methodologies for quantifying the impact of training on participants' behavior and organizational outcomes.

By addressing this gap, the present study offers a valuable contribution toward advancing understanding in this area and providing a foundation for future work.

Regarding measuring business impact, participants' self-reporting data indicate that the lean training program contributed to tangible benefits, such as time savings, cost reductions, and improved planning coordination. While self-reported data may lack the structure and precision of formal performance metrics, it provides a rich source of contextual insights, capturing the diverse ways in which lean practices are applied across projects and operational settings. Measuring the outcomes of continuous improvement initiatives remains challenging (Belekoukias et al., 2014). This fact presents an opportunity to develop more rigorous measurement frameworks that validate the impact of lean practices. Such frameworks would ensure that the benefits of lean practices are both realized and accurately documented, supporting broader organizational learning and development. Additionally, they would strengthen the evidence base for lean practices, facilitating a more precise understanding and broader recognition of their value.

In terms of challenges and opportunities, survey participants highlight that the availability of participants' time and increased involvement from management are key factors that could further strengthen the program and enhance the engagement of participants. Feedback indicates that, in some regions, the program is still viewed as a parallel or secondary task rather than an integrated strategic opportunity to support operational excellence. Increasing management engagement in the program, such as by participating in selected training sessions or exchanges, along with the potential to introduce lean management training (or something in this direction), presents key opportunities for improvement in this area. This outcome correlates with the findings of Netland (2016), where lean managerial commitment and involvement, along with training and education, are ranked at the top of critical success factors for implementing lean.

The feedback also highlights the importance of a systematic training program in fostering a community-driven approach to lean implementation rather than relying solely on individual efforts. Establishing and sustaining a sense of community among participants is seen as critical for the long-term success of lean practices. One notable suggestion from the feedback emphasizes the value of maintaining an active lean community beyond the completion of training. For example, involving experienced participants from previous cohorts in mentoring and training new participants could not only keep them engaged but also provide practical demonstrations of how lean principles can be effectively applied in real-world projects. This peer-to-peer communication is perceived as particularly effective in conveying the practical benefits of lean construction. Participants noted that learning directly from colleagues who have successfully implemented lean practices can demystify concepts, build trust, and inspire greater confidence in adopting these methods.

Similarly, survey inputs also underline the value of adopting a collaborative and team-oriented approach to lean and continuous improvement, especially when addressing common challenges across diverse operational contexts. By fostering cross-functional synergies and promoting transparency, organizations can more effectively tackle complex issues that exceed the scope of individual problem-solving efforts. Collaboration enables teams to pool their expertise, share resources, and align their goals to achieve more comprehensive and sustainable outcomes.

LIMITATIONS AND FUTURE WORK

The findings of this study should be interpreted within the context of the case study, which may limit their direct applicability to other scenarios. However, the structured training approach and systematic methodology adopted provide reliable data for understanding the impact of lean training on participants' behavior and organizational performance. This approach not only offers valuable insights for refining the program's future direction but also contributes

meaningful evidence to the scientific understanding of training's effect on organizational outcomes. In terms of future work, the long-term nature of this training program presents an exciting opportunity to collect additional data, further strengthening the evidence base in this area.

CONCLUSIONS

This study provides empirical evidence demonstrating the effectiveness of lean training programs in facilitating the adoption and implementation of lean practices among construction professionals. Notably, 80% of survey respondents reported applying lean tools and methods in their daily operations after the training. The findings further highlight tangible operational benefits, including reduced process lead times, increased production capacity, and improved communication efficiency. These results demonstrate the practical value of such training initiatives in driving operational excellence.

The findings also underscore the need for robust measurement frameworks to quantify training programs' impact on individual behaviors and organizational outcomes. The self-reported data, while offering valuable contextual insights, reveal opportunities to develop more precise metrics to validate the benefits of lean practices. Such frameworks could enhance organizational learning, ensure the sustainability of lean initiatives, and strengthen the evidence base for their effectiveness.

Key opportunities for enhancing the success of lean training programs include addressing time constraints and enhancing support and management sponsorship at different organizational levels. Tailoring training content to meet specific needs, fostering a sense of community among participants, and incorporating peer mentoring and cross-team collaboration emerged as promising approaches. These strategies not only enhance the program's immediate impact but also support sustained long-term improvements by building stronger connections and shared ownership among participants.

Overall, this study contributes to the academic literature on lean implementation by bridging the gap in understanding the link between training and tangible outcomes. It also provides actionable insights for practitioners seeking to design and refine training programs that deliver measurable and sustainable performance improvements. Future research should focus on developing and validating methodologies for assessing the broader impact of lean training and exploring innovative approaches to overcome the identified challenges.

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