

# DESIGNING AN EFFECTIVE TRAINING PROGRAM FOR SYSTEMATIC LEAN CONSTRUCTION IMPLEMENTATION

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## ABSTRACT

Training and education stand out as pivotal factors for the successful implementation of lean construction. Despite their critical role, current literature lacks comprehensive guidance on the development and implementation of lean training programs within the context of construction organizations. This paper aims to address this gap by presenting the case study of a multinational construction service provider developing and implementing a training program aimed at fostering a broader and sustainable integration of lean construction practices within the organization. The analysis includes the insights and perspectives of 95 trainees, gathered through an electronic survey. The results show a positive evaluation of different components of the program after 2 years of implementation. The case study emphasizes the significance of a collaborative approach to find an adequate balance of standardization and flexibility required to effectively deploy a unified training program across diverse local contexts and construction operations within the organization. The valuable insights derived from this case study serve as a resource for both researchers and practitioners, providing practical guidance for those looking to implement training programs. Furthermore, it supports in identifying best practices and potential pitfalls that warrant careful consideration in similar initiatives.

## KEYWORDS

Lean construction, Training, Education program.

## INTRODUCTION

Lean construction principles, derived from lean manufacturing and the Toyota Production System, have gained widespread recognition in the construction industry for their potential to enhance efficiency, reduce waste, and optimize project outcomes (Ballard, 2000; Koskela, 1992). Central to the successful implementation of lean practices is the imperative for adequate training programs tailored to the specific needs of construction professionals.

Despite the importance of training in achieving overall success in lean construction implementation, there is a lack of literature and documentation providing examples of training approaches aiming to sustainably support its adoption in corporate environments (Tsao et al., 2012). Notably, most of the literature refer to education in university setups with a lack of focus

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on how these concepts could be implemented in corporate environments (Alves et al., 2016; Rybkowski et al., 2018).

This paper aims to contribute to this area by presenting a case study of a structured approach to lean construction training program developed and implemented in a large European construction service provider. The authors describe the training program development and analyze the results up to date considering 2 years of effective implementation. The authors also build upon trainees' survey to include the perspective of participant in the case study.

## **RELATED LITERATURE**

Lean construction aims to optimize project delivery by minimizing waste, improving collaboration, and enhancing value for all stakeholders involved. Achieving these objectives requires a paradigm shift in the organizational culture, requiring a workforce that is well-versed in lean principles and practices (Koskela et al., 2002).

Literature emphasizes that skilled professionals and workforce are essential for successful lean construction implementation (e.g., Aslam et al., 2020). Adequate lean construction trainings serve as a vehicle for skill acquisition, providing practitioners with the necessary knowledge to apply lean concepts, fostering a network of capable construction professionals able to execute lean practices at the different phases of the project lifecycle. The transformative impact of lean construction training has the potential to extend beyond individual skill development to encompass a positive organizational culture development. Scholars argue that lean implementation requires a cultural shift towards continuous improvement and collaboration (Ballard & Howell, 1998; Koskela et al., 2002). Therefore, training initiatives contribute to this cultural transformation by instilling a mindset of learning and adaptability, vital components for the sustained success of lean practices within an organization.

Several studies have identified the lack of adequate lean awareness and understanding as critical barriers in successful lean construction implementation (Sarhan & Fox, 2013). According to Watfa and Sawalha (2021), the successful implementation of lean construction requires a certain level of technical proficiency in the tools and techniques essential for its proper execution. In fact, the Lean Construction Journal has recently launched a special issue call for lean education devoted to consolidating best practices and simulations for enhancing lean education (Lean Construction Journal, 2023).

Researchers have dedicated significant attention to lean construction education, offering comprehensive guidelines for the development and implementation of training programs. For instance, Hirota and Formoso (1998) offered guidance in developing lean construction training programs. The authors highlight the ease with which trainees can grasp fundamental concepts like processes, operations, conversion, flow activities, and the overarching notion of waste. However, they also emphasize the challenge trainees face in fully comprehending and seamlessly integrating lean construction principles and approaches. Based on several years of experience, Tsao et al. (2012) provide different perspectives and lessons learned in lean training and education. The authors provide guidelines for developing adequate training that considers a good mix of learning modules, case studies, simulations, and field trips. Similarly, Pellicer and Ponz-Tienda (2014) outline the approach and outcomes of a lean construction course established as part of a master program in civil engineering. The proposed approach covers key aspects of lean construction, including its historical evolution, value stream mapping, pull production, The Last Planner® system (LPS), standardization, optimization of construction operations, Building Information Modelling (BIM), and Integrated Project Delivery (IPD). The authors credit the course's success to its dynamic approach, which integrates lectures, exercises, classroom games, and a term project. In a similar direction, Nofera et al. (2015) provide detailed descriptions of a teaching approach for lean construction targeted at university students. The authors also offered feedback on the effectiveness of the approach and suggests potential

areas for improvement. Only a few studies have addressed lean construction education in corporate environments. For instance, Alarcón et al (2006) and Pavez and Alarcon (2008) report critical factors, barriers, and recommendations for the implementation of lean in construction organizations. The authors highlight that professionals' adequate social and technical competences are essential for efficient lean construction implementation.

Previous research in lean training and education provides valuable insights and guidance for the formulation of effective training programmes. However, a significant proportion of this literature focuses predominantly on the higher education environment (Tsao et al., 2012). Applying the results of these studies may become challenging when trying to use them directly in corporate settings, where professionals have diverse profiles. Furthermore, literature highlights the variability in the approaches adopted by construction industry companies in relation to lean construction training (Forbes et al., 2018). This variability is attributed to differences in organisational structures and strategic priorities. In particular, the translation of lean training programmes into corporate settings faces additional challenges, including resistance to change and the need to align training initiatives with the operational priorities of professionals tasked with project delivery. This paper aims to address this gap contributing to knowledge by presenting a practical case study of an organisation developing and implementing a training programme aimed at fostering lean construction skills among its professionals.

## **RESEARCH METHODOLOGY**

This research uses case study approach. Case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clear (Yin, 2014). The authors use different sources of data to describe and analyze the case study. This includes observations, documents produced by people involved in the case study, and surveys. An online survey was conducted at the end of the study to collect feedback and perspectives from individuals who successfully completed the training program. The authors triangulate data from the different sources to build a comprehensive understanding of the case and derive the insights and conclusion of the study.

## **CASE STUDY**

### **BACKGROUND**

The case study involves the development and implementation of a lean construction training program in a multinational construction services provider based in Switzerland. In addition to its presence in Switzerland, the organization conducts active operations across various central European countries, including Germany, France, Austria, Norway, and Sweden.

The main challenges the organization aims to address are related to scalability of lean construction implementation and sustaining lean practices in the long term. Prior to implementing the program, the organization conducted a series of lean construction pilot projects where lean construction specialists acted as coaches, actively supporting the different project teams. Lean construction specialists were centrally recruited by the organization and strategically positioned to provide dedicated support to project teams. The organization soon realized 2 main challenges in this approach. The first relates to resource constraints to efficiently broaden lean implementation. Depending on project complexity, lean construction specialists could only manage a handful of projects simultaneously. Scaling up lean construction implementation to a wider number of projects in different locations would require hiring an important number of additional specialists. The second challenge relates to the transfer of knowledge from one project to another and the dissemination of learnings within the organization. In many cases, people involved in the pilot projects learned the application of a specific tool and method in a given context without having a broader understanding of the

fundamentals and principles of lean construction. Furthermore, this project-based approach generated in many cases ad hoc implementation of different tools and methods defaulting the establishment of a certain level of standardization and systematization that supports leveraging learning across different projects.

Consequently, the organization opted for a transition from a project-centric strategy to a more “enabling approach.” This involved the training and activation of a supplementary layer of lean construction champions, specifically targeting individuals in closer proximity to operations, such as project managers and site engineers. This strategic shift aimed to cultivate greater autonomy in lean construction implementation, reducing dependence on central designated lean construction specialists and promoting long-term scalability.

## **LEAN TRAINING PROGRAM DEVELOPMENT**

The development of the lean training program involved 3 distinct phases: identification of requirements, development of the training program, and implementation.

### **Requirements**

The program’s organizational learning objectives aim to help trainees to gaining the knowledge, skills, and competencies required to implement lean construction independently and effectively. These overarching objectives guided the creation of the training concept and materials, ensuring a consistent approach in teaching lean principles and methods. By standardizing the training, the organization seeks to improve efficiency and benefit from the shared expertise of participants.

Nevertheless, reaching this standardization posed some challenges considering the broad range of requirements. Along with operating in different countries (different cultures and languages), the organization also executes various types of complex infrastructure projects covering a large variety of construction services including roads, bridges, special foundations, and tunnels. Thereby, the first step in developing the program was to reach a level of understanding of the needs of local contexts and types of projects. For this purpose, the authors conducted semi-structured interviews and workshops with local stakeholders in different locations to capture requirements to steer the training program development. These included target audience, delivery approach (e.g., online, face to face), duration, as well as the relevant specific lean subjects, tools, and methods to be prioritized.

### **Program development**

The overall structure of the program, as well as the content of the different training modules was developed collaboratively by all lean construction specialists involved in previous pilot projects. The content from pre-existing lean construction training modules within the organization was consolidated, enhanced, and supplemented with additional materials to fulfill the specified requirements. This was based on a structured plan to continually review and enhance the program's design and content using a Plan Do Check Act (PDCA) cycle.

Figure 1 depicts the overall program design consisting of 6 phases. The initial phase involves the nomination of employees for the training program. This involves selecting individuals from various business units, either through nominations or volunteering, in collaboration with management. This approach aims to ensure that the participants have the local support to invest time in the program and the personal willingness and commitment of different individuals to participate in the training. The second phase is onboarding and kickoff, where participants are introduced to the components of the program, including scheduling the different training sessions and workshops. In general, the program operates on a yearly basis, with local country units (e.g., Norway, Germany) defining their training schedules according to the local context. This aims to provide the flexibility to adjust the program according to the constraints and planning of the local organization.



Figure 1: Lean training program design

The third phase involves the delivery of different training modules. Except for the module “lean principles,” the sequence in training delivery relies on local planning based on business and operational needs. For instance, country units focusing on tunneling construction may prioritize and focus on different modules than units building bridges. Thus, local lean specialists responsible for conducting the trainings are provided with significant flexibility in delivering and adapting module content to meet specific needs.

The next phase considers the execution of a “live case” on an individual basis. During the live case, trainees are tasked with identifying improvement opportunities and applying the knowledge gained from the training to tackle those challenges. In this way, along with the training they can experience the problem-solving approach experimenting with new tools and methods for continuous improvement. Live cases are documented based on the structure provided by the A3 report. Close to the end of the program, trainees in a country unit (or region) get together and present their cases in peer feedback sessions. This provides them with the opportunity to share and exchange their cases and lessons learned with peers, gather feedback, and improve their approach.

At the end of the program, trainees complete a standard proficiency test to receive an external certification. This provides them with the opportunity to obtain proof of their training completion and competences in lean. To finalize the program, all trainees gather for a one-day event/conference organized at the company’s central office where they receive their official certificate. In this event, selected cases are presented in parallel sessions (in a conference mode), so trainees can also exchange and learn from cases developed by colleagues in other countries. The event also includes a field visit to partner organizations where they can see lean implementation in other contexts (e.g., manufacturing contexts or other projects). Different networking events are organized after program completion aiming to keep the community active, engaged, and exchanging ideas about continuous improvement.

## PROGRAM RESULTS

The results of the program presented in this section correspond to an online survey distributed to trainees at the end of the program. The purpose of this survey is twofold. First, to ensure quality in the delivery of the different modules, as well as to understand the value it delivers to participants in performing their work. Second, identify opportunities for improvement in different areas of the program (e.g., content, timing, organization, etc.). The survey considers a comprehensive analysis of 95 responses, including 38 inputs from the initial program implementation in 2022 and 57 from the subsequent training cohort in 2023.

In Figure 2, participants were initially asked about the overall rating for the training program and how likely they would recommend it to their colleagues. On average, participants rate the program with a 4.3 score (1 – very poor, and 5 – excellent). Similarly, the average score for recommending the program to a colleague is 4.4 (Figure 2).

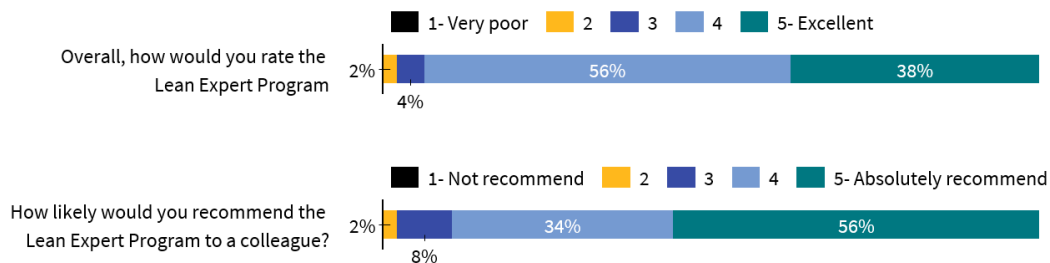


Figure 2: Overall lean training program evaluation

Following a similar approach, Figure 3 summarizes feedback from different aspects of the program. Overall, the program received positive evaluations in all dimensions, especially regarding the knowledge and capabilities of the trainer, as well as the interactive approach to deliver the content.

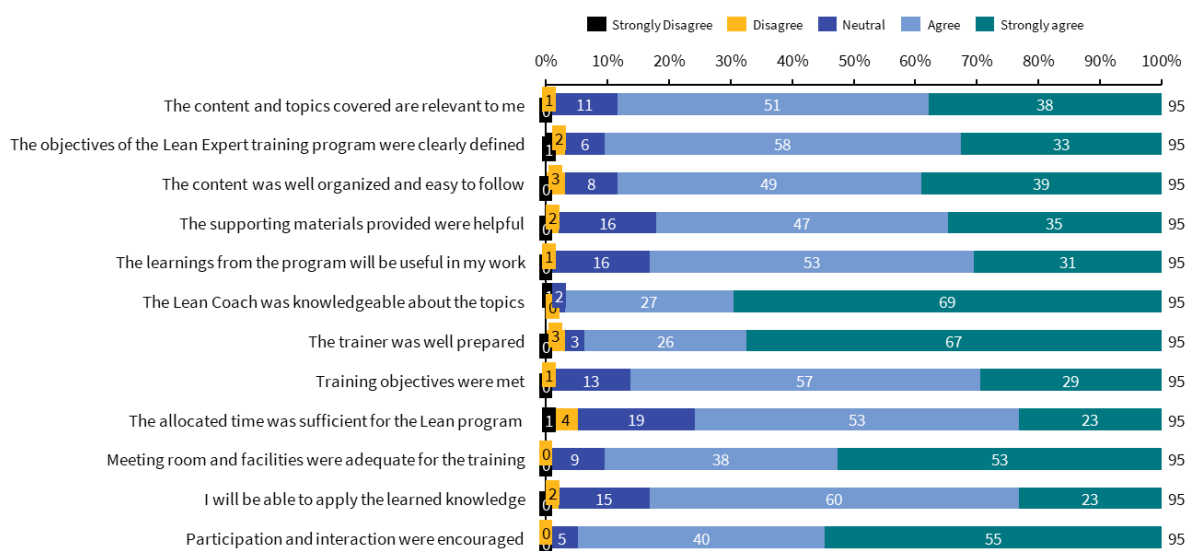


Figure 3: Training program evaluation

Following the plus and delta approach, survey participants were asked to offer written insights regarding the program's strengths and areas for improvement. On the positive side, numerous responses underscored the value of exchanging ideas and experiences with colleagues from diverse business divisions during various training sessions and the program's closing event. Another highlighted aspect is the hands-on approach to training, incorporating real-case implementations and simulations to illustrate the practical application of lean principles. While this aspect received positive evaluations, participants expressed a strong desire for even more hands-on involvement and real-life examples to demonstrate the significance of these principles in their daily work. For instance, some inputs indicate that certain sessions were “still too theoretical and not applicable 1 to 1 to construction operations.” Other inputs indicate that “sometimes it was hard to transfer all of the examples to actual situations on site.” Further opportunities for improvement relate to the time availability for people to undertake the program and the challenge to balance this with their daily operations. This aligns with the

dimension “the allocated time was sufficient for the lean program” in Figure 3 which received the highest “disagree” and “neutral” inputs. Some people indicate that the time required for the program was “difficult to combine during an ongoing project.” Others indicate having “...little time parallel to work.”

## **DISCUSSION**

The authors build the discussion section triangulating learnings and results of the case study organizing them into 2 main areas: program development and implementation (including survey results).

### **PROGRAM DEVELOPMENT**

#### **Internal vs external training**

At the beginning of the process the authors were confronted with the discussion of developing an internal vs external training program. In-house training utilizes internal resources, tailoring content to organizational needs, while external training, leverages external industry experts and practices (e.g., Abhishek et al., 2018). The organization already explored external trainings with dissimilar results. Most of the feedback for this was the lack of practical examples to assimilate the concept and a limited range of practical tools provided in these trainings. For instance, most examples were related to high rise building construction using takt planning but not too related to complex infrastructure (e.g., road, tunnel construction). Furthermore, organizing a training in different countries and languages proved to be complicated with an external provider/consultant, thus the decision was made to develop an in-house training. This approach required significant investment at the beginning of the process. The experience shows that a tailored approach for the organization pays off contributing to increased buy-in from participants. Another positive aspect of an internal training is the flexibility to continuously improve the program based on real case examples and learnings from operations (e.g., incorporating live cases as best practices).

#### **Standardization versus flexibility**

The program balances both standardization and flexibility by incorporating in the design modules which can be organized and delivered in the training according to the local operational context of a regional/country unit. The delivery of foundational modules related to lean construction principles and basics is mandatory for all units, while certain method/tool-oriented sessions are emphasized according to the local context. For instance, a region working with different subcontractors and difficult interfaces may emphasize coordination via LPS, while other units working on tunneling projects place more emphasis on Value Stream Mapping to support adequate material flows in critical supply chains. Accommodating the needs of different countries and operations required an intense collaborative development process gathering requirements and building consensus among the lean construction specialists (trainers) to design the training program.

## **IMPLEMENTATION**

#### **Building a strong network and the “multiplier” effect**

Along with providing trainees with skills to implement lean construction more independently, the program allows the creation of an additional network of people capable and willing to experiment with new methodologies for continuous improvement. This additional network creates a “multiplier” effect supporting the scalability and transfer of good practices from one project to another. Although not the case for all trainees, the experience shows that in many cases trainees started implementing their learnings (e.g., a lean tool or method) in new projects

with little, or no support from a designated lean construction specialist. This is a positive effect that was originally one of the goals of the program. The experience also demonstrates that, in order to keep this network active, it is very important to consider the organization of regular exchanges where trainees can keep exchanging ideas and knowledge.

### **Quality of live cases**

A critical component of the training program is the live case, where trainees can identify opportunities for improvement and put in practice learnings in a structured approach to problem solving documented in an A3. This allows the identification and consolidation of various ideas and approaches to problem solving realized by trainees. However, there is a considerable variation in the quality of the cases in terms of both approach and content. While some live cases are executed exceptionally well, others merely meet the minimum requirements to pass the program. Our experience indicates that the issue lies not so much on the quality of the training but rather on the time availability of participants to invest in their live cases and the accessibility of local trainers to provide support and coaching. Working on the live case demands time and dedication, often underestimated by participants. Therefore, it is advised to recommend trainees to start with the problem formulation of their live case right at the beginning the program and to introduce the basic problem-solving processes as early as possible. As per our experience, participants tend to postpone the live case till the end of the program, prioritizing daily business/operations. This also matches the “time allocation” feedback collected in the survey. Another option could involve facilitating pair or group live cases to encourage collaboration and teamwork in the problem-solving approach simultaneously.

### **Participants dropping out**

While the trainee nomination phase involves aligning with local management and conducting personal discussions to assess both management support and individuals' interest in the training, the program still encounters instances of participants dropping out. Our experience shows that this has something to do with priorities defined by participants. When they have urgent matters to solve at the project level, they prioritize this over the program. When a participant has missed too many sessions, they are asked to leave the program, or alternatively to resume the following year. The time factor and balancing program participation versus daily business activities again plays an important role. The attendance rate for trainings is best when training dates are defined collaboratively involving trainees at the beginning of the program.

### **Practice-oriented sessions**

One of the most important aspects highlighted by the trainees is the inclusion of hands-on sessions and real-life implementation cases. Most of the modules include different types of simulations to support the learning experience. Similarly, the collective and bottom-up approach allowed the identification and centralization of good practices which are shared in the different training modules. The inclusion of these internal success stories demonstrates to trainees the applicability of lean in real context, while at the same time serving as inspiration of good practices to be implemented in projects. These current state best practices, templates and supporting materials to implement are consolidated and shared company-wide via an internal SharePoint “toolbox” website. As highlighted in the survey, trainees express a desire for more real-life cases. In response, the third round of the program incorporates the involvement of past trainees as guest speakers in various modules. These former trainees share insights into their experiences and the practical implementation of lean methodologies in their projects. Incorporating colleagues or peers into discussions on lean implementation not only cultivates participant buy-in, as they observe firsthand how their peers apply lean principles in real-world scenarios, but also enriches the sessions by addressing the challenges encountered during the implementation of specific methodologies in projects.



## LIMITATIONS AND FUTURE WORK

The findings of this study should be considered within the following limitations. In particular, the case study considers the specific context of a single organization. While recognizing the potential challenges associated with directly extrapolating the findings to other contexts, the authors assert that the empirical insights gained from this study offer valuable perspectives. These insights are relevant to researchers and practitioners involved in the design and delivery of lean training programs and contribute to a broader understanding of effective practices in similar efforts.

In terms of future work, a post-training survey 12+ months after completing the program would provide insights into whether the training has been integrated into daily operations and sustained. This is something that the authors envision to implement in the next years.

## CONCLUSIONS

This paper presents an innovative training program to scale up and support a sustainable implementation of lean construction in a multinational construction service provider. The positive evaluation of the program's various components is based on feedback from 95 trainees who have undergone the program over the 2 years since its effective implementation.

In terms of development, the collaborative and bottom-up approach to training development facilitated the creation of a program that effectively balances the need for standardization and flexibility. This approach ensures the implementation of a training program that leverages internal knowledge while meeting the diverse requirements of an international organization operating in differing geographies and construction-operation contexts. Insights gained through the implementation process highlight the importance of integrating real-life case studies and hands-on sessions into the training methods, fostering a more effective assimilation of various lean concepts. The delicate equilibrium between daily operational demands and the time commitment necessary for program participation also emerges as a pivotal consideration, as it significantly impacts the quality of participant engagement and involvement in the program.

The insights presented in this case study act as a valuable resource for researchers and practitioners alike, offering practical guidance for those aiming to execute training programs. Additionally, it assists in recognizing optimal approaches and potential challenges that require thoughtful consideration in similar initiatives.

## ACKNOWLEDGMENTS

We extend our gratitude to all individuals who have contributed to the development and participation of this lean training program. We also appreciate the engagement and valuable insights provided by the participants who have gone through it thus far.

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