

LEAN CONSTRUCTION WITH OR WITHOUT LEAN – CHALLENGES OF IMPLEMENTING LEAN CONSTRUCTION

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ABSTRACT

Since the introduction of Lean Construction, implementation of Lean Construction method, tools, and thinking has been a challenge. The success of Lean Construction is evident, but still implementation challenges emerge, among others, culture, training, leadership, but also partial implementation of Lean Construction. Some reports indicate that the major implementation challenges are related to mis-conceptualization of lean construction tools, and case studies have found that often Lean Construction was either partially or incorrectly applied.

Denmark is one of the pioneer countries in the Lean Construction journey, with the driving force of Sven Bertelsen and MT Højgaard among others. It is considered a country with a widespread and deep implementation of Lean Construction. But how disseminated is Lean Construction in reality? And do those who claim to apply lean construction actually do lean construction?

On the basis of these questions this research contributes with a survey with a magnitude of 500 practitioners from the Danish construction industry. Results of this survey are compared with recent IGLC research on implantation challenges of lean construction. This research itself does not put forward any improved guide on how to implement lean construction. Instead it brings light to how lean construction is actually applied. In itself this is very interesting, and is valuable knowledge that can be used in further research on lean construction theory and on implementation of lean in the industry.

KEYWORDS

Implementation, Last Planner System, Knowledge

INTRODUCTION

In Lean Construction communities we are quite sure about Lean Construction's ability to optimize construction processes, and we have a good feeling on a widespread and successful use of lean. But how widespread is the implementation of Lean Construction in reality? And do those who claim that they apply lean actually do lean? These are really good questions in relation to implementation of Lean Construction worldwide. Despite the advantages of the LPS, research has shown that many organizations face significant barriers when implementing Lean Construction ideas (Ballard and Kim 2007; Hamzeh 2011; Viana et al. 2010).

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In the past 5 years more than 20 papers have been presented at IGLC conferences putting evidence forward on obstacles and barriers for successful implementation of Lean Construction. To this a significant amount of academic papers published elsewhere can be added, documenting an increasing awareness of the barriers on implementing Lean Construction and the necessity of surfacing this topic. On the other hand several case studies showcase successful use of Lean Construction, but most often not highlighting the change and implementation process. This leads to a rough conclusion that successful implementation is possible but troublesome.

THE NEED FOR FOCUSING ON IMPLEMENTATION

Several studies point out the need for strengthening the focus on implementation. Polesie et al. (2009) state that when implementing lean principles in construction organisations it is important to balance standardisation of activities with site managers' motivation. In order to increase the understanding of which processes that should be standardised without negatively influencing the site manager's ability to individually manage the project.

Nesensohn et al. (2012) applies the concept of "true North" to develop a guideline that takes a firm through a change process of becoming lean. It involves a 15-step model of maturing the organization to become a lean organization that delivers projects in one reliable end-to-end process.

Since Lean Construction has been adapted worldwide, successful implementation requires a proper adaptation to both the country's culture and the company that runs it. Considering these two factors. Cerveró-Romero et al. (2013) explores ways to add value during implementation while respecting the culture of the country and the company.

Barros and Alves (2007) and Leigard and Pesonen (2010) points out that many of the case studies on implementation of lean addressed implementation issues for a single project and do not consider implementation in a more holistic approach, e.g. as business models and opportunities.

ENABLERS AND DISABLERS – A LITERATURE REVIEW

At least 80 scientific papers constitute the foundation of this literature review on implementation challenges. Many papers are based on single or few construction projects. Others are based on industry surveys, either interviews or questionnaires. Finally, a few of the papers are summarized literature reviews, e.g. Leigard and Pesonen (2010) and Porwal et al. (2010). Main focus is on recent papers, i.e. within the last 5 years.

Table 1 presents a chronological review of scientific papers addressing implementation challenges of applying Lean Construction practice.

Table 1: Chronology of recent studies on implementation challenges.

Author(s)	Implementation challenge
Ballard and Kim (2007)	Presents a 14-step implementation model, inspired by Kotter’s “leading change”. The model is developed on basis of common implementation barriers.
Barros and Alves (2007)	Identifies that few articles discuss Lean implementation in a larger perspective as strategic business models etc.
Pavez and Alarcón (2008)	Discuss the dynamics of implementing Lean in an organization and identify that enterprise vision, technical and social competence need to be developed simultaneously in the organization.
Friblick et al. (2009)	About change production and planning methodologies in general. Requires more knowledge than available. The need of education is underestimated.
Kalsaas et al. (2009)	The largest challenge is the relationship between the architect, the general contractor and the owner, as the pattern in the relationship appears to be dysfunctional in order to create best possible condition for cooperation. Moreover, mis-conceptualization of Lean Construction tools.
Brady et al. (2009)	Minimum involvement of construction workers. Inadequate preparations and training. Lack of role definition. Inadequate information. Time constraints due to deadlines. Non-integrated production supply chain.
Polesie et al. (2009)	Discusses the challenges of standardised activities and processes to reduce waste and increase efficiency. Based on interviews with eight site managers in three medium-sized Swedish construction firms, the indications are that processes should be developed slowly with a bottom-up approach
Chesworth et al. (2010)	Cultural maturity and human capital. It is an evolutionary process where empowerment and maturity is central.
Viana et al. (2010)	Questionnaires combined with interviews with senior staff in contractors. Contractors seem to only implement part of the LPS system, e.g. weekly work plans, but neglecting the look-ahead and constraints removal. Moreover, culture, personal qualifications, and lack of communication are identified as key barriers.
Leigard and Pesonen (2010)	The ambition is to establish a standard framework of the fundamentals required to deploy Last Planner System
Morrey et al. (2010)	Understanding path dependencies will enable them to be overcome, or capitalised upon, and that such an analysis of path dependencies is a useful diagnostic tool for lean implementation.

Porwal et al. (2010)	17 papers from 2000 – 2009 on the implementation topic. 12 general trends were discovered. Among others Lack of training, Resistance to change. Lack of leadership and management support. Requires additional resources. Partial implementation.
Nesensohn et al. (2012)	It is highlighted that the implementation of Lean in construction project management often requires both a change in organisational culture and structure. It is also stressed that the effective implementation of Lean requires a rigorous analysis of the organisation's capability in relation to becoming more lean
Ahiakwo et al. (2013)	The paper concludes by discussing possible barriers hindering the full potential of LPS. These barriers include; lack of commitment to change and innovation, and starting off the implementation half way into start of the project.
Barbosa et al. (2013)	A single mega project. Status after year 1 out of 10: The greatest difficulty for the implementation of LC concepts was to promote understanding to field employees, such as foremen and crew leaders. It was difficult to understanding of the new philosophy of planning and production, as well as the importance of complying with the program that they helped draft.
Cerveró-Romero et al. (2013)	5 different projects in one contracting firm. Discovered Barriers are: Language and culture, resistance towards change of senior craftsmen. Incorrect interpretation of LPS. Lack of training for contractors and subcontractors.
Sarhan and Fox (2013)	Based on interview with industry three significant barriers to implantation of LC were discovered. Lack of adequate awareness and understanding. Culture & human attitude issues. Lack of top management commitment. Also included an extensive literature review, citing more than 40 scientific papers. Contractual issues. Culture and human attitudinal issues. Resistance to change. Financial issues. Lack of top management support. Lack of lean construction awareness and mis-conceptualization of methods.

A wide range of implementation barriers are discovered in the review, but some occur more often. The most common barrier seems to relate to issues around insufficient knowledge (Friblick et al. 2009; Sarhan and Fox 2013; Viana et al. 2010), lack of training (Brady et al. 2009; Cerveró-Romero et al. 2013; Porwal et al. 2010) and education (Brady et al. 2009; Jara et al. 2009; Mossman 2009), and the maturity in general (Chesworth et al. 2010).

Cultural issue is also an often-mentioned barrier (AlSehaimi et al. 2009; Cerveró-Romero et al. 2013; Nesensohn et al. 2012; Sarhan and Fox 2013). Lean Construction is implemented world wide, with much variation in cultural contexts. Chesworth et al. (2010) mentions that cultural maturity and human capital, is an evolutionary process where empowerment and maturity is central for successful implementation. The culture of the construction industry is known to be opportunistic, prone to conflict and resistant to change (Bejder et al. 2008; Rooke et al. 2003). Therefore, changing traditions and culture seems to be a necessary prerequisite for implementing Lean Construction (Sarhan and Fox 2013).

MIS-IMPLEMENTATION OF LEAN CONSTRUCTION

Several of the identified barriers, cf. table 1, is related to in-correct use or implementation of Lean Construction methods and mis-conceptualization of lean construction theories and tools (Kalsaas et al. 2009). Through a large industry survey Viana et al. (2010) found that many contractors only implements selected parts of e.g. the Last Planner System. Lindhard and Wandahl (2013) confirm this through 5 case studies and a survey, documenting that a partly implemented Last Planner System can be a main barrier to increased efficiency.

Porwal et al. (2010) and Ahiakwo et al. (2013) also found that Lean Construction principles often are either partially applied or implemented half way through the project. In Cerveró-Romero et al. (2013) analysis of 5 different projects the conclusion is also that Lean Construction methods is incorrect interpreted and implemented.

RESEARCH FOCUS AND DELIMITATIONS

The identified mis-conceptualization and wrongly or partly implementation is a central issue in understanding the current use and widespread of Lean Construction. This topic is, therefore, in focus in this research.

The research questions are hence “How widespread is the actual use of Lean Construction principles?” and in addition to this “How, and how correct, is Lean Construction implemented in companies/projects?”

This research only investigates the Danish construction industry, and is methodological based on a questionnaire approach.

METHOD

It was decided to apply a questionnaire as means of collecting data of how widespread (disseminated) as well as how deep (not mis-conceptualized) Lean Construction is implemented. Furthermore, it was decided to use an online survey tool that could distribute the questionnaires by email and collect the data through an online database. Reported disadvantages of using questionnaire for data collection (de Vaus 1993; Delgado-Hernandez and Aspinwall 2005), such as interpretation of questions, low response rate and sampling issues, were handled by preliminary testing of the sample in terms of validity and reliability.

DESIGNING THE SURVEY

Google Docs were used to develop the questionnaire and to collect the data. The survey was design to take into account the respondents different experience with Lean Construction. A schematic presentation of the survey structures is illustrated in figure 1. Besides the questions shown in figure 1, a range of background questions was also applied, i.e. company type, age, experience, etc.

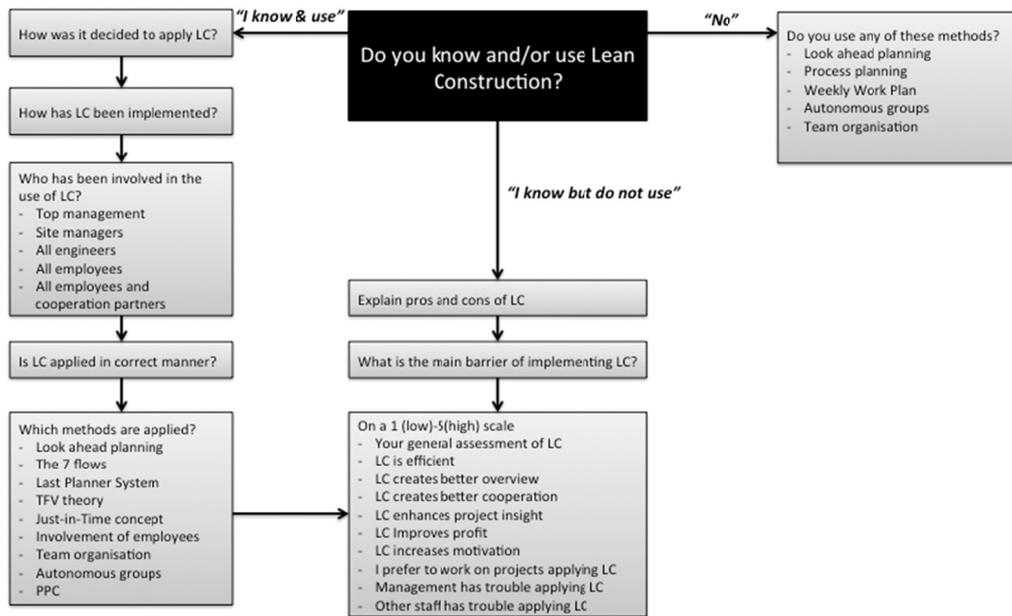


Figure 1: Schematic illustration of questionnaire structure (own translation into English language).

DATA COLLECTION

The original questionnaire was written in Danish language. The questions seen in figure 1 are, therefore, later translated. The theoretically population was all practitioners in the Danish construction industry. Focus was on obtaining as large sample as possible, therefore the questionnaire was open for all to answer, and distributed widely. Social media, mail groups etc. combined with direct company approach has resulted in a sample consisting of almost 500 respondents. Figure 2 show the distribution on respondents based on company type and organizational level. The survey was carried out anonymously, but respondent could provide contact details if they were interested. The questionnaire was open for answering for about 40 days, and thereafter closed.

SAMPLE VALIDATION

Due to the data collection method it is not possible to calculate a response rate. Instead the 485 answers are analyzed to check for comparability with population.

Figure 2A illustrates that 70% of the sample's respondents is management. This percentage is very high, and do not reflect that 70% of people working in the construction industry has a management position. On the other hand it also reflects that companies in the construction industry often are relatively small companies, e.g. a master and a few apprentices.

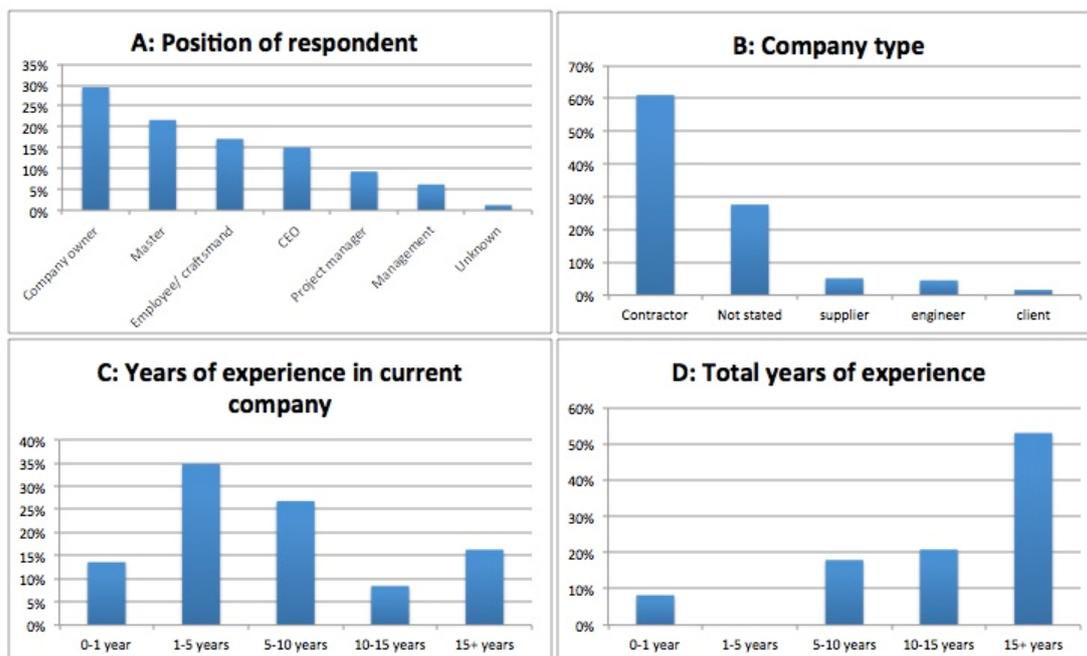


Figure 2: Distribution of basic demographic data.

The sample consists of mainly contractors, 60% as illustrated in figure 2B. This high percentage can be explained by the fact that lean construction often is seen as a production, planning and control philosophy focusing on execution of production. In general the sample has a high accumulative experience, since more than 70% exceeds 10 years of experience, cf. figure 2D. Figure 2C illustrates the mobility of the industry, where it can be seen that the distribution of experience in current company not is related to the accumulative experience distribution. In total it is concluded that the sample is a valid representation of the construction industry’s view on this matter.

FINDINGS AND DISCUSSION

The questionnaire developed 3 different “roads” depending on how the respondent answered the first question “Do you know and/or uses Lean Construction?” The distribution to this answer is illustrated on the left hand side in table 2.

Table 2: Left hand side, n= 485. Right hand side is based on “no” hence n=375

Do you know and/or uses LC?		Do you use any of these methods?	
I know and use	30 (6%)	Look ahead planning	144 (28%)
I know but do not use	80 (17%)	Process planning	83 (16%)
No	375 (77%)	Weekly work plan	201 (39%)
		Autonomous groups	49 (10%)
		Team organization	33 (6%)

Main conclusion from table 2 is that the awareness of Lean Construction is considerable low. Only 23% of the sample do know and/or apply the principles of

Lean Construction. This is unexpected low. Moreover, only 6% do actually apply LC methods. But when analysing the data more deeply this perception changes. Out of the 77% of the sample who did either know or use LC many of them applies different planning techniques, cf. right hand side of table 2. In fact only 71 out of the 375 (19%) did not use one of the different planning techniques that could be seen as sub element of LC and especially the Last Planner System. It seems therefore possible that many in fact are Lean without knowing it.

If investigated how many of the 375 respondents that have checked both Look ahead planning, Process planning and Weekly Work plan as applied tool, the amount of “I know and use Lean Construction” increases from 30 (6%) to 66 (14%).

Relevant it is also to analyse the large sub sample of respondents claiming not to have applied Lean Construction, to investigate if any respondents in this group might have mis-conceptualized or mis-implemented Lean Construction. This can be done in terms of analysing which subparts of the Last Planner System the respondents seems to have implemented and used. This data is illustrated in table 3.

Table 3: Possible mis-implementation of LC (Last Planner System), n=375.

Planning method applied (sub element of LPS)	Number
Look ahead planning only	42 (11%)
Process planning only	20 (5%)
Weekly work planning only	93 (25%)
Look ahead and Process planning in combination	5 (1%)
Look ahead and Weekly work planning in combination	34 (9%)
Process and Weekly work planning in combination	13 (3%)

From table 3 it can be concluded that 25% of the sample, who has not implemented lean, applies Weekly work plan. This is a very high percentage also in relation to the percentage of the sample that has applied either look ahead planning (11%) or process planning (5%). A possible explanation is that the expression “A weekly plan” is a commonly used method for planning your work, and could as such not be directly (standing alone) connected to any Lean or Lean Construction principle. The same could be the case for applying process planning (5%), but unlikely for the Look ahead planning which refers to a very specific sub part of the Last Planner System. When combining two of the three sub planning tasks it is also very likely that the company in fact have attempted to implement the Last Planner System, but again without that the actual respondent is aware of this Lean Construction process.

Hence 94 respondents (42 + 5 + 34 + 13), equal to 25% of the sample, has mis-conceptualized or mis-implemented Lean Construction. This is an extreme high percentage. If related to the complete sample of 485, we can conclude 19% or more has mis-conceptualized or mis-implemented Lean Construction. This number can grow as we later analyse the group of respondents who has replied that they actually are conducting Lean Construction. Why this mis-conceptualization or mis-implementation has occurred cannot be analysed based on these data, hence this group of respondents (the one answering “no” to whether they know and/or uses LC) has not been asked question in relation to implementation of LC since it would not have made sense to the respondents. But clearly, education, training and knowledge,

as mentioned in the literature study, must be one of the main barriers. Also one could guess that lack of resource also could come into play.

Shifting focus now to the 30 respondents who stated that they know and currently applies Lean Construction methods. On a Lickert scale from 1 (low degree) to 5 (high degree) the 30 respondents answered the question “*Is Lean Construction applied in the correct manner?*” The distribution is illustrated in table 4.

Table 4: Actual vs. intended use of Last Planner System, n=30.

Is Lean Construction applied in the correct manner?		Which tools are applied?	
1 (Low degree)	1 (4%)	Look ahead planning	24 (80%)
2	1 (4%)	7 flows	12 (40%)
3 (neutral)	13 (48%)	Last Planner Concept	6 (20%)
4	9 (33%)	TFV model	1 (3%)
5 (high degree)	3 (11%)	Just-in-time concept	15 (50%)
		Involvement	14 (47%)
		Team organisation	9 (30%)
		Autonomous groups	7 (23%)
		PPC	6 (20%)

Table 4 also illustrates the distribution among the application of different Lean Construction concepts, such as Look ahead planning, PPC, etc.

From the left hand side of table 4 it can be seen that the respondent perceives Lean Construction to be correctly implemented. Only 8% answers below neutral. This perception do not match the data on the right hand side of table 4 illustrating the application of different sub parts of Lean Construction. E.g. only 20% of the respondents do actually apply a PPC measurement, even though 80% uses a Look ahead schedule. There seems, therefore, to be both a mis-match between intended application and actual application as well as a tendency towards partly implementation of Lean Construction. The mis-conceptualization can be further observed in the data by e.g. the disharmony of applying the 7 flows (40%) and applying the Last Planner concept (20%).

In this sub sample it is possible to further investigated reasons in the implementation strategy for this mis-conceptualization. The respondents were asked to answer an open-end question on how Lean Construction was implemented in their company. Certainly not all respondents are able of answering this question, among others because they might not have been employed in the company at the time of implementation. Figure 3 illustrates the groupings of the different implementation strategies. It is evident, that the main implementation strategy is through internal education. This should prove to be a sound strategy. But also a large group of respondents just implemented it through “good sense” or as DIY projects. This is theoretically not a sound strategy.



Figure 3: Grouping of different implementation strategies, n=30.

The last group of respondents, those who know Lean Construction but do not use it (n=80) has among others been asked what they consider as the main implementation barrier. This was on an open-end question. The main implementation barrier mentioned is lack of knowledge, which corresponds well with the conclusions of the literature review. The respondents often also mention lack of commitment, cooperation, and communication. This is not a technical skill, but more personal and soft barriers, closely related to the general resistance towards change. All these barriers have also been identified in the literature review. Such a resistance could be treated in terms of developing “the burning platform” and Kotter’s generic implementation model as mentioned in Ballard and Kim (2007). It seems therefore that the implementation barrier sometimes not is on a single project, but more in terms of anchoring the change in companies by seeing Lean Construction as a strategic business model. This view has been presented by Pavez and Alarcón (2008), Barros and Alves (2007), and Leigard and Pesonen (2010).

CONCLUSION

Barriers when implementing Lean Construction are identified as very import focus area, and extremely relevant for future success and further development of Lean Construction in the pursue of an efficient construction process. This research addressed two questions in that relation. The first question was on how widespread the actual use of Lean Construction is. This has been investigated in the Danish construction industry through a questionnaire survey with 485 replies.

The knowledge of Lean Construction was identified to 23%, implying that 3 out of 4 practitioners do not know Lean Construction. This should be improved, and it should be possible to improve.

The actual use of Lean Construction principles is even less widespread. 6% of the sample did know and actually use Lean Construction. The survey also investigated whether any unintended did apply Lean Construction or elements that is derived for Lean Construction, e.g. Look ahead Planning. 8% of the sample uses Lean Construction principles without known or calling it for Lean Construction. Therefore, the actual use of Lean Construction principles increases to a total of 14%

Mis-conceptualization and mis-implementation of Lean Construction was in the literature review identified as a main issue. This research confirms this problem. More than 25% applied Lean Construction elements (typically the Last Planner System) either partly or wrongly. This is a serious issue, because the full effect of e.g. an improved planning and control system will most likely not occur when implemented partly or wrongly. It seems that lack of knowledge, education and communication on the right level seems to be the main issues for this problem.

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