

# COMBINING LEAN CONSTRUCTION WITH MATURITY MODELS

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It has been widely acknowledged that maturity models provide organisations with benefits when implementing a change or improvement strategy. The construction industry has shown particular interest in maturity models as it increasingly seeks to manage organisational change. One type of change some organisations in the construction industry are seeking to manage is the implementation of Lean Construction (LC). The aim of this research is to explore the benefits of bringing together LC and maturity models. Hence data relating to the views on the topic amongst eleven LC practitioners, based in six different countries, was gathered through interviews. The qualitative data collected were analysed using the framework approach. The findings reveal that some of the interviewees already take advantage of maturity models in their practices. Further the findings unearth new potential benefits, applications and possible limitations from the use of maturity models in LC. Overall the data supports the tentative proposition that a focus on investigating a synthesis of the maturity model and LC concepts is a worthy avenue of further research for the academic community in construction management. As a pre-cursor to such investigation the paper introduces a framework of attributes of LC maturity, which is derived from the results of the interviews.

Keywords: framework approach, innovation, lean construction maturity, maturity model, organisational analysis.

## INTRODUCTION

It has been two decades since Lean Construction (LC) first appeared within the construction management research. Since then it has received a significant amount of attention from both practitioners and academics, which is evident through the amount of publications available on the topic. Nesensohn and Bryde (2012) observed that the first occurrence of the term LC was in 1993 through the “1st workshop on Lean Construction” co-ordinated by Lauri Koskela. Recent literature reports that LC is a new paradigm and project delivery system with the potential to deliver outstanding performance improvement in the construction industry (Sage *et al.* 2012). This is confirmed by reports of projects in the UK and US utilising LC. For example claims are made of projects such as a hospital building, a medical office building, HEI buildings and an outpatient facility which have an out-turn of approximately 19% below market cost (Mossman *et al.* 2011).

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However LC is criticised as being not applicable to all types of construction projects (Winch, 2002; 2010). Moreover Green (1999) in particular criticised the ideology that underpins Lean in terms of its appropriateness to construction activities in the UK; with a specific focus on the (perceived) neglect of human resource management in the Lean paradigm. Despite these criticisms it is undeniable that LC is prominent as a strategy for innovative management practices within parts of the construction industry.

It is argued that LC involves not only applying certain tools or principles but it contains the organisation, production and management of construction from an holistic perspective (Koskela and Ballard 2012). Hence the transformation towards LC lead to changes at both the temporary organisation (project) and the strategic management level (Ballard and Howell 1998). Furthermore the organisational transformation towards LC requires long-term and deep-rooted cultural change. This is necessary to embed a Lean philosophy as an integral part of how the organisation operates (Nesensohn *et al.* 2013). Correspondingly, it is necessary to have a clear direction of where an organisation wants to go within their Lean journey.

Moreover the transformation process requires the involvement of the top management, in financial terms as well as managing human resources. Although even with this support success is not guaranteed (Almeida and Salazar 2011). Since LC is seen as innovative improvement approach, a strategy to implement LC often needs changes to the organisational culture and its people (Green *et al.* 2008). However the expected benefits of such innovation are not always clear to see. Hence organisational assessments are a crucial part of an innovation strategy (Mcelroy 1996). Such assessments provide guidance for the enterprise transformation, information about strengths and weaknesses and a prioritising of planned improvement efforts (Perkins *et al.* 2010a). One way to guide such organisational assessments is through the utilisation of a maturity model (MM).

## **MATURITY MODELS**

MM have been mainly studied in organisations within software engineering. The Capability Maturity Model Integrated (CMMI) is the best known MM to emerge out of this sector (Wendler 2012). Research has focused on MM in other contexts, such as: portfolio management, project management, and knowledge management. Some of these studies stress the advantages of the concept of a MM in general terms. So it is claimed that MM enable organisations to assess their current organisational capability/maturity and allow them to implement a change or improvement strategy in an organised way (OGC 2010). Furthermore, it is claimed that an MM provides people with directions and information to prioritise improvement actions, and initiating a cultural change (Pennypacker 2005). Moreover the developers of the CMMI posit that MM guide and improve the ability within an organisation to develop a culture of excellence (CMMI Product Team 2010). In addition to these claimed benefits a main driver of the development of new MM seems to be the information generated. Such information is essential to organisations in planning and directing their on-going transformation efforts (Perkins *et al.* 2010b).

Nevertheless, both the CMMI and its predecessor the Capability Maturity Model (CMM) have not escaped criticism (Hartman and Skulmoski 1998). For instance the CMMI was criticised for its lacks of a guaranteed pay-off in relation to the additional effort and cost of moving upwards in maturity (Anthes 1997). Furthermore there were early sceptical voices. Benbasat *et al.* (1984) highlighted the absence of empirical

support for the concept of maturity stages (levels) within the research domain of information systems - a domain bridging computer science and business management.

Despite these criticisms the construction industry has recognised the potential of MM. Practitioners and policy makers in the UK have signalled agreement of the usefulness of developing MM in construction. This has been through collecting empirical data in the form of questionnaires, case studies and expert panel surveys (Amaratunga *et al.* 2002b). Attempts have been made to contextualise an MM, such as the CMMI, to the construction processes to influence the industry. In fact there are examples such as the Standardised Process Improvement for Construction Enterprises (SPICE) which is a model for construction processes (Sarshar *et al.* 2000), and the development of a standard model for e-procurement from Eadie *et al.* (2011).

In relation to LC and MM there has been limited attention paid to the topic in the literature. One area that received attention is the research on cultural maturity in Lean-managed organisations (Chestworth *et al.* 2010). Likewise is some attention towards lean reported in the form of the organisational self-assessment tools i.e. the Lean Enterprise Self-Assessment Tool (LESAT) within the aerospace industry developed by the Massachusetts Institute of Technology (MIT). This provides an understanding of the Leanness (maturity of Lean Manufacturing) of the organisation to guide the transformation (Perkins *et al.* 2010b). Another example within Lean Production environments is the Shingo Prize Model®. This includes some of the most comprehensive methods to assess the Leanness of an organisation (Bergmiller and Mccright 2009). However the LC literature has neglected to give much attention to MM so far.

Looking outside academic literature in terms of LC and maturity shows some notable attempts within the government and other institutions to advance the topic. For instance the UK Highway Agency (HA) contextualised the LESAT to a Lean Maturity Assessment Toolkit (HALMAT). The aim being to determine the Leanness of the supply chain in relation to the objectives of the HA (Highways Agency 2010). Work has been undertaken regarding the maturity in LC by industry policy makers such as the European Construction Institute (ECI). They developed a scoring system on the basis of a maturity grid (ECI 2012). Such maturity grids are characterised by a text description of each maturity level. This is different to the CMMI-like models that consist of a formal and more complex architecture (Fraser *et al.* 2002).

So it is posited that study of the application of an MM contextualised to LC will be a fruitful avenue for research. It will support organisational transformation towards LC. Therefore the purpose of this research is to gauge the normative views of LC practitioners (LCP) of the benefits of bringing together LC and MM. However, it is important to note that the interviewed LCP are selected on the basis of their experiences of using LC, be they good or bad, rather than as being particular advocates of LC. Indeed the data reveals that some of them concur with Green's (1999) well known critiques of the "dark side of Lean".

## RESEARCH METHODOLOGY

Given the exploratory nature of this study a qualitative research strategy was adopted. It made use of semi structured interviews as the data collection method (Amaratunga *et al.* 2002a). This form of interviews is a powerful and flexible way to understand the attitudes and opinions of individuals (Fontana and Frey 1994, Kvale 2007). Furthermore semi structured interviews have been recommended as appropriate to

increase the depth and breadth of knowledge about the specific phenomena within the construction sector (Shehu and Akintoye 2010). Additionally this form of interviews is frequently utilised to good effect in built environment research (Fellows 2009).

Hence a purposive sample of selected LCP was constructed. The selection criteria was as follows: (1) at least two years of practical experience in LC; (2) experience in a senior management (SM) position; (4) at least five years of working experience in construction management either in an operative or consultative role. The sample contained people from six different countries. These were: UK (LCP#2 and #11), USA (LCP#05, #06, #07 and #10), Germany (LCP#01 and #08), Spain (LCP#03), Peru (LCP#09) and Chile (LCP#04).

The research focuses on two domains: LC and MM. Yet the sample contains only practitioners from LC. This must be considered as a limitation of the study. However it seemed to be more appropriate to concentrate on LCP rather than to interview MM practitioners from outside the construction management domain.

The selected LCP were provided with a one page written summary of MM prior to the interview to ensure a base level of understanding about the MM concept existed. Each LCP confirmed at the beginning of the interview to have read and understood this summary. Additionally the summary was outlined verbally by the interviewer before commencing the interview. Each interview lasted approximately 45 minutes. They were tape-recorded and transcribed afterwards.

The transcripts were analysed using the framework approach (Ritchie *et al.* 2003). This approach utilises charts or matrices to organise the data. It distils key topics for each of the participants while focusing on the central element of the thematic framework (*ibid.*). There are six systematic steps that have been sequentially performed within the research: (1) Familiarisation, (2) Identify descriptive categories, (3) Indexing or (4) Pilot charting, (5) Charting and (6) Investigation and interpretation (Ritchie and Spencer 2002).

## RESULTS

The analysis of the data produced two broad themes and the next section presents the results for each.

### **Theme 1: Combining LC with MM, a LC maturity framework**

The first theme within the interviews focuses on issues related to the potential synthesis of LC and MM to produce a LC maturity framework.

#### *Applicability*

A potential application was identified by LCP#01, #04, #10 and #11. They expressed the view that an LC maturity framework could be applied to monitor and measure where an organisation is placed in terms of a Lean transformation programme. As such it could identify areas for further improvement. LCP#01 pointed out that "this could be something that is applied before LC implementation takes place as a preparation stage".

A limitation to its application was identified by LCP#02. They stated that it would be applicable for big projects that run for years but much more limited for smaller and everyday projects. LCP#04 expressed the view that it was more applicable to owner than contractor organisations. This view was shared from LCP#02 who stated that owners should only measure themselves to see how good they are - not their suppliers.

### *Focus*

There was a general agreement amongst LCP#01, #04, #05, #07 and #11 that project organisations with an embedded owner perspective are a likely focus of any LC maturity framework. However this doesn't exclude its adaptation to all kinds of organisations. LCP#01 emphasised that: "in a project organisation there are the key players, and they come up with valuable and useful information...if it would focus on only one, a very important part of the project would have been left out". This point was built upon by LCP#07 who stated that it has to be focused on the whole project organisation. A slightly contrasting view was put forward by LCP#02 and #06. They pointed out that such narrow focusing would limit any future framework. Furthermore, all parties involved in LC should use such a framework.

### *Usefulness*

Amongst all interviews there was a general acknowledgement that a LC maturity framework would be very useful. This was explained by LCP#02 and #08 through the benefits of an evaluation of their own development in terms of LC. For instance it would have been beneficial for them in terms of getting an idea of where they were and whether they were getting better or not. This point was also made by LCP#11, #04 and #10. As articulated by LCP#10: "if you don't have any measurement you can measure against then you running into the fog or into nowhere". A similar argument was made by LCP#04, who commented that "if you don't measure where you are at this point, it's very difficult and very hard for an organisation to improve". As summarised by LCP#09, who stated that without such a framework you might be "thinking that you are applying things that you not really are".

## **Theme 2: Attributes of LC maturity**

The second theme identifies attributes that can measure or, at least, be used to recognise maturity in LC. Seven attributes were identified: customer-focus, thinking, culture & behaviour, business results, continuous improvement, processes & tools and expertise. Together they provide a framework of attributes of LC maturity (as shown in Figure 1).

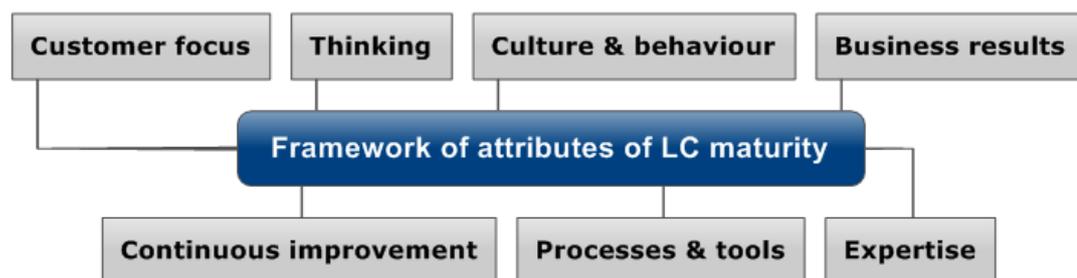


Figure 1: A framework of attributes of LC maturity

### *Customer focus*

The first attribute identified, especially by LCP#04, #05 and #09, was the importance of customer focus. This takes the form of first understanding and then measuring and monitoring customer value. This was neatly summarised by LCP#05: "the first thing I ask is do you understand your customer's value? The second thing is: do you know [by] how much you are deviating from your customer's value?" By answering these two questions maturity in LC focuses on establishing if the organisation or project is customer-driven. A link here was made between the identification and measuring of waste and the thinking of the organisation in terms of what the customer really wants

and need (LCP#04). A final element of this attribute was measuring the actual satisfaction of the customer (LCP#08).

### *Thinking*

Thinking as an attribute for LC maturity was predominantly identified by LCP#01, #05, and #07. Its importance was stressed particularly by LCP#05 and reflected in the statement: "maturity is not just behaviour, but also the thinking because the thinking leads to behaviour". Three types of thinking were identified: 1) process thinking (LCP#01); 2) systemic thinking (LCP#05 and #07); 3) scientific thinking (LCP#05 and #07). Systemic thinking was explained by LCP#05 through the example of seeing the customer and the processes in a systemic way. They further described that "scientific thinking is the ability to collect data to support the decision making or to support the creation of their processes and how they test their hypothesis and how they put measures in place in order to make adjustments".

### *Processes & tools*

That processes and tools are a significant attribute for maturity was noted by several interviewees. For instance: LCP#05 - "systemic processes"; LCP#01 - "process oriented work"; LCP#11 - "different processes and standardised work"; LCP#04 - "value stream maps for [their] processes". This attribute was elaborated upon by LCP#11, who described how "maturity could be seen in all processes and [the processes] should be reflect a Lean philosophy, Lean approach or Lean thinking". In this point LCP#09 concurred. They stated that "maturity is about "how much the process is aligned to really encourage Lean". LCP#07 introduced the topic of tools, arguing that any deployed should be used in a Lean way.

### *Expertise & learning*

The importance of having expertise in LC was elaborated through the actual knowledge that is required about Lean i.e. by LCP#04, #05, #08 and #09. According to LCP#05 knowledge is needed of the five elements of Lean thinking: 1) identify customer value; 2) identify the value stream; 3) create flow; 4) create pull; 5) pursue perfection (Womack and Jones 2003). LCP#02 highlighted that the degree of learning about Lean is the absolute critical indicator in terms of LC maturity. The importance of learning was further emphasised by LCP#04, #07 and #10. They stated that the amount and focus of training, how people engaged with the training and how successfully they applied what they learnt would show how mature an organisation was.

### *Culture & behaviour*

The interviewees described various indicators in terms of culture and behaviour, such as: communication, trust, collaboration and leadership. LCP#03 stated: "I would say communication is the most important aspect in this regard". They also pointed out that it is important to have trust between the people. An example of the collaboration attribute was given by LCP#01. They described how people who are more mature in LC work better together and collaborate more. The issue of leadership was neatly summarised by LCP#10: "leadership is one of the most important ones. The leaders have to understand [LC] and to believe [in it]". In this context the vision or mission of the organisation was regarded as important. For instance LCP#04 and #08 described how it had to be directly aligned with the goal of becoming Lean. Whilst a constancy of purpose and approach after setting the vision/mission was a key attribute of behaviour as identified by LCP#05, #07 and #11.

*Continuous improvement*

LCP#02 and #05 indicated that a mature LC organisation will practice continuous improvement in a systemic way.

*Business results and approach*

Finally the actual business results achieved were identified by LCP#1, #07, and #11 as an attribute of LC maturity. This involved the achieving of targets, especially the level of quality and of costs. In addition the commercial approach was highlighted; for instance, whether it was price-driven or a cost-driven approach.

**Additional notes**

An important point emerged from the interview discussions related to the fact that LCP#07 and LCP#05 actually used a MM for their own Lean purposes. The MM were developed and being used internally within their organisations to support their LC transformation challenges and to gather information of LC maturity. For instance LCP#07 had a MM "... that we use for the Last Planner® System and a generalised MM that we use for Lean management". LCP#05 called their MM a "maturity tool", which was developed to assess projects in terms of their maturity for LC. This is an important point because due to the gap in the literature it wasn't expected that the LCP are more advanced in the development and use of the concept of MM for LC transformations than the academic community.

**DISCUSSION**

Conceptually there is no reason why LC and MM cannot combine. This is supported by the fact that 2 out of the 11 LCP interviewed had developed and used their own MM for LC. But the interview findings stress the gap in knowledge in terms of LC maturity. The research revealed general agreement amongst the LCP in terms of the potential benefits offered by such a combination. Overall MM have the ability to facilitate the transformation of an organisation towards LC. This ability can be harnessed for temporary project-based organisations as well as single entities within projects, such as owners/clients or contractors. In this context the required information about LC maturity would have to consider the owner/client perspective as well as that of the designers, contractors and project managers - if it was being applied within a temporary project-based organisation.

The interview findings are consistent with the reported benefits of MM in general within the literature i.e. Perkins *et al.* (2010b). However the data revealed new ideas, limitations and claims in terms of LC maturity and the absence of a MM for LC. Such ideas, limitations and claims cannot be confirmed or refuted through a lack of evidence in the existing literature. For instance the interviews revealed the normative views of the LCP on new ideas to apply a MM within LC practices. There are issues to address in terms of limits and exclusions of any MM for LC. One viewpoint is that a MM for LC ought to be limited to projects of a certain size. Another viewpoint is that such a model ought to have a focus on the temporary organisation. In such an organisation key players will reside with the required information in terms of assessing LC maturity.

To date the academic community within construction management and LC has not developed a unifying MM for the discipline. The development of such an MM would need to be done through rigorous research, to enable a critical investigation of the claims and experiences of adherents of LC and construction industry practitioners. This paper has made a small contribution to the development of a LC MM by

considering the normative views of a small international sample of LC practitioners. Analysing these views has enabled a framework of attributes of LC maturity to be formed. This framework makes a significant first contribution towards a MM for LC.

## CONCLUSIONS

LC is receiving increasing attention within the construction industry but supporting mechanisms for organisations seeking to transform themselves towards LC are lacking. MM are present in the construction industry but are predominantly used within the project management and process management areas. The literature shows that MM can provide guidance to support organisations dealing with change i.e. to introduce LC. Through 11 interviews with industry practitioners this paper explored normative views of the topic. The findings revealed that a combination of LC with MM could potentially deliver some of the same benefits as claimed from the wider MM literature. The findings further suggest that such a combination is perceived as providing a useful supporting mechanism for organisations transforming themselves towards LC. Whilst some views of the practitioners are aligned with the existing literature, there are some whose veracity can best be tested through the development of a LCMM by the academic community. A framework of attributes of LC maturity has further been proposed based on the interview findings. This framework provides a structure in which LC maturity can be measured or at least recognised. The framework provides a solid foundation on which further research can be built in relation to using MM in LC.

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