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A Measurement Model For Lean Construction Maturity

Claus Nesensohn¹, David Bryde², and Christine Pasquire³

Abstract

Question: How can you differentiate between an organization relatively immature in Lean Construction and one relatively more mature in Lean Construction (LC)

Research Method: Collection of qualitative data using mixed methods of interviews and focus group

Findings: A validated model for LC maturity is presented comprising of 11 key attributes and 60 behaviors, goals and practices that enable a distinction between levels of maturity to be made

Limitations: Given the small sample no claims of wider generalizability of the model can be made without further research

Implications: The model provides a means of delineating organizations in terms of the level of LC maturity

Value for authors: The model can be used by practitioners to guide their decision-making and support their strategic choices when implementing LC

Keywords: Maturity models, measurement, transformation, change process

Paper type: Main Papers

Introduction

Lean Construction's (LC) growing popularity is even acknowledged by those who question the applicability of lean to the construction sector (Green et al. 2008). Green draws our attention to his critical definition of LC as a "complex cocktail of ideas" (Green, 2002, p. 148). This notion of a complex cocktail actually has its merits in that LC is not pigeonholed as a narrow and prescriptive management technique applicable to the construction context. The notion also stresses the inclusive nature of the LC movement. It is reflected in the broad scope of many definitions of LC, a typical, recent, and useful one being that "Lean Construction: refers to the application and adaptation of the underlying concepts and principles of the Toyota Production System (TPS) to construction. As in TPS, the focus is on reduction in waste, increase in value to the customer, and continuous improvement" (Dave et al. 2016, p. 87). Yet the danger of too much pluralism in the discipline of LC is that it leads to fragmentation and, hence, it opens LC to critics who

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refer to it as a somewhat nebulous concept: the negative connotations of a “complex cocktail” of ideas. If it is not clear what constitutes LC, as it is too complex a cocktail, then it may be difficult to both introduce and to improve LC practices in an organization.

Since Maturity Models (MM) facilitate an organizational assessment of its current maturity (Pennypacker, 2005; Perkins, et al. 2010a; Perkins et al. 2010b), which can also be described as measuring against a defined reference point (MM) (Cooke-Davies, 2007), such an MM for LC would describe what a more mature organization looks like, in terms of LC. Furthermore such organizational assessments of maturity can provide a number of benefits, such as: showing a path to achieving excellence by evaluating how to implement best practices (Amendola, et al. 2016); guidance for the transformation with information about strengths and weaknesses (Perkins, et al. 2010a); awareness of the current state and improvement requirements (Wendler, 2012); support in implementing change in a systematic and well-directed way (Cooke-Davies, 2007); and an enabler to a sustained embedding of business processes (Eadie, et al., 2011).

To date MM-related research and conceptual developments has focused predominantly on the software engineering industry (Nesensohn, et al., 2013a). This work has resulted in the creation of the Capability Maturity Model Integrated (CMMI) which it is claimed is the most well-known (Wendler, 2012) and the most widely adopted MM (Eadie, et al., 2011). However the tried and tested MMs, such as the CMMI, are generic and they do not provide the necessary data i.e. the specific attributes and processes which are associated with maturity in terms of LC. Yet existing MMs such as the CMMI have potential in providing a starting point for developing an MM for Lean (Nightingale and Mize, 2002). Furthermore, Nesensohn et al. (2013a) call for further work to develop such a model for LC which is grounded in empirical study. This paper responds to this call by presenting a validated model, called the Lean Construction Maturity Model (LCMM) which provides a model for assessing LC maturity that is, in part, informed by the approach taken by the CMMI. This model enables organizations to assess their current LC maturity and can be used to differentiate between organizational immaturity and maturity in terms of LC. The paper specifically describes the research method used to validate the LCMM, which was done using focus groups, and presents the validated model - which was first introduced in a paper presented at IGLC 2014. A second aim of the paper is to contribute to our understanding of how the measurement of organizational maturity in LC could be undertaken, by using the LCMM to illustrate differentiating characteristics between organizations “mature” and “immature” in LC.

Research method for validating the model

The original research utilized a mixed method design to develop the LCMM. This enabled a more complete picture of human behavior and experience (Morse, 2003) which was important as the key informants for the original research had practiced LC over time and hence attached meaning to the phenomenon of “LC maturity” and to the maturation of LC within organizations. Its primary research design method was a phenomenological approach taken involving focus groups (FG) with semi-structured interviews as supplementary components. Since this paper is focusing on the validation of the developed LCMM we refer here to the detailed development of the LCMM in previous publications such as, (Nesensohn, 2014, Nesensohn, et al., 2014a). To validate the LCMM it was necessary to undertake another empirical study, which made use of experts (Ricardo, et al., 2014) who were involved in the data collection stage of the original research, to ensure the



interpretation of the data was accurate - this validation strategy is known as member checks. The validation involved interviews with three experts followed by one further FG with three experts. All of these participants were LC experts involved in Lean projects for between 3 and 19 years. The sample comprised LC experts working as contractors or in engineering companies, or as a consultant.

The interviews took place following the FG member check. The interviews had an approximate duration of one hour; and the participants received a document, which described the developed model and its elements, with several explanatory figures, prior to the interviews. In the interviews the participants were asked about the completeness and accuracy of the previously collected data and if there was anything missing in the model. They were also asked for their views on the practical suitability of this model.

The FG member check was chosen to enhance accuracy and correctness of the findings (developed model) and their interpretation (Creswell, 2013). This FG was conducted similar to those conducted as part of the primary data collection. Hence this validation FG had the advantage of including an observer who provided a guideline. Contemporaneous notes were recorded on flipcharts and at the end of the FG the participants verified the accuracy of these notes.

The developed model was presented to the FG participants. To increase the credibility of the validation the model was presented in sections rather than as a whole. The sections were: model structure; top layer; and each single factor including its Key Attributes, Behaviors, Goals and Practices (BG&Ps), as well as Ideal Statements. Finally, the maturity levels were considered, including the practitioner-led assessment. This enabled a focus on all elements of the model without getting too distracted by the detail of each individual component. The presentation took approximately thirty minutes to complete. It used several figures and hand-outs to enable participants to gain a fast and complete understanding of the model. Following this the participants were asked for each section [outlined above]: is this valid from your point of view? The overall response to this question for each section was very positive. All participants agreed that the LCMM with its factors, Key Attributes, BG&Ps, and Ideal Statements was valid.

Similar to the member check with the individual interviews, it was important to seek opinions on the practicability and suitability of the LCMM in practice. Hence the participants were asked: *what are your views on the practical implementation of the LCMM?* In response to this question all participants agreed that they see the model as suitable for practice. In addition, the participants agreed that the LCMM offers a good methodology and diagnostic tool for an organisation to get from A to B in a Lean Journey. Two participants indicated that it seemed practical to them that the LCMM enables one to see where they are. You look at the overall picture of your maturity, you see where your gaps are, and you are able to prioritise where you want to improve in terms of Lean maturity. Furthermore, one participant stated that the model is a very good tool to start a discussion about LC within the organisation. Moreover, all participants saw this model as an enabler for organisations to create a plan to achieve more maturity in LC. Although the participants indicated that it is quite possible that the prioritisation needs some more data analysis to identify those areas that are most important to the specific organisation.

The most striking result to emerge from the validation is that all participants agreed with one individual who stated that the LCMM *“really deconstructs [simplifies] and explains Lean in a better way [than] something [we] had before”*. In addition, the FG

believed that the LCMM includes a lot of elements which explain, in the words of one participant, the concept and philosophy in “*a very good way*”. Other responses to this question focused on the assessment of LC using the LCMM. It was agreed that assessors using the LCMM need to know what they are looking for, so a real understanding is needed in order to undertake the assessment process. Further, it was felt that the LCMM would be useful for consultants who would be able to use it to know what level 4 looks like. Both findings clearly highlight the fact that it is important to assess LC maturity through a practitioner-led assessment, rather than using the LCMM as a self-assessment tool. This is because the assessor really must know the LCMM in detail and be an expert in LC.

Finally, two participants indicated that despite the agreed practical suitability of the LCMM there are possible barriers to its use. For instance, it was stated “*we need to generate a need and a want for this LCMM in the industry*”. Another participant stated that a lack of “*leadership*” is a main barrier, which would need breaking down.

The validated LCMM is presented in next section.

The validated LCMM

Eleven Key Attributes (KAs) demonstrate the first major element of the LCMM - see Table 1. These key attributes are organized through 6 high-level factors: Philosophy, Leadership, Learning, People, Processes & System and Outcomes & Outputs. The factors represent an overall flow and a direction from left to right. This need for flow was a major finding from the final validation stage of the research process. To achieve this flow it was decided to integrate the framework from the EFQM Excellence Model as the top layer for the LCMM (EFQM, 2012). Hence having such a top layer, with defined factors, provides a unique element for the LCMM. This is shown in Figure 1 (page 6).

Behaviors, Goals & Practices (BG&P) were created which are distinguished as follows:

- a *behavior* associated with LC maturity
- a *goal* in the form of the [desired] characteristics of a more mature organization
- a *practice* which is considered to be important for LC maturity.

Sixty BG&Ps were defined, each comprising of a name, as an identifying component, and at least one Ideal Statement per component - which must be met for an organization to satisfy the related Key Attribute for a given maturity level. These Ideal Statements play a vital role in measuring the maturity of LC.

The LCMM and “Mature” vs “Immature” Organizations

The main applicability of the LCMM for LC maturity within the construction sector is for organizations which are either planning to further embed LC in their organization or those who are starting upon their Lean journey. This includes organizations such as: clients, contractors, and sub-contractors. Organizations like architects and engineers may also benefit from utilizing the LCMM. The results of the validation process indicated that the LCMM enables organizations to get a systemic and holistic overview of the current state of maturity in LC. Therefore the model provides an explanation of the differences between mature and immature organizations in terms of LC.

Table 1: The Eleven Key Attributes (KAs)

Key Attributes/KA	Purpose of KAs
1. Lean Leadership	The purpose of Lean Leadership is to establish and maintain leaders who actively encourage and drive individuals and teams towards more maturity in LC.
2. Customer focus	The purpose of Customer Focus is to establish and maintain an understanding and focus on both internal and external customer value
3. Way of Thinking	The purpose of Way of Thinking is to establish and maintain a holistic approach of thinking that supports LC maturity.
4. Culture & Behaviour	The purpose of Competencies is to establish and maintain a foundation for individuals and teams to continuously improve the competencies required to drive the transformation towards LC.
5. Competencies	The purpose of Competencies is to establish and maintain a foundation for individuals and teams to continuously improve the competencies required to drive the transformation towards LC.
6. Improvement Enablers	The purpose of Improvement Enablers is to make it possible for the people and the organisation to improve their LC maturity
7. Processes & Tools	The purpose of Processes & Tools is to establish and maintain an improvement of the processes that deliver the ultimate value.
8. Change	The purpose of Change is to establish and maintain a context by which the change towards LC is intrinsic.
9. Work Environment	The purpose of Work Environment is to establish and maintain working conditions that encourage individuals and teams.
10. Business Results	The purpose of Business Results is to enhance the alignment of performance criteria with the contribution of individuals and teams.
11. Learning and Competency Development	The purpose of Learning and Competency Development is to insure that individuals, teams and the organisation are constantly learning to enhance their skills, knowledge and competencies.

More mature organizations are able to identify their strengths and weaknesses in terms of LC implementation. Hence they have a process or model in place which enables them to assess and illustrate gaps and areas with higher levels of maturity in relation to some aspect of LC. More mature organizations utilize data which they have gathered to guide their decisions and support their strategy in the prioritizing of planned improvement actions towards greater maturity. Since the validation process suggested that the LCMM provides organizations with such guidance for their transformation, this data can be used to develop targeted interventions and workshops aimed at improving the maturity of a particular BG&P.

More mature organizations have a common language in terms of their Lean journey, whereas immature organizations are characterized with the use of buzzwords and unclear definitions of those words. So individuals have difficulties in understand the meaning of

the specific phrases, terms and words, which works against the establishment of shared meaning and commonly agreed methods to achieve LC goals and strategies. The LCMM addresses some of these problems, helping to establish a common language and raise shared awareness of the LC philosophy and its associated concepts within an organization.

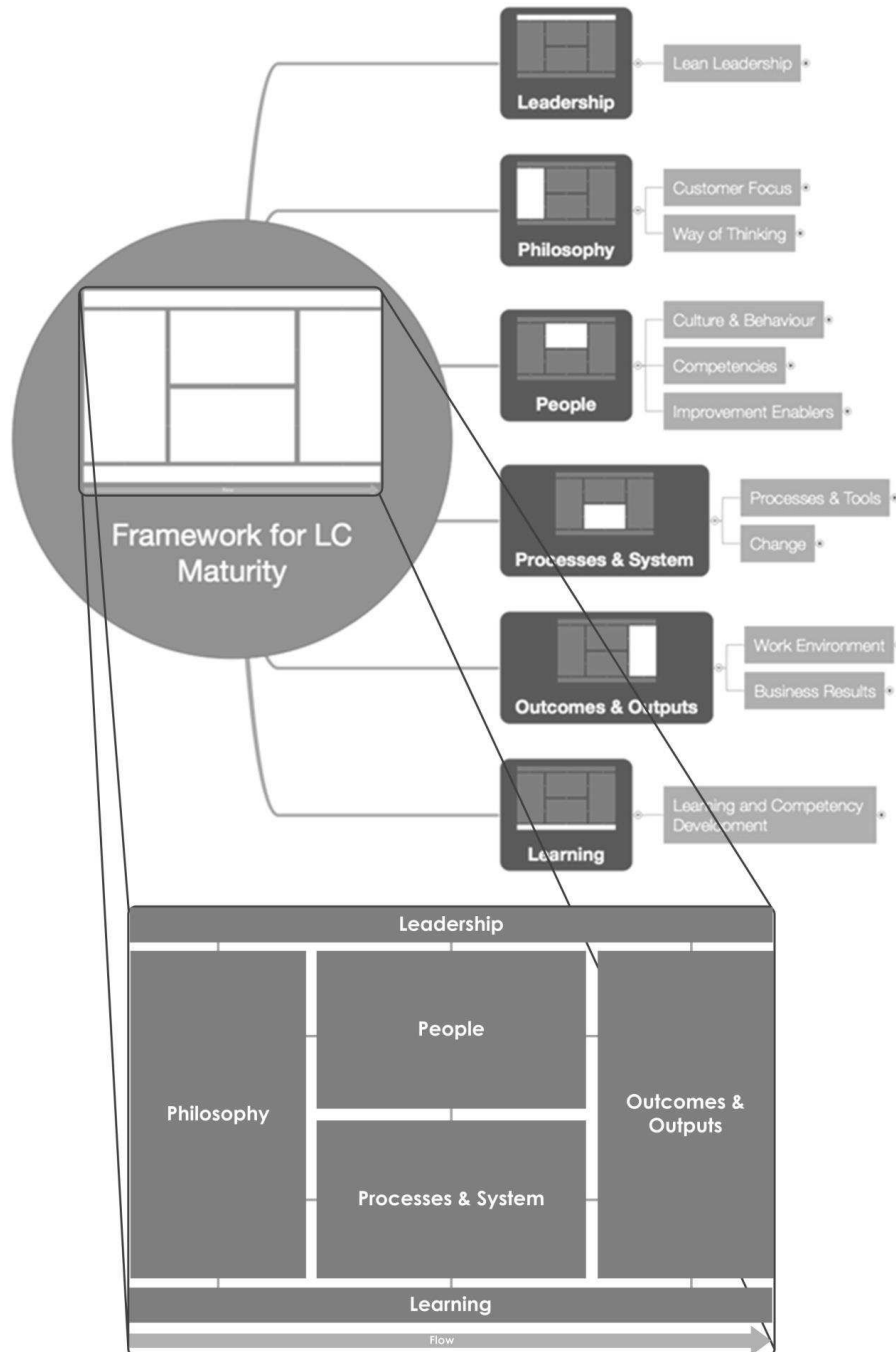


Figure 1. The LCCM

Limitations of the Model

All aspects of the LCMM might not be easily transferable to the context of short-term construction projects and to temporary organizations, because the value generated through the LCMM, which is likely to be realized over a relatively long time-frame, could

be difficult justify from a short-term financial cost-benefit analysis perspective. A further limitation to applying the LCMM is the fact that the assessors need to know the model and LC very well in order to achieve the desired results. This adds to the cost of applying the model i.e. training assessors and paying for assessments by outside experts. A final limitation of the LCMM is the risk of its inappropriate use as an organizational assessment tool. Since the Key Attribute “Culture & Behavior” of the LCMM seeks to establish trust and collaboration, it would be a totally inappropriate use of the model as a method to blame other divisions or parts of the organization for some perceived failure of LC implementation. This is because a blame culture is incompatible with the underpinning philosophy of Lean and is not conducive to one of its key concepts, namely continuous improvement.

Conclusions

This paper has presented the final version of the LCMM, which has been validated through three individual interviews and a FG with three participants. This validation confirmed the applicability of its overall structure and constituent elements, its usability to practice, implications of its use and possible limitations. The LCMM enables an organization to gain a systemic and holistic overview of their current state of maturity in LC. It supports them in planning and directing their transformation towards greater maturity in LC. The validation confirmed the suitability of the LCMM as an appropriate method to measure the current state of maturity and to support organizations in planning and directing their transformation towards greater LC maturity. A contribution to knowledge of the LCMM is the conceptualization of LC presented in the model. Hence, a common understanding of Lean concepts and the LC philosophy adopted by a specific organization and its individuals can be achieved by interacting with the model. The deployment of the LCMM can stimulate discussions about LC within an organization, which are necessary to raise awareness and energize activities to either start or continue on an LC journey. In terms of using the LCMM it is stressed that it needs the involvement of the right person to oversee its implementation and that this person needs a deep understanding of the model and of LC. To finally conclude, the LCMM provides a unique opportunity to improve the LC capability in organizations. As well as helping to increase LC maturity it provides a tool for aligning and measuring sought after improvements in the management-related activities of organizations in the construction industry.

Further Work

Increasing our knowledge about LC maturity and the ability to measure the current state of maturity, as well as supporting organizations around the world in their transformation towards greater maturity in LC, is vital. Thus, the outcome of this research, in the form of the LCMM, provides a solid foundation for further investigation into the application of the concept of MMs to LC. Further work needs to be done to test and strengthen the whole range of propose benefits of MMs in general and the LCMM in particular. This should be considered within a case study-driven research strategy. Additionally, the generalization of the emergent elements of LC maturity as well as the 11 Key Attributes of LC - articulated in the LCMM, can be confirmed or disconfirmed through further empirical evidence. For example, the LCMM may be applicable to



consultancies/service organizations in the construction industry, such as principal quantity surveyors, but this potential applicability needs to be further investigated.

References

- Amendola, L.J., Depool, T., Artacho, M.A., Borrell Martinez, L. & Martin, M. (2016). Proposal for a Maturity Model Based on Expert Judgement for Spanish Project Organisations. In Project Management and Engineering Research 2014, Muñoz, J.L.A., Blanco, J.L.Y. & Capuz-Rizo, S.F. (eds.) Switzerland, Springer International.
- CMMI Product Team. (2010). CMMI for services, version 1.3 S. E. P. M. Program, Trans.). Pittsburgh: Software Engineering Institute.
- Cooke-Davies, T. J. (2007). Project management maturity models. In P. W. G. Morris & J. K. Pinto (Eds.), *The Wiley Guide to Managing Projects* (pp. 1234-1255). Hoboken, New Jersey: John Wiley & Sons, Inc.
- Creswell, J. W. (2013). *Qualitative inquiry & research design : Choosing among five approaches*. London: Sage.
- Dave, B., Kubler, S., Främling, K. & Koskela, L. (2016). Opportunities for enhancing lean construction management using the Internet of Things. *Automation in Construction*, 61, pp. 86-97.
- Eadie, R., Perera, S., & Heaney, G. (2011.) Key process area mapping in the production of an e-capability maturity model for UK construction organisations. *Journal of Financial Management of Property and Construction*, 16(3), pp.197-210.
- EFQM (2012) An Overview of the EFQM Excellence Model. 8.
- Green, S. D. (2002). The human resource management implications of Lean construction: Critical perspectives and conceptual chasms. *Journal of Construction Research*, 3(01), pp.147-165.
- Green, S. D., Harty, C., Elmualim, A. A., Larsen, G. D., and Kao, C. C. (2008). On the discourse of construction competitiveness. *Building Research & Information*, 36(5), pp.426-435.
- Morse, J. M. (2003). Principles of mixed methods and multimethod research design. *Handbook of mixed methods in social & behavioral research*. A. Tashakkori and C. Teddlie. Sage, London, 189-208.
- Nesensohn, C., Bryde, D. J., Fearon, D. J., and Ochieng, E. G. (2013a). "Combining Lean construction with maturity models". In: *Proc. 29th Ann. Conf. of Association of Reserachers in Construction Management*. Reading, UK, Sep. 2-4.
- Nesensohn, C., D. Bryde, E. Ochieng, D. Fearon and V. Hackett (2014a). "Assessing Lean Construction maturity". In: *Proc. 22nd Ann. Conf. of the Int'l. Group for Lean Construction*. Oslo, Norway, Aug. 25-27.
- Nesensohn, C. (2014). An Innovative Framework For Assessing Lean Construction Maturity. *Ph.D.*, Liverpool John Moores University, (available at <http://ethos.bl.uk>).
- Nesensohn, C., Demir, S. T., & Bryde, D. J. (2013b). "Developing the True North route map as a navigational compass in a construction project management organisation." *Lean Construction Journal*, 2013(1), 1-18.
- Nightingale, D. J., & Mize, J. H. (2002). Development of a Lean enterprise transformation maturity model. *Information Knowledge Systems Management*, 3(1), 15-30.
- OGC, O. o. G. C. (2010). *Portfolio, programme and project management maturity model (P3M3®): Introduction and guide to P3M3®*. Norwich, UK: Cabinet Office of Rosebery Court Retrieved from <http://www.p3m3-officialsite.com>
- Pennypacker, J. S. (2005). *Project portfolio management maturity model*. Pennsylvania, USA: Center for Business Practices.

- Perkins, L. N., Abdimomunova, L., Valerdi, R., Shields, T., & Nightingale, D. (2010a). Insights from enterprise assessment: How to analyze LESAT results for enterprise transformation. *Information Knowledge Systems Management*, 9(3/4), 153-174.
- Perkins, L. N., Initiative, L. A., Valerdi, R., Nightingale, D., & Rifkin, S. (2010b). *Organizational assessment models for enterprise transformation*. Proceedings of INCOSE International Symposium, Chicago, USA.
- Ricardo E. Arriagada D. and Luis F. Alarcón C. (2014). Knowledge Management and Maturation Model in Construction Companies. *Journal of Construction Engineering and Management*, 140(4), -1.
- Wendler, R. (2012). The maturity of maturity model research: A systematic mapping study. *Information and software technology*, 54(12), 1317-1339.

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