

Re-conceptualizing Lean in Construction Environments – 'the case for "AgiLean" Project Management'

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Through undertaking a comprehensive literature review and through the analysis of primary data collected from interviews with Lean Experts and Project Managers working in Germany, this research identified clear limitations and barriers to Lean in construction. These relate to the structure of the industry, working culture and to the management of complex construction projects. These limiting factors are specific to construction. This leads to Lean advocates re-conceptualizing the nature of the built environment, with the general approach being to make construction more like production. However, an alternative approach may be to re-emphasize construction as projects. So a Lean management approach needs the ability to react to change and become more flexible. This is not currently the focus of Lean construction approaches, as it requires a stable platform where processes can be forecasted with a high degree of certainty and hence can be optimized. Lean construction, therefore, might be improved with the inclusion of Agile paradigms. This paper introduces an approach labeled "AgiLean PM". The approach will be useful in situations where Lean needs to be more Agile. These situations are not just in the design phase of the project, but also in the execution phase of construction.

Key Words: Agile, AgiLean, Lean, Project Management, Germany

Introduction

Construction projects are typically high in complexity and to manage such highly complex projects calls for new management paradigms (Williams, 1999). In search for such paradigms the construction industry has promoted the use of "Lean": a management philosophy originated in the automotive industry. Lean is highly topical in the construction industry, yet it has a 'Guru-Hype' type character (Green, 1999b). This character has resulted in a discourse which is regarded by some as an extremely one sided interpretation of the usefulness of Lean (Green, 1999a; Green & May, 2003). It neglects or does not give sufficient consideration to the critical literature and research which exists on Lean production (Green, 1999b). Caught up in the hype and momentum that Lean has generated, management methods that have been in place for many years are articulated as Lean, merely because they focus on efficiency and effectiveness. This is articulated by Hines et al. (2004, p.1006): "[…] any concept that provides customer value can be in line with a Lean strategy, even if Lean production tools on the shop floor, such as kanban, level scheduling, or take time, are not used". Researchers who consider only the positive aspects of Lean can neglect the underpinning theory, which is that a tool is Lean when it fulfills the Lean principles, because the Lean principles fulfill Lean thinking. Therefore there needs to be a clear relationship between thinking, principles and tools which cannot be neglected (Womack and Jones, 2003). Such a relationship is not present in Lean construction (Mossman, 2009). If there is a tool or method which is effective and efficient in the project life cycle of a project, but does not fit into the Lean principles and therefore not in the frame of Lean thinking, such a tool or method is effective and/or efficient in management, but is not necessarily Lean. The concept of being Lean in construction is not simple, as it "[…] consists of a complex cocktail of ideas including continuous improvement, flattened organization structures, teamwork, the elimination of waste, efficient use of the resources and co-operative

supply chain management" (Green, 1999b). It is this complexity that perhaps explains why it has not been widely implemented in the construction sector. Lean in construction was introduced by Koskela (1992), four years after the term 'Lean' was introduced by Krafcik (1988) to production. Comparing developments in production with those in construction indicates that the construction industry has not reached the same level of implementation and usage of Lean. This suggests that there might be barriers to implementing Lean in construction which need further investigation (Mossman, 2009). Hence this paper seeks to explore the key barriers and limits of Lean in construction, with a view to understanding how Lean can be best applied to achieve its fundamental goal of continuous improvement. To facilitate this, the trends in literature have been reviewed, and semi structured interviews with key informants have been conducted.

This paper shows work in progress as part of a wider research project, which aims to combine project management [PM], Lean and Agile methodologies, in order to improve Lean in a way that it is more Agile, i.e. "AgiLean". As part of the research the limits as well as the barriers of Lean in construction have been identified, which are summarized in this paper. The paper is structured as follows: first, the limits, barriers and disadvantages of Lean are outlined; second, the research method is explained; after this, the results of the collected data are presented, followed by a discussion of the findings; finally, conclusions are drawn.

Literature review

The limits in the industry

The construction industry is dominated by medium and small-sized companies (Office for National Statistics, 2010), which explains why the industry acts more locally than globally (Woudhuysen and Abley, 2004). This is not only the case in the United Kingdom (UK), as similar structures and behaviors can be attributed to the whole of the European construction industry (Bennett , 2000). This characteristic results in a high attention to flexibility in Europe's built environment, which is unlike that in the USA's or Japan's construction industries (ibid.). A fragmented construction market creates the ability to act flexibly when dealing with highly variable workloads (Construction Task Force, 1998). A typical construction project also requires a high variety of workman, such as "[...] carpenters, bricklayers, plumbers, pipefitters, electricians, painters, roofers, drywallers, sheet metal workers, glaziers, and labourers" (Eccles, 1981, p. 337) and an increasing variety of experts, e.g. architects, quantity surveyors, structural engineers, mechanical and electrical engineers, acoustics, safety (Walker, 2007). Even on a small-scale project large numbers of parties and contributors are involved (ibid). The coordination and management of the work of these specialists is a complex task (Eccles, 1981), which is unique for each project (Construction Task Force, 1998) and results in the mapping of the supply chain in any construction project very difficult to do (Bertelsen, 2003). This high variety of involved specialists and contributors results not only in a functional separation but also in a separation of firms (Eccles, 1981; Winch, 1989; Construction Task Force, 1998; Walker, 2007). This separation has to be managed during a construction project, which is a major difference compared to projects in other industries (Winch, 1989).

Early critical literature focusing on adapting Lean production in other countries then Japan (see, for example: Cusumano, 1994; Dedoussis, 1995; Humphrey, 1995; Morris and Wilkinson, 1995; Lillrank, 1995; Recht and Wilderom, 1998) leads to the conclusion that midsized and small companies are not using Lean approaches (Dohse et al. 1985; Recht and Wilderom, 1998). Hence, if there are already barriers to adapting Lean production in other countries and other market segmentations, the low success rate of using Lean in a fragmented construction industry might be somewhat expected. The high degree of fragmentation creates a high level of complexity to construction projects. Dealing with complexity is not a central tenet of Lean construction, though the aim is to reduce the high complexity of construction projects by using Lean (Bertelsen, 2003; Ballard and Howell, 2004). So, the structure of the industry (highly fragmented) is a barrier to Lean construction, which has been recognized by the Construction Task Force (1998, p. 8) in the UK. They argued that "[…] the extensive use of subcontracting has brought contractual relations to the fore and prevented the continuity of teams that is essential to efficient working". However, in the evangelical nature of Lean research (Green, 1999a) if something does not fit into the Lean philosophy it has to be changed in a way that it fits. Therefore this barrier has been removed through introducing partnering by the Construction Task Force (1998) to the industry. Though the introduction of partnering has potential negative impacts, as it creates a higher profitability for powerful industrialists (ibid.), facilitated through

higher buying power, which has negative consequences on the so called 'partners' (Green, 1999c). In fact some of the best advocates of partnering are or have been under investigation by the Office of Fair Trade (Ibid.). Analyzing the potential consequences and scenarios caused by changing the fragmented structure of the construction industry into a model which reflects that in car manufacturing or retail will be not investigated further, as it is beyond the scope of this paper.

Culture and labor

The fragmented nature of the construction industry causes a highly hierarchical and static organizational structure in construction projects, which has been suggested as Best Practice by the Office of Government Commerce (2003) in their latest Procurement Guide for project organization. Besides a functional separation a firm separation takes place (Winch, 1989). This is in contrast with Lean organizational structures, where hierarchies are flat, dynamic and related to minimal staff functions (Jenner, 1998). Lean project management (PM) focuses on the project as a whole in order to avoid conflicts (Ballard and Howell, 2003). But considering the high degree of fragmentation in the construction industry Lean PM operates in an environment of high degree of cultural diversity within the different firms involved in the project (Wild, 2002). This cultural diversity creates psychosocial dynamics which can cause conflicts within and between individuals and groups, with significant impacts on the project (ibid.). Conflicts arise because each organization is focusing on their own (mainly economic) interest and do not focus on the project as a whole (Winch, 1989; Bertelsen, 2003). So instead of re-engineering Lean construction, which is derived from Lean production (Green and May, 2003), the Lean construction movement seeks to change the existing project environment; through changing the organizational structure (Ballard and Zabelle, 2000; Ballard, 2000) or the whole industry (Construction Task Force, 1998) in order to push for Lean.

A fundamental principle of Lean is a focus on continuous improvement (Womack and Jones, 2003); not only in the processes, but in labor improvement, such as the promotion of lifetime employment (Recht and Wilderom, 1998). Lifetime employment can be applied by the construction organizations, but not by the project, as it is a so called 'temporary production system' (Ballard and Howell, 2003), which results in that each "[…] project requires new design work, and new production problems to be solved, but, by the time these are solved the project has ended and not all expertise gained is transferable" (Winch, 1989, p. 337). The focus on continuous improvement brings with it the human cost of control (Green, 1999a), as the "[…] ultimate test for an effective project team is that it should 'work like a well-oiled machine' " in a Lean environment (Green and May, 2003, p. 101). The human cost of control is caused for instance by Lean tools like 'process observation', where the staff will be observed if they are working well and in the right sequence through video recording, note and protocol taking (Corfe, 2011). The human costs of Lean construction are explored by Green (1999a; 1999b) and Green and May (2003), with the conclusion: "The term 'karoshi' is now in common use amongst Japanese workers to describe sudden deaths and severe stress resulting from overwork. Muda is to be eliminated; karoshi is the price to be paid" (Green, 1999b, p.25).

Lean in construction

Koskela (1992) was instrumental in developing the theory of a Lean management approach to construction, four years after the term was introduced by Krafcik (1988). This work was expanded by Ballard (2000), who developed 'the last planner system' and made the Lean management approach applicable for construction. Lean has been developed in an environment (production/manufacturing) where "[…] raw materials are progressively transformed over a series of separable steps into the final product" (Eccles, 1981, p. 337). Construction on the other hand, "[…] is large and usually immobile; there is a higher degree of complexity in the number and range of component parts; its production on site introduces varying degrees of uniqueness"; and it "[…] must be more durable and is often more expensive than other manufactured goods" (Gann, 1996, p.438). Furthermore the constructed facility is built at the point of consumption (Demir et al. 2011) which is in contrast to manufacturing where finished products are transported to market (Gann, 1996). Winch (1989, p. 338) stated that "[…] construction projects are amongst the most complex of all production undertakings", and there is little research to date that refutes this. The management of construction projects are generally characterized by "[...] physically large and expensive products, separation of design from construction, powerful clients, extensive specializations, delivery or products at the client's premises and bespoke designs usually without prototype models or precedents to provide guidance [...]" (Ankrah et al. 2005, p. 730). Even if the constructed facility itself is static, the environment in which the facility is constructed is highly dynamic. Bertelsen (2003) describes the project dynamics as typified by a top down management approach. Top

down management means planning from a macro view to a micro view (from abstract to detail). The top down management approach has room for changes, as at the beginning generating a detail plan, in many cases, is not possible. Changes are required because of the uniqueness of each project (Roesel, 1987). Knowledge and experience cannot be directly transferred to another project (Winch, 1989). In construction there are source of uncertainty: changing weather conditions, fluctuating material costs which vary depending on market influences, uncertainty about ground conditions, changing designer teams consisting of architects and engineers formed only for that particular project. As a result changes in the project life cycle cause a dynamic environment in construction, whereas manufacturing consists of a static environment and a dynamic product. The contrast between the environments of construction and manufacturing creates a dilemma for the implementation of Lean. Namely, Lean is particularly suited to static environments where high repetition and a low variety exist (as it is originated from there). Lean needs a stable platform where processes can be forecasted and optimized (Andersson et al. 2006). Lean shows limitations in a highly dynamic environment where a low repetition and a high variety exists (Cusumano, 1994; Hines et al. 2004; Andersson et al. 2006); for instance construction projects, "[…] as there is no room for flexibility due to the focus on perfection […]" (Andersson et al. 2006, p. 289).

The problem of adapting Lean to construction has been recognized by Ballard and Howell (1998) who stated that for construction projects Lean production is insufficient. Likewise the Construction Task Force (1998, p. 18), who argued that the "[...] parallel is not with building cars on the production line; it is with designing and planning the production of a new car model". Ballard and Howell (1998; 2004) argue that Lean construction differs from Lean production in a way that it is able to deal with the dynamic nature of construction projects, but that the complexity in the construction process needs to be reduced and changes are not welcome (as change is a type of waste).

Method

The research project, of which this paper reports a part of, seeks to develop a new method for the management of construction projects. This method will focus, on the one hand, on the elimination of waste through perfecting the internal processes, whilst on the other, being flexible and reacting to changes in the project circumstances. As part of the research, the limitations of Lean need to be identified and fully understood. To achieve this understanding the research utilized semi- structured interviews, which have the capacity to provide insights into how research participants view the world (Bryman, 2008). Interview guidelines were prepared in advance and were sent to the interview participants. Potentially the questions asked could deviate from the scheduled interview guide depending on how the interview progresses. This flexibility is a clear advantage of semi structured interviewing, which allows the research to explore why things happen in the way they do (Moore, 2000). Hence, when collecting the data, the aim is to refine the literature and create a link between theory and practice. Therefore the interviews are explanatory rather than none descriptive. Purposive sampling was used to select a group of highly experienced managers from well-known companies in the fields of construction and management consultancy in Germany. As such, interviews were conducted with five experts in the field of 'Lean' in order to understand what difficulties are experienced when implementing Lean in construction practice. Seven project managers were also interviewed in order to explore how they perceive Lean and to identify if they are using any Lean approaches on their projects.
A brief presentation about Lean principles, as well as the methods associated with the approach, was given to the interviewed project managers, in order to give them a clear understanding of the topic and a solid foundation for gathering data. The interviews lasted on average one hour each. They were tape recorded and transcribed. The transcripts were then analyzed using the Computer Assisted Qualitative Data Analysis Software, NVIVO.

Interview findings

Most of the Lean Experts (LEs) as well as Project Managers (PMs) believed that the construction industry needs to be restructured in order to successfully establish a sustainable Lean movement in the sector. LE 2 stated: *" if you want to do Lean, then you need to take the people with you, that means that you need to create an environment which enables this, which also eliminates this natural 'everyone against each other' attitude*". The LEs criticized the construction sector for trying to manage increasingly complex projects with traditional methods. However, the fragmented nature of construction, and the separation between design and execution causes conflicts over the project life cycle of a project until the operational phase; which impact on the implementation of Lean. The conflicts

between involved parties have been described by LE 1 as follows: "*the designer sees himself mostly as the consultant of the client, as the one who has to care about the contractor not 'ripping off' the client; this results in difficulties for the project communication between the involved parties*". Negative relationships between the involved parties, coupled with their different interests, were stated as a major barrier to implementing Lean. Therefore, besides the structure of the industry, if Lean wants to be implemented in construction the project culture needs to be changed too. The cultural aspect is related to the conservative character of the industry. The conservative character of the industry or by the involved parties in construction was stated as a main barrier by all interviewed participants. LE 1 explained this conservative character by comparing it with quality management, which when it was first introduced was rejected by the construction industry, but is now accepted as essential.

The LEs and PMs agree that Lean construction is focused more on the execution phase than the whole project life cycle. PM 2 stated that Lean construction, which covers the whole project life cycle of a building, would only be possible for private clients, but not for the public clients. LE 4 related this issue to the high level of regulations, stipulations, specifications and guidelines. These set "*the fee system, the tasks of the construction management, which limits these modern management methods*". All the LEs stated that the client's interest in doing a Lean project is essential for implementation. However, PM 5 said that the clients do not see a need to use Lean methods in a project, as the design and execution are mostly fixed with lump sum contracts. The LEs specifically argued that a lot more of construction could be prefabricated and built off-site. This view was shared by the PMs too, who concluded that construction is still largely rooted in traditional craft-based building. LE 4 linked this to the fragmented nature of the construction industry, which ends up in the management of numerous firms, because a construction element has "*things like trade borders, who is doing what (interfaces)*". LE 4 further explained that one party will design something and this element will be built by several different groups. As a result, the high separation between design and execution, the involvement of several different trades, as well as the fact that those trades are mostly different companies, limits the usage of prefabricated elements.

Taking the management perspective, the changing construction project conditions, i.e. changing team, site conditions, weather conditions, firms etc. creates a unique character for each project. Projects change over their project lifecycle and each project is unique. This results, according to LE 4, in changing Lean approaches and tools during the project and from project to project: "*once you have found a Lean approach which fits perfectly for that project, you can only use it for this particular project, and the next time you have start from new*". This results in less attractiveness of Lean construction in comparison with Lean production, as it is regarded as less affordable at the beginning, having to be set up from new. Furthermore, LM 4 stated that they are using Lean construction mostly for plant construction projects, where the constructed facility can be seen as a shell and the focus is more on the machines inside the building.

To summarize, the Lean Management companies were of the opinion, which was being reflected in practice, that Lean production tools and methods need to be re-engineered and adopted to the construction industry. Therefore all the LEs were selling or consulting Lean, but there was no uniform approach to Lean amongst the people interviewed.

Discussion

Early proponents of Lean argued that the result of Lean construction is a new delivery system which can be applied to any kind of construction - see, for example, Howell (1999). This would include complex projects with high degrees of uncertainty and time compressed schedules. The results of the research suggest that this is not the case in practice. The interviews, which support the literature findings, have shown clear barriers for- and limitations of- Lean construction. These barriers and limitations are related to the nature of construction projects and are as follows:

- fragmented nature of the construction industry
- negative relationships between the involved parties (for instance architect versus contractor, contractor versus sub-contractor)
- the high number of parties involved in a construction project
- changing project teams
- changing project conditions

- no support by the client
- regulations and stipulations (in Germany)
- the separation between design and execution
- the focus of Lean being more on the process than on the people

These limitations can be related to the originating environment of the Lean paradigm. Lean has its origins in the automotive or manufacturing industry (Womack et al. 1990; Womack and Jones, 2003). The environment of production (plant) is static, i.e. there is a sequence of activities which have been mapped in order to produce the prototype, which has then been developed to make the activity as efficient as possible (Womack et al. 1990). A tool is Lean when it fulfills the Lean principles, which are: to specify value, identify the value stream, flow, pull and pursuing perfection (Womack and Jones, 2003). These have been developed in a static environment for a dynamic product, which will be re-produced several times. So the best environment for Lean is one which is static, stable. However, construction is highly dynamic and the product is immobile. Therefore, most forms of construction can be seen as the opposite to mass production, from which one can conclude that in theory construction and production have little in common. But in construction-related practice it is possible to create a routine way of working for some activities. These activities are mainly in the execution phase. For this reason the use of Lean management methodologies has primarily been focused on its use by main contractors, who are managing this phase.

However, the dynamic environment of construction projects makes the implementation of Lean management philosophies difficult, as there is no space for flexibility due to the focus on perfection (Andersson et al. 2006). But given that projects change over their life cycle (Hunt, 2006; Eriksson and Torstensson, 2006) there is always a demand for flexibility when realizing a project. Hence there is also a trend towards 'Lean less' in PM, which has led to a focus on more 'Agile' (flexible) management approaches as a potential solution (Agerfalk and Fitzgerald, 2006). "Agile PM" methods focus on the team as an important expertise factor, aiming to satisfy the client and react to change (Chin, 2004; Hunt, 2006; Dyba and Dingsoyr, 2008).

The construction industry now faces two ways to implement Lean; one is to change the built environment so that Lean is more applicable; the other is to change Lean. The first approach is to reduce the construction projects' complexity and the second approach is to develop a method to be able to deal with that. The authors propose the second approach. This view is supported by the findings from the exploratory interviews. Dealing with complexity is related to being more flexible, more Agile. Therefore Lean needs to be more Agile if it wants to reach the same amount of acceptance in practice as it has achieved in theory. To do this there is a need for a method that we label as "AgiLean". In this sense the term "AgiLean" is carefully chosen, as preferable to other alternatives, such as "Leagile". "Leagile" uses Agile in the design phase and then has a de-coupling point to switch to Lean in the execution phase (Naim and Barlow, 2003). The notion of "AgiLean" is that the foundation is Lean, but that in some situations, including through the execution phase, Lean needs to be "agitated" i.e. become more irregular, rapid and agile – hence "AgiLean". AgiLean PM is underpinned by universal PM methodologies, such as those from the Project Management Institute (PMI) on the strategic level. At the operational level it synthesizes modern management paradigms, such as Agile and Lean. This ensures that the whole project view is taken. It enables the right paradigm to be chosen depending on the requirements of the project. The outcome is the management of project uncertainty in an effective and efficient manner.

Conclusion

Barriers to the implementation of Lean construction are mostly related to the nature of construction projects. This is unsurprising as construction projects are amongst the most complex of all project undertakings. Lean holds many advantages and benefits for its users. Instead of trying to implement Lean in construction environments in a way that it merges with its environment, many Lean theorists and practitioners have tried, with varying degrees of success, to revolutionize the construction industry, i.e. changing construction in order to implement Lean. The authors propose that Lean needs to be more project-oriented. It needs to be able to cope with change and needs to be able to focus on the whole project lifecycle. Therefore approaches to Lean construction need to focus on making it more Agile. This leads to a new approach which we label "AgiLean PM". AgiLean PM will eliminate waste, will be able to react to change and focus on the whole project lifecycle. Such an approach is a way of dealing with complex construction projects in order to achieve maximum performance. AgiLean PM builds on the strengths and addresses the

weaknessess of Lean and Agile through a process of synthesization. This new approach harnesses existing PM tools. It is underpinned by universal approaches on the strategic level. It focuses on eliminating waste and pursuing perfection through the adaption of Lean principles. Further, through the application of Agile principles, it will be capable of dealing with uncertainty through the ability to react to changes. This is illustrated in Figure 1 below.

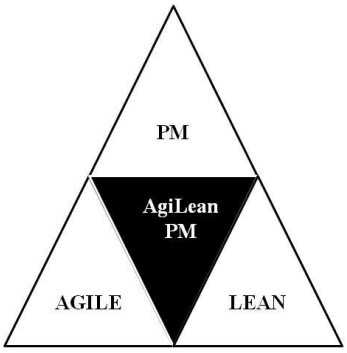

Figure 1: AgiLean PM Framework

The detailed AgiLean PM framework is still in progress. Once established, the development of AgiLean tools and the agitation of Lean practices will be the focus of further work and research.

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