

APPLYING LEAN IN CONSTRUCTION – CORNERSTONES FOR IMPLEMENTATION

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ABSTRACT

The majority of lean transformations fail to meet their initial expectations and end up as disappointments. Excessive focus on specific tools and failure to understand the philosophy or to motivate people in continuous improvement are often blamed for this. This research explores the cornerstones for successful lean implementation in the construction business. Research results based on 39 semi-structured interviews conducted in Finland and California suggest that managers should pay attention to the following aspects: building trust, motivation, ensuring skills and competence, developing and selecting the right people, and providing leadership. In general, lean should be embraced as a comprehensive management philosophy which requires a long-term viewpoint in order to achieve competitive advantage. In construction, it is important to pay attention to the way people are recruited, emphasize their social skills, and develop them through training. Building trust and constructing project teams based on participants' suitability and competence will help to move the industry forward, but managers should also learn to take advantage of crises, when organizations are at their most receptive.

KEY WORDS

Lean construction, transformation, culture, change, implementation.

INTRODUCTION

When the characteristics of lean organization were described by Womack et al. (1990) in the book *The Machine that Changed the World*, the interest toward lean started to grow. Later, Womack and Jones (2003) captured lean thinking into five principles – specifying value, identifying value stream, making value flow, pull, and pursuing perfection – and ever since, the diffusion of lean practices to many different industries has increased.

However, it is reported that the majority of lean transformations have fallen behind their initial expectations and achieved only modest success (Emiliani and Stec 2005). The success of other companies seems hard to replicate even though the tools and practices are often clearly described in the literature. Hence, many studies have focused on lean implementation during the past decade. The objective has been to identify different factors that make the difference between success and disappointment (Achanga et al. 2006, Scherrer et al. 2009) or to explain certain outcomes otherwise (Bhasin and Burcher 2006, Emiliani and Stec 2005).

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In the context of implementing lean in construction, various implementation practices and strategies have been presented. Alarcon et al. (2005) recommend an implementation strategy involving the development of training and research actions, proactive interaction, and collaboration among companies to overcome barriers related to time, lack of training, and general self-criticism. Arbulu and Zabelle (2006) propose a bottom-up implementation strategy in which lean is phased in to avoid resistance and ensure adequate support and leadership capabilities from management. The implementation practices of Danish and Californian contractors were compared by Jorgensen et al. (2005), who pointed out that lean must be set against the context in which it is being implemented. Key factors for lean implementation in construction have also been identified in various case studies but a wider study collating these insights in a single report, however, does not seem to exist.

This research investigates the construction industry so as to find out what industry professionals consider to be the basis for a successful lean implementation. The research question formed to specify the objective for this research is:

- What are the cornerstones for lean implementation in the construction business?

The paper is structured so that at first a brief historical background of lean is presented to provide general information on how lean thinking diffused into the construction industry. Then a literature review is conducted to conceptualize lean philosophy into an understandable framework and to avoid a common mistake whereby lean is understood as a collection of tools. The framework is then used in defining and identifying cornerstones from the interview data. Finally, the research findings are discussed and compared to existing literature, and conclusions made.

LEAN IN CONSTRUCTION

HISTORICAL BACKGROUND

Lean production is a management methodology that was developed on the shop-floors of Japanese car manufacturers, in particular, at Toyota (Womack et al. 1990). Until the mid-1990s, the primary emphasis was on reducing internal waste from production processes. However, lean as a concept has evolved over time with the organizations adopting it. A key development was the move away from merely eliminating waste and reducing costs to an approach that seeks to enhance value for customers and links this to customer needs. (Hines et al. 2004).

Lean thinking now focuses on identifying and delivering customer value by enabling a smooth product flow through value-adding processes. Although it started on the production floor, lean thinking quickly spread across the whole value chain and product lifecycle—from identification of customer requirements through to delivery of the finished product. Thus, lean concerns the entire organization, extending to involve both upstream and downstream stakeholders so as to ultimately constitute a lean enterprise. (Womack and Jones 2003).

The construction industry was exposed to lean ideas in the 1990s. First, Koskela (1992) challenged the industry to explore and adopt new concepts and techniques from manufacturing industry. Ballard (2000) developed the now widely used Last Planner® System of production control, while in the UK, lean manufacturing was promoted as a model to be emulated (Egan 1998). The lean construction movement has since expanded all over the globe.

LAYERS OF LEAN

Although lean construction has received increasing attention from academics and practitioners over the last two decades, it is still difficult to define exactly what the term “lean construction” means. There is neither a commonly used definition nor very much discussion of lean construction as an entire framework, as most prefer to approach it from more restrictive angles. (Jorgensen and Emmitt 2008). In order to get an understanding of lean as a whole, therefore, the most important aspects of it are described in the following paragraphs.

Principles and Culture

People often confuse lean with its tools or techniques and then fail to transform the organizational culture into one that empowers people and promotes lean philosophy throughout the value chain (Spear and Bowen 1999). However, as Bhasin and Burcher (2006) insist lean needs rather to be seen as a mindset that governs how one looks at a business or its processes. In lean, the general objective is to create customer value and make it flow without interruptions toward customers (Womack and Jones 2003). Lean culture can be described in terms of the following key tenets:

- *Customer first.* The five principles of lean—specifying value, identifying the value stream, flow, pull, and perfection—can be understood as strategic level principles applicable to all parts of a supply chain. These principles represent one philosophical perspective of lean concentrating on understanding and maximizing customer value (Hines et al. 2004).
- *Continuous improvement* (or *kaizen*) is the process of making incremental improvements, and achieving the lean goal of eliminating waste that adds cost without adding value (Liker 2004). *Kaizen* ensures that the change does not end at one radical improvement, but that it involves a gradual improvement in the competence of all processes and people (Womack and Jones 2003).
- *Respect for people.* In lean, a great emphasis is placed on developing and empowering people. The knowledge of individuals or suppliers is appreciated and utilized when making decisions by consensus. The secret behind Toyota’s continuous success is in its deeper business philosophy and understanding of people and human motivation (Liker 2004).

Practices

A cultural transformation that involves people understanding and implementing a new philosophy to be successful, requires a system that can provide a basic stability and empower people. In addition to the philosophy and principles of lean, there are some effective practices that should guide lean organizations’ daily activities. These are not tools as such, but practices help to identify problems while at the same time protecting the system from variation and thus provide a basis for continuous improvement and learning. The common practices that should be adopted are:

- *Eliminating waste, unevenness, and overburdening.* The underlying principle of production leveling is that variation in products and processes usually causes problems; therefore it should be eliminated to keep the system stable, allow for minimum inventory and prevent further waste creation (Liker 2004).

- *Standardization* helps to define problems as the gap between the target and actual condition. Rigorous standardization protects systems from variation and provides a basis for continuous improvement and organizational learning—key competitive advantages to be achieved with lean (Morgan and Liker 2006).
- *Visual management*. In any process the ability to recognize and to remedy abnormal conditions quickly is important. As people are usually attracted by what they see, the objective here is to make communication simple and attractive (Tezel et al. 2010) so as to increase peoples' awareness of the current status of any process.

Tools and Methods

Hines et al. (2004) state that at the operational level, the use of any tools is possible if it supports the organization in implementing lean principles with the goal of providing enhanced customer value. Thus, the tools and methods represent the more practical perspective of lean where the focus is often on waste elimination. However, the use of any specific tool or method should be carefully considered in the context of the business environment, as each has its own specific requirements and lean transformation is a dynamic process, unique to each organization (Worley and Doolen 2006). The specific needs of different business environments mean that a wide variety of tools and methods have been developed for and used in lean implementation. Lean production, lean product development, and lean construction can be seen as toolboxes of lean in their specific environments.

- *Lean production*. Largely been imitated from Toyota, the tools of lean production have the objective of minimizing the production lead time by perfecting the flow of materials and information. Techniques of lean production include, for example, just-in-time, kanban, single-piece flow, SMED, 5S, andon, jidoka and poka-yoke (Ohno 1988).
- *Lean product development*. The main idea of lean product development is to take all available knowledge into account early in the product development process by front-loading it with skilled people. Tools or methods that tackle the specific needs of product development include, for example, co-location, QFD, and supplier involvement (Morgan and Liker 2006).
- *Lean construction*. Many of the above mentioned techniques have been transferred into construction and supplemented with methods like the Last Planner® System (Ballard 2000), relational contracting (Matthews and Howell 2005), choosing by advantages (Parrish and Tommelein 2009), and target costing and BIM (Pennanen and Ballard 2011).

BUILDING A LEAN ENTERPRISE

Earlier, lean construction was regarded as one of the lean toolboxes which suggest that it is merely a methodology that organizations can use in their construction projects. However, a lean organization utilizes the lean philosophy across the entire organization, which is the only way to create a lean enterprise and to achieve the full benefits of lean. In fact, the lean enterprise is a complex socio-technical system which consists not just of the core company but of the network of companies which aim to

provide mutual benefits through collaboration. There is a foundational difference in lean enterprise in that it identifies multiple stakeholder values instead of just those of the customer: what is a wasteful activity for one company may still provide value for the network (Bozgodan 2010). This is particularly relevant in the construction business where companies are heavily influenced by other project participants.

CORNERSTONES FOR IMPLEMENTING LEAN IN CONSTRUCTION

Thirty-nine semi-structured interviews were conducted in several companies and projects in Finland and California during fall 2011. The aim of the interviews was to explore practitioners' perceptions of lean implementation and thereby to identify cornerstones for the successful implementation of lean in construction. Interviewees represented a wide variety of construction professionals: architects, designers, project managers, project engineers, lean champions, and general or other senior managers. As the construction industry is very much a project intensive business, interviewees may naturally have had a project mindset and which may have affected their responses.

The interviews produced an extensive list of different factors that were thought to be important in lean implementation. After reflecting on these factors in respect of the different layers of lean, we have deduced that the implementation cornerstones represent larger concepts rather than more specific items, such as specific tools, bonus systems, or traits. Thus, we have grouped the factors into five categories that can be regarded as cornerstones for the implementation of lean in construction (Figure 1).

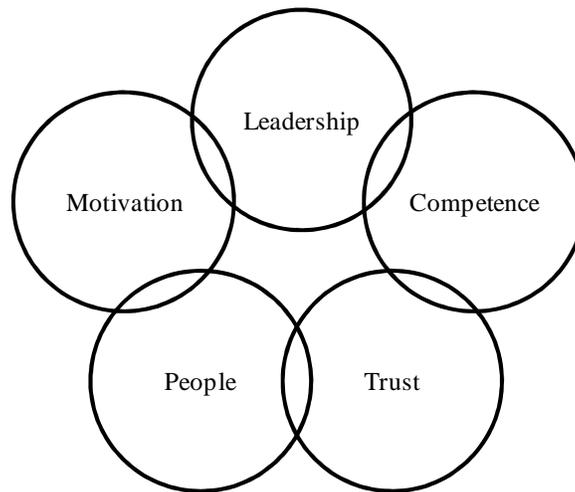


Figure 1: Cornerstones for implementing lean in construction

LEADERSHIP

The following quote from one senior associate perfectly highlights the important role of leadership and management in lean implementation:

“Leadership and management, if you don’t have those, then no matter [what] you do, you’re not going to have everybody involved in it and have a buy-in.”

Among interviewees in general, leadership and its related managerial aspects were regarded the most important factors influencing the success of lean implementation.

Interpreting the answers in more detail, this cornerstone comprises two main aspects. First, managers need to be committed to learning and understanding what it means to become lean and to changing their own behavior accordingly. They have to set an example and ensure a buy-in among people. Secondly, management needs to provide adequate resources to support a cultural transformation. Learning must be supported by organizing training, acquiring external lean consultants if needed, and, most importantly as the benefits may not be realized immediately, by allowing enough time for people to learn. As more projects are delivered utilizing lean, more and more people are exposed and become engaged with lean ideas, and thus begin to work differently.

COMPETENCE

Going lean requires a certain holistic understanding of lean philosophy to see how the system works as a whole. In construction where the time frame for learning is limited and project teams consist of people in multiple roles with different levels of knowledge and understanding of lean, training has a crucial role in supporting lean implementation. Also seen as crucial in providing knowledge and helping others to see things through a lean mindset is a change-agent or a lean champion someone who is dedicated to promoting lean in an organization and its projects (guides, trainers, consultants, helpers, senseis were among the other terms used by interviewees for this role). In short, it was thought that a wider comprehension needs to be in place when implementing lean because people need to know and understand what is happening.

PEOPLE

This group or cornerstone includes aspects concerning both individual people and other organizations. Starting with people, it was noted that implementing lean requires people who are willing to work with new concepts and come out of their silos, which effectively means also having the social skills to work in more collaborative environments. Knowing a partner's core competences and interests is important as it helps to understand who you are working with, prior to that, in selecting the project team and other participants based on the suitability of their skills and traits. However, many interviewees considered that more customers, design firms, and contractors committed to lean ideas are needed. Respondents clearly felt that real benefits and high optimization cannot be achieved without the help of others and that their hands are often tied if colleagues are not committed to the process or learning new, collaborative ways of working. This shows how dependent project-based companies are on other organizations, and leads to the issue of trust.

TRUST

Building trust among the companies involved in a project was seen as vital to lean implementation, as this quotation from one MEP project manager suggests:

“Trust among the companies involved in the project—you have to have trust; it's probably the biggest cornerstone.”

Some interviewees considered that an appropriate contractual agreement balancing the interests of participants can be a cornerstone for lean implementation; in our analysis, however, this essentially just provides means for building trust along with motivation. A few interviewees also thought that in order to optimize projects,

someone should always be in charge; otherwise people would find a way to self-optimize. Developing just a contractual framework to support lean may not be enough to make people to behave in a certain way. Instead, the company or person in charge should set the tone, establish expectations and the conceptual framework, and then involve those willing to work within this.

MOTIVATION

Interview data shows multiple aspects that are used to motivate people and companies to learn and implement lean. Construction organizations in general were thought to need a little bit of ‘an outside influence’ from clients and lean consultants to transform their thinking and working methods. Also mentioned were financial incentives, saving money, and making work more efficient. Installing the culture of continuous improvement, however, probably needs something more fundamental: namely, the involvement and engagement of people. Using metrics may come to help when motivating people, for example, while exposing problems helps to build urgency and shows the need for improvement. Interviewees thought that in order to stay committed to learning and improving, opportunities must be offered to people to use their skills and to see how lean concepts work in practice.

DISCUSSION

The analysis of interview results reveals some construction-specific aspects that are not generally mentioned in the wider literature on lean implementation. Building trust appears to be crucial in moving toward more collaborative ways of working in the construction industry. In this context, it should be understood that the contractual frameworks are only a part of the equation, and that more attention should be paid to how people are recruited and developed through training and how project teams are constructed. It was apparent that social skills are implied in lean construction, and that these should be included into recruitment criteria while a long-term viewpoint should be taken towards the development of people and supplier relationships.

For the most part, the interview results support the point made by Achanga et al. (2006), Bhasin and Burcher (2006), Spear and Bowen (1999), Worley and Doolen (2006), that strong leadership ethos and committed management and support have a great influence in the success in implementing lean within an organization. However, we were left with the feeling that construction companies have a quite centralized approach where the responsibility of actual cultural change is often on the shoulders of “lean champions”. Rather, managers need to take the prime responsibility in transforming themselves and their organization from “fat” to lean behaviors (Emiliani 1998) and balancing the objectives set for lean and their own behaviors, management practices, and business metrics (Emiliani and Stec 2005). The right leadership behaviors that link up the theoretical concepts to practical applications are needed in order to make a real impact in construction organizations and industry (Orr 2005). It is also worth remarking that in successful transformations, there is always a powerful coalition leading the change (Kotter 1995).

One thing that did not come up during the interviews was the comprehensiveness of lean. This may be because most of the interviewees work in projects and thus develop a project or operations mindset when discussing the implementation matters. In the literature, the comprehensiveness of lean is discussed by many authors. Emiliani and Stec (2005) stress that lean is a management system whose objective is

to change the way all work activities are performed, not just those in operations. Womack and Jones (2003) think that real benefits of lean can only be achieved by implementing the philosophy across the organization while Liker (2004) also promotes the total approach. Spear and Bowen (1999) believe that people often confuse the tools and practices with the system itself and fail to see the different elements that support each other as a system. Focusing only on tools and techniques may lead to lean being built on an unstable foundation where the basic understanding is not in place (Radnor and Walley 2008).

The other thing that was mentioned only by one interviewee relates to a more traditional change management strategy—management by crisis. Womack and Jones (2003) state that managers should be encouraged to take advantage of any crises, as an organization free of crisis may not be ready to change. Kotter (1995) has similar experiences and also stresses the importance of establishing a sense of urgency in making a successful transformation. Internalizing this may open up great avenues for implementation. A lean approach demands that the best people are sent to help where problems arise and a culture of teamwork to be developed to replace the stubborn, “I can do it by myself” mentality.

CONCLUSIONS

Many organizations around the globe are now interested in using lean to improve their businesses. However, they often fall behind their initial expectations and fail to transform their culture into one that empowers people and promotes a lean philosophy throughout the value chain. It is suggested that one of the problems is the dominant focus on tools rather than understanding the philosophy as a multi-layer concept that comprises layers of principles and practices which, in conjunction with the tools, make systems stronger. In this research 39 interviews were conducted in order to identify cornerstones for successful lean implementation in construction business.

In lean implementation in the construction business, according to the results of this study, managers should pay attention to the following cornerstones: building trust, motivation, ensuring skills and competence, developing and selecting the right people, and providing leadership. The common tool-focused approach is not adequate if the aim is to engage people in a continuous improvement and transform the organizational culture with the aim of building up sustainable competitive advantages. A better approach is to start building trust between individuals and other organizations and to ensure that employees understand what is happening and why. Leadership is needed as everyone must learn and adopt new ways of thinking and working, while commitment and support is needed to give the members of an organization enough time to show results.

As many construction organizations are currently working with lean, the cornerstones identified in this study should help them to overcome at least some of the problems they encounter with implementation. The exact methods by which each cornerstone should be put in place will be unique to each organization, but the analysis made in this study has revealed some of the practices that are already used in construction. The important thing is to consider how the practices and tools suit the needs of organizations and not to take lean as a cookbook recipe for success.

This study has some limitations. Most of the interviewees work in projects and thus may not have the vision to see what constitutes the organization-wide success

with lean. Also, the interviews were conducted in two countries and the findings may not represent the understanding of the whole industry. As Green and May (2005) and Jorgensen et al. (2005) have pointed out, the understanding of lean or lean construction often has localized features. Future research should be expanded to other countries for a more comprehensive view of how lean is practiced around the globe and how managers work with and around the cornerstones.

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REFERENCES

- Achanga, P., Shehab, E., Roy, R. and Nelder, G. (2006). "Critical success factors for lean implementation within SMEs." *Journal of Manufacturing Technology Management*, 17 (4) 460-471.
- Alarcon, L., Diethelm, S., Rojo, O. and Calderon, R. (2005). "Assessing the impacts of implementing lean construction." *Proc., 13th Annual Conference on Lean Construction*, IGLC, Sydney, Australia, 587-393.
- Arbulu, R., and Zabelle, T. (2006). "Implementing lean in construction: How to succeed." *Proc., 14th Annual Conference on Lean Construction*, IGLC, Santiago, Chile, 553-565.
- Ballard, G. (2000). "The last planner system of production control." Ph.D. Diss., School of Civil Engineering, The University of Birmingham.
- Bhasin, S. and Burcher, P. (2006). "Lean viewed as a philosophy." *Journal of Manufacturing Technology Management*, 17 (1) 56-72.
- Bozdogan, K. (2010). "Evolution of the Lean Enterprise System – A Critical Synthesis and Agenda for the Future." *Encyclopedia of Aerospace Engineering*.
- Egan, J. (1998). "Rethinking Construction." Department of Environment, Transportation and the Regions, London.
- Emiliani, M.L. (1998). "Lean behaviors." *Management Decision*, 36 (9) 615-631.
- Emiliani, M.L. and Stec, D.J. (2005). "Leaders lost in transformation." *Leadership & Organization Development Journal*, 26 (5) 370-387.
- Green, S. D. and May, S. C. (2005). "Lean construction: arenas of enactment, models of diffusion and the meaning of 'leanness'." *Building Research & Information*, 33 (6) 498-511.
- Hines, P., Holwe, M. and Rich, N. (2004). "Learning to evolve: a review of contemporary lean thinking." *International Journal of Operations & Production Management*, 24 (10) 997-1011.
- Jorgensen, B., Emmitt, S. and Ballard, G. (2005). "Divergent focus in the application of lean ideas: Examples from Denmark and California." *Proc., 13th Annual Conference on Lean Construction*, IGLC, Sydney, Australia, 395-403.
- Jorgensen, B. and Emmitt, S. (2008). "Lost in transition: the transfer of lean manufacturing to construction." *Engineering, Construction and Architectural Management*, 15 (4) 383-398.

- Koskela, L. (1992). "Application of the new production philosophy to construction." *Technical Report #72*, Center for Integrated Facility Engineering, Department of Civil Engineering, Stanford University.
- Kotter, J.P. (1995). "Leading change: Why transformation efforts fail." *Harvard Business Review*, 59-67, March-April.
- Liker, J.K. (2004). *Toyota Way: 14 management principles from the world's greatest manufacturer*. McGraw-Hill, New York.
- Matthews, O. and Howell, G.A. (2005). "Integrated Project Delivery - An Example of Relational Contracting". *Lean Construction Journal*, 2 (1) 46-61.
- Morgan, J.M. and Liker, J.K. (2006). *The Toyota Product Development System: integrating people, process and technology*. Productivity Press, New York.
- Ohno, T. (1988). *Toyota Production System – Beyond large scale production*. Productivity Press, New York.
- Orr, C. (2005). "Lean leadership in construction." *Proc., 13th Annual Conference on Lean Construction*, IGLC, Sydney, Australia, 345-351.
- Parrish, K. and Tommelein, I.D. (2009). "Making Design Decisions Using Choosing by Advantages." *Proc., 17th Annual Conference on Lean Construction*, IGLC, Taipei, Taiwan, 501-510.
- Pennanen, A., Ballard, G. and Haahtela, Y. (2011). "Target costing and designing to targets in construction." *Journal of Financial Management of Property and Construction*, 16 (1) 52-63.
- Radnor, Z. and Walley, P. (2008). "Learning to walk before we try to run: adapting lean for the public sector." *Public Money & Management*, 28 (1) 13-20.
- Scherrer-Rathje, M., Boyle, T.A. and Deflorin, P. (2009). "Lean, take two! Reflections from the second attempt at lean implementation". *Business Horizons*, 52 (1) 79–88.
- Spear, S. and Bowen, K. (1999). "Decoding the DNA of the Toyota Production System." *Harvard Business Review*, 97-106, September-October
- Tezel, A., Koskela, L. and Tzortzopoulos, P. (2010). "Visual management in construction: study report on Brazilian cases." *SCRI Research Report #3*, University of Salford.
- Womack, J., Jones, D. and Roos, D. (1990). *The Machine that Changed the World*. Rawson Associates, New York.
- Womack, J. and Jones, D. (2003). *Lean Thinking: banish waste and create wealth for your corporation 2nd ed.* Simon & Schuster, New York.
- Worley, J.M. and Doolen, T.L. (2006). "The role of communication and management support in a lean manufacturing implementation." *Management Decisions*, 44 (2) 228-245.