

LEAN CONSTRUCTION FOR INNOVATION: A SYSTEMATIC REVIEW OF IGLC PROCEEDINGS

Darcy Zelenko¹ and Duncan Maxwell²

ABSTRACT

The implementation of Lean Construction (LC) is hindered by a lack of comprehensive understanding of innovation in the built environment, making it hard for firms to implement potential improvements. This paper contests that a consideration of LC as innovation can stimulate greater uptake, because it encourages firms to think more broadly about its implementation. The study aims to understand contributions to innovation scholarship from the perspective of LC, and to build an argument for considering LC as innovation to increase uptake. Papers published in IGLC conferences across the last 25 years form the basis for a systematised literature review (SLR), that utilises thematic analysis to synthesise understandings about innovation from the LC community. From the findings, six major themes emerge relating to innovation that are prominent in the reviewed literature: Relationship of LC to Innovation, Innovation Models, Barriers, Drivers, Innovation Strategy Essentials, and Collaborative Efforts. The paper argues that LC be considered an innovation for construction in and of itself, and a theoretical model is presented to aid understanding of LC as innovation. Future research pathways are identified, for example workshops with LC experts and practitioners to verify and expand the findings of this paper.

KEYWORDS

Innovation, Lean construction, Built Environment

INTRODUCTION

LC is a production management philosophy that seeks to minimise waste and increase value (Koskela et al., 2002). It has been demonstrated to be a contributor to addressing issues of stagnant productivity in the construction sector (Li et al., 2012). It is based on the following underpinning principles; value, value stream, flow, pull, and perfection (Bertelsen & Koskela, 2004) These principles are enacted through implementing key lean practices of; Just In Time (JIT), Total Preventative Maintenance (TPM), Total Quality Management (TQM), and Human Resource Management (HRM).

The term Lean Production (LP) was coined by John Krafcik in his Master's thesis and came to prominence as a catch-all for the principles underpinning Ohno's Toyota Production System as a result of the influential study of Womack et al., published as *The Machine That Changed The World* (Leong et al., 2015). LP can be considered a form of managerial innovation (Belfanti, 2018), and first radically transformed the Japanese automotive industry. The adoption of Lean's counterpart in construction has yet to take hold in the sector — in as comprehensive

¹ PhD Candidate, Future Building Initiative, Monash University, Melbourne, Australia, darcy.zelenko@monash.edu, <https://orcid.org/0009-0008-4700-3467>

² Director, Future Building Initiative, Monash University, Melbourne, Australia, duncan.maxwell@monash.edu, <https://orcid.org/0000-0002-9039-1441>

a way as the global automotive production sector — and productivity in the sector continues to stagnate. Reasons for the inability for Lean to take hold in construction relate to insufficient knowledge, a lack of sufficient training, and issues relating to maturity of the concept. Across the past decade, studies have demonstrated an industry awareness for LC in a general sense (Gao et al., 2020) but practitioners are less aware of specific associated principles and tools and as a result uptake has remained limited (Ahmed et al., 2020). Although Lean can be likened to a tool to enable innovation, in construction this been limited to minor changes of a technical nature.

INNOVATION

Influential economist Joseph Schumpeter developed an understanding of "*innovation*" as "any *doing things differently*" in the realm of economic life" (Schumpeter, 1939). He details these differences as five types of innovation:

- Introduction of a new good, or a new quality to an existing good.
- Introduction of a new process to a specific industry
- Inception of a new market
- Creation of new supply lines of input materials
- Organising industry in a new way

Innovation in construction is often linked to the interpretation of the sector as a 'product system' (Blayse & Manley, 2004). The prevailing definition of the term in construction is that proposed by Slaughter (1998) as "...*the actual use of a nontrivial change and improvement in a process, product, or system that is novel to the institution developing the change.*" Xue et al. (2014) calls for a more holistic understanding of innovation, absent in recent contributions. Innovation diffusion theory offers holistic ways to consider the diffusion of new methods or technologies (Rogers et al., 2014). This knowledge is used by firms and institutions to inform decisions about innovation investment to ensure the most optimal allocation of resources in pursuit of growth (Sundbo, 1995). Schumpeter established a wide range of interpretations of innovation, however the prevalent interpretation by Slaughter constrains the meaning. There is a gap of understanding between what innovation can be perceived as more generally, and the construction-specific interpretation of the term. As a broad production management philosophy, LC provides a more holistic lens from which to broaden interpretation of innovation.

SCOPE OF INVESTIGATION

This scope of this paper is limited to describe innovation across the construction value chain and focuses on activities that are crucial to the creation of buildings. Despite this narrow focus, there are influences of construction innovation, situated within the wider built environment. The nomenclature used in this paper reflects this thinking.

Koskela (1992) defines construction as a production-focussed sector, involving the design, and assembly of objects that are by nature, fixed in place. The products of construction are unique due to the combination of production-based factors that differentiate buildings (physical structures) from other things that humans create. Bertelsen and Koskela (2004) outlines 'peculiarities' that differentiate construction projects from the outputs of other production-based sectors as; possessing a one-of-a-kind nature, existing in situ, through the cooperation of temporary multi-disciplined teams.

OBJECTIVES AND STRUCTURE

The objectives of this paper are: to understand the contributions to innovation theory made by the IGLC community; to discern if there is precedent within the community for the philosophy of LC to be considered as innovation; and if so, to understand how can this precedent can be used to increase innovation uptake in the construction sector.

A SLR and thematic analysis is used to analyse innovation scholarship from the IGLC proceedings database — representing the state-of-the-art in LC research and practice — from the past 25 years. The results are synthesised into six themes that help to address the objectives. The discussion reflects on the results of the SLR to make the argument for considering LC as innovation. Such a consideration allows for a more holistic approach to be taken to understand and implement LC. The construction innovation model being developed as part of a PhD research project is then refined, utilising the inputs of the SLR to present an LC-specific innovation model to assist LC practitioners increase implementation. The paper contributes new knowledge to innovation theory from the IGLC community, and makes the argument to consider LC as a form of management innovation to enable greater uptake. The paper concludes by outlining implications for research, discussing limitations of the study, and highlighting potential opportunities for future work to verify and refine the findings.

METHODOLOGY

The approach to research taken by the study was to utilise a SLR, and thematic analysis to synthesise the findings. SLRs provide a structured and transparent process to undertake a qualitative analysis, that is reproducible and reliable (Tranfield et al., 2003). Thematic analyses are useful in the context of this paper because they enable the extraction of common themes and divergent perspectives from a wide array of studies, essential for synthesising broad research findings (Braun & Clarke, 2006).

The following research question was formulated to direct the SLR:

What is the relationship between LC and innovation from academic literature, across the past twenty-five years?

To answer this question the IGLC database was searched for papers mentioning ‘innovation’ across the past 25 years through Google Scholar and Publish or Perish (Harzing, 2007). For efficiency, a majority (300) of the 514 entries returned (according to Google Scholar ranking) were selected for review. These 300 papers contained no duplicates and were initially screened for eligibility. The criteria for initial eligibility were that a paper had to propose new knowledge about innovation in the built environment, through the inclusion of model, framework, or formulated understanding, that was not part of a literature review, or background section. The initial screening process reduced the pool of papers down to 24 for subsequent thematic analysis. QSR Nvivo 14 was the platform chosen to analyse the data collected (QSR International, 2024). A ‘lean-coding’ approach was utilised for the researcher to create a focused initial pool of themes and codes to commence data analysis, that was then refined or expanded as necessary (Creswell, 2013).

RESULTS

SAMPLE ANALYSIS

Thematic analysis was used to analyse the 24 eligible papers from the IGLC database and derive codes relating to the furthering the understanding of innovation in the built environment. The distribution of publications from 1999 to 2023 (Figure 1) shows that research activity concerning Lean Construction and innovation has been ongoing. There is a wide geographical distribution of papers (Figure 2) across different continents suggesting the potential for international collaboration. The United States is the country that has produced the most amount of research about innovation in the context of IGLC proceedings.

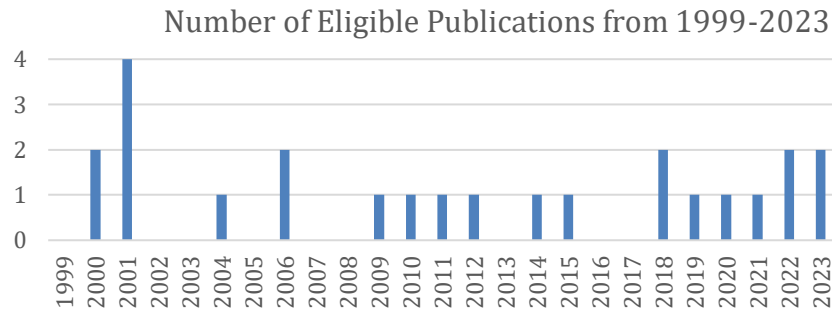


Figure 1 - Number of publications per year, from 2010 to 2021

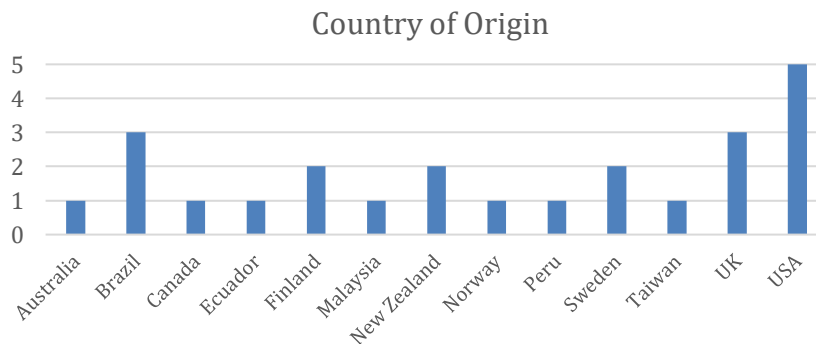


Figure 2 - Number of publications per year, from 2010 to 2021

A synthesis of data was derived through grouping similar codes into categories that based on similar concepts and meanings (Allen, 2017). The categories were then reviewed and refined by revisiting the dataset of eligible papers, that resulted in the emergence of key themes. The key themes were then constructed and underwent a further review process to ensure they adequately captured the meaning of the constituent codes.

DEVELOPED THEMES

The developed themes are as follows:

Relationship of LC to Innovation

- The first theme synthesises the relationship between LC and Innovation, derived from IGLC literature (Table 1), the thematic analysis of the SLR established that Lean *is* a form of managerial innovation in itself, and can provide support to facilitate broader innovation.

Innovation Operations - Existing LC Context

- The second theme identifies operational understandings of innovation in the LC context, in IGLC literature. The SLR identified 7 examples of different understandings used to describe aspects relating to innovation (Table 2).

Barriers to innovation

- The third theme identifies barriers to innovation in IGLC literature (Table 3).

Drivers of Innovation

- Theme 4 concerns drivers of innovation, prevalent in IGLC literature, outlined Table 4.

Innovation Strategy Essentials

- The fifth theme identified, points towards a systemic approach that is required for innovation to drive sector-wide change, one that shifts away from siloed, project-centric endeavours (Table 5).

Collaborative Efforts

- The sixth and final theme that emerged from IGLC literature that stressed the importance of collaborative efforts in driving innovation (Table 6).

Table 1: Innovation and LC

Lean is a form managerial innovation

- LP is viewed as a radical managerial innovation (Gomez, 2009; Koskela & Vrijhoef, 2000)
- Lean Production (LP) is innovative approach to the management of production systems (Hirota & Fomoso, Carlos T., 2001)
- Lean can form part of an innovation strategy (Iordanova et al., 2020)

Lean is a facilitator of innovation

- Lean is a tool for establishing an environment for innovation (Etges & Caten, 2023)
- LC can help drive innovation (Etges & Caten, 2023; Hirota & Fomoso, Carlos T., 2001).
- Incorporation of lean principles would drive industry-wide innovation (Hunt & Gonzalez, 2018)
- Implementing Lean principles both before and during the innovation process is essential for minimising flow waste and enhancing teamwork (Roman & Li, 2014).
- Lean theory can be used as a conceptual foundation to explain innovative practices in construction (Etges & Caten, 2023; Tommelein & Beeche, 2001).
- Last Planner System (an innovation) generated using LC principles (Hunt & Gonzalez, 2018)

Table 2: Innovation in Existing LC Context — Operational focus

Model Name	Description of model
Technological Capability (Freitas & Heineck, 2012)	Classifies innovation by level of technology
Implementation Scheduling (Ballard, 2001)	Implementation strategy combined with Target Cycle Time
Creative Process Support (Berg et al., 2018)	Teamwork and brainstorming methods used to generate new ideas
Problem-space Framework (Etges & Caten, 2023)	A “Double Diamond” approach to identify pain-points and propose innovative solutions
Drivers of Change (Henrich et al., 2006)	Implementation model considering absorptive capacity, and drivers
Manufacturing Templates (Koskela & Vrijhoef, 2000)	Explains transfer of production templates from manufacturing to construction
Simplified Diffusion Model (Poshdar et al., 2019)	Diffusion model from the perspective of the user

Table 3: Innovation barriers as identified

Boom-bust Cycle

- Inhibits investment and companies can't take a long-term view (Hunt & Gonzalez, 2018)
- Margins are low in bust, and actors are too busy in boom (Leiringer, 2001)

Organisational Culture

- Ingrained culture of operation inhibits innovation (Hunt & Gonzalez, 2018)
- Inherent organisation of construction, and theory deficiencies (Koskela & Vrijhoef, 2000)
- Organisations don't want to jeopardise control and often maintain status quo (Leiringer, 2001)
- Unwillingness to share IP amongst project actors (Hunt & Gonzalez, 2018)
- Inability or reluctance to address problems (Koskela & Vrijhoef, 2000)
- Myopic supply chain management, and the diffusion challenges posed by organisational and institutional structures (Koskela & Vrijhoef, 2000).

Operations

- Working practices of construction managers – too task oriented with not enough time allotted for reflection (Hirota & Fomoso, Carlos T., 2001)
- Planning effectiveness Schedule deviation (Castillo et al., 2015)
- Potential for innovation initiatives to collide (Leigard & Pesonen, 2010)
- Hard to measure efficiency in construction, and benchmark data (Henrich et al., 2006)

Cost

- Projects need to be viable, ahead of consideration for innovation (Kennedy et al., 2023)
- Competitive bidding pushes down budget for innovation (Leiringer, 2001)

Table 4: Main drivers of innovation in LC

A Culture to Support Innovation

- Companies can foster a culture of innovation by improving professionalism and efficiency. This can be practically achieved through improved onsite practices, the introduction of quality assurance practices and safety rules (Davey et al., 2000).
- Develop a culture that facilitates innovation, by fostering a willingness to take risks, experiment, but also acknowledging and learning from failures (Hamzeh, 2011).
- Action Learning can be used to drive cultural change to foster innovation (Davey et al., 2000).
- Role of change agents (Leigard & Pesonen, 2010; Poshdar et al., 2019).
- Reform the patent process to create innovation-friendly culture (Stevens, 2022).
- There is a negative hierarchal relationship that separates consultants and clients, from contractors, inhibits innovation from occurring (Hunt & Gonzalez, 2018)
- Achieving buy-in from entire team in required to implement an innovation(Hunt & Gonzalez, 2018; Roman & Li, 2014)

Unique Project Requirements

- The adoption of innovation by contractors was due to site specific issues, with one contractor stating “We look for innovation when we are forced to” (Hunt & Gonzalez, 2018)
- The project nature of construction provides the ability to silo innovation trials, facilitating a “narrow and deep approach” (Arbulu & Zabelle, 2006).
- Innovation should also consider the inherent advantages* of construction of; zero stock, high flexibility, and satisfactory social needs (Chang & Lee, 2004)

Table 4 continued: Main drivers of innovation in LC

<p>Role of Client</p> <ul style="list-style-type: none">• Clients can be an important innovation enabler due to a combination of their experience, and technical knowledge (Hunt & Gonzalez, 2018).• Improved engagement between academia and industry for networking to incubate research collaboration, both in regards to LC and innovation more generally (Hunt & Gonzalez, 2018).• Theory of Inventive Problem Solving as an enabler of innovative ideas (Roman & Li, 2014) <p>Market Forces</p> <ul style="list-style-type: none">• Competitive pressures, market pull, and technology push all drive firms to adopt new technologies (Chang & Lee, 2004)• Push-driven innovations come from pressure from customers, suppliers, or regulators. Pull-driven innovations arise from recognized performance gaps (Henrich et al., 2006)• New materials and/or equipment launched into the market usually trigger innovation initiatives in construction (Henrich et al., 2006).

Table 5: Innovation Strategy Essentials

<p>Need for Government Reform</p> <ul style="list-style-type: none">• Government needs to take a larger role in fostering innovation in the built environment at all stages. ie support for inventors, incentives for innovation, and the allowance of innovation on construction projects through the use of performance-based specifications (Stevens, 2022).• Construction contract structures, such as design-bid-build inhibit innovation due to the separation of design, and construction (Hunt & Gonzalez, 2018). <p>Strategies for Adapting and Managing Innovation</p> <ul style="list-style-type: none">• Innovation (technical change) in construction should; be driven by market pull, should be limited to construction component standardisation, and consider the available labour market (Chang & Lee, 2004).• Highly impactful innovation (radical or organisational innovations) from other industries need to be abstracted, then adapted to fit a new context (Koskela & Vrijhoef, 2000).• Efficient information exchange for efficient innovation management (Castillo et al., 2015).• Creativity is necessary to foster innovation, and needs to be defined clearly by management, and what creative practice aims to achieve (Berg et al., 2018). <p>Knowledge Management and Market Alignment</p> <ul style="list-style-type: none">• Trivialisation of innovation due to a loss of credibility coming from a saturation of 'low-quality' information (Etges & Caten, 2023).• Firms should dedicate time to understanding real market need ahead of adopting a technology for sake of technology-push (Chang & Lee, 2004).• Organising a company's learning processes in a considered manner facilitates the accumulation of technological capability, that is needed to generate and manage innovation (Freitas & Heineck, 2012).• Translating knowledge into formalised structures and disseminating via dedicated roles leads to better accumulation and continuity, despite staff turnover (Freitas & Heineck, 2012).• Companies that are seen to be innovative attract staff (Bou Hatoum et al., 2022).

Table 6: Collaborative Efforts

Strategic Partnerships Create Opportunities for Innovation

- Partnering to deliver tailored technological solutions across projects (Freitas & Heineck, 2012)
- Increased levels Industry-led research partnerships, that combines public resources and industry knowledge creates a more innovative environment, (Gomez, 2009; Stevens, 2022)
- Collaborative work involving universities, suppliers, and companies is essential for innovation development (Roman & Li, 2014).

Construction Firm Networks are Important for Diffusion of Innovation

- Large enterprises have the capacity to utilise R&D investment to drive innovation (Etges & Caten, 2023; Poshdar et al., 2019). SME don't have this ability, and instead need to rely on clusters and networking to innovate (Poshdar et al., 2019).
- SMEs adopt the innovation successes of market leaders (Etges & Caten, 2023)
- The interrelated nature of SMEs on construction projects can facilitate or impede innovation diffusion (Poshdar et al., 2019) .

Innovation Collaboration Requires Support and Resources

- Collaboration, through structured settings like workshops with practitioners from across different firms, has been demonstrated to help develop skills to further innovation strategy (Etges & Caten, 2023).
- Collaborative practices help discover, facilitate and implement innovation, but are time consuming (Berg et al., 2018; Hunt & Gonzalez, 2018; Stevens, 2022)

DISCUSSION

Viewed as a whole, the SLR points towards how innovation can be more deliberately pursued in LC. The resulting IGLC Innovation Model compiles the data to present an holistic pathway for this journey where Lean is both a strategic and managerial enabler of innovation, a path that has drivers as well as barriers, and where collaboration is an key factor in a broader suite of more operationally-focused understandings.

The SLR supports the earlier claim by Belfanti that Lean has been considered a managerial innovation (Table 1). LC creates an environment for innovation to occur, the SLR revealed how Lean principles, and LPS act as innovation drivers. Furthermore, Lean theory was suggested as useful in explaining innovative practices in construction.

Current understandings of innovation in IGLC literature are not holistic in scope, and instead tend to concentrate on singular, technical focus areas. The aspect of implementation was most prevalent in identified operational-focused understandings of innovation in LC, ahead of ideation and classification (Table 2).

Major innovation barriers that the SLR identified fell under four classifications. These barriers primarily related to the organisational culture and operations of construction (Table 3). The boom-bust cycle of construction, and cost, were identified as secondary barriers.

A number of innovation drivers emerged as a result of the SLR (Tables 4-6). First, the role of culture in supporting innovation were identified by a significant number of papers as an innovation driver (Table 4). Also, the role of the client, market forces, and unique project requirements of construction, were identified by a lesser number of papers as drivers of innovation.

Additionally, the key role of strategy was identified as a prominent driver of innovation across a number of different levels (Table 5). The management of knowledge to; accumulate technological capacity, and to best understand market needs, was identified prominently in the SLR. The SLR also identified strategies for adapting and managing innovation, and need for government reform to a lesser amount as possessing strategic importance to driving innovation.

Finally, the importance of collaborative efforts was identified in by the SLR as a key driver for innovation in IGLC literature (Table 6). The use of strategic partnerships was seen as important to create opportunities for innovation. Networks of construction firms were also seen as crucial to the diffusion of innovation across the sector. A need to adequately support and resource Collaborative efforts was identified as important for their viability.

The content generated from themes three to six can be synthesised into a model of influencing factors on innovation, as described by IGLC literature (Table 7).

Table 7: IGLC Innovation Model

Themes	Sub-themes
Strategy Essentials	Government Reform, Strategies for Adapting and Managing Innovation, Knowledge Management and Market Alignment
Drivers	Role of Client, Unique Project Requirements, Culture, Market Forces
Barriers	Boom-bust Cycle, Organisational Culture, Operations, Cost
Collaborative Efforts	Strategic partnerships, Construction firm networks, Adequate resources

The work of this paper contributes to an ongoing PhD research project that is examining the value of understanding and pursuing innovation in an holistic way, across the built environment disciplines. Holistic thinking enables firms to identify outside factors that can be valuable to consider When applied to the innovation process, holistic thinking can a targeted pursuit of more impactful innovation, and the increased economic growth it brings (Mazzucato, 2011). What this IGLC Innovation Model reveals is the importance to LC innovation and implementation when considered from a similarly connected and holistic standpoint. Such a perspective can consider the multi-factorial benefits of lean that sit across the value chain and work from the strategic level of business down to the operational benefits felt in projects.

When considered together, the themes and sub themes proposed in the IGLC Innovation Model shifts practitioner thinking away from an operational level, towards taking a broader approach to pursuing innovation. Such an approach is useful because the selection, analysis, and comparison of potential innovations for implementation can be informed by more-informed thinking. The holistic approach proposed in this paper encourages firms to devote time to strategising innovation through first developing capacity in knowledge management to build technological capacity, and recognising the important role of collaboration, through aspects such as construction firm networks, can play in achieving successful innovation implementation. This is alongside considering other aspects of innovation, that feature more prominently in construction innovation literature, like drivers, and barriers.

The emerging model proposes a way to consider innovation from an holistic standpoint in a LC-specific context and can be useful to managers to facilitate the adoption of LC, increase its uptake/utilising, or to explore specific technical process innovations that LC can support. The model can be used to assist firms in understanding wider factors, associated with innovation implementation. This can help managers to better make the case for both LC, and other innovation, within the wider construction sector.

The themes covered in the SLR present a guide, showing the relationship of LC to Innovation, revealing that innovation models already exist and are supporting LC, but also identify barriers and drivers of innovation. To increase uptake of innovation the final themes identify the need for a strategic approach and one that is inherently collaborative. The IGLC Innovation Model links LC and innovation. This is interesting because it represents a combination of two related efforts in the built environment, both broadly aimed at improving construction productivity. As the construction sector continues to evolve, the IGLC Innovation

model can be useful to practitioners in guiding the adoption of innovation that meet the demands of future construction projects.

CONCLUSION

This paper examines the relationship between LC and innovation in the construction sector, utilising a SLR of IGLC proceedings from the last 25 years. The findings of the SLR were bundled into six key themes that represent the major contributions towards innovation theory from the perspective of LC scholarship. The findings are used to support positioning LC as a form of managerial innovation. The argument is made that this allows innovation theory to be utilised to help increase uptake through increasing an understanding about the role of LC for managers. The research uses the findings of the SLR to introduce an IGLC-specific Innovation Model, that is aimed at enhancing comprehension and increased uptake. Considering LC as innovation can allow for a greater body of research to be drawn upon to facilitate greater diffusion in industry. Correspondingly, augmenting built environment innovation theory with LC theory also sees a combined approach taken to boost innovation uptake. While a connection has been established, the research is limited by its theoretical nature. Further work is needed to strengthen the case for the IGLC Innovation Model. Empirical studies are needed to build-out the argument, and test the validity of the Model. This should be complimented with expert workshops to feed-in input from industry that can be used for further refinement, and help contribute to Lean Theory to improve productivity in the construction sector.

ACKNOWLEDGMENTS

This research is supported by the Monash Cox Scholarship in Architecture and Building 4.0 CRC. The support of the Commonwealth of Australia through the Cooperative Research Centre Programme is acknowledged.

REFERENCES

- Ahmed, S., Hossain, Mr. Md. M., & Haq, I. (2020). Implementation of lean construction in the construction industry in Bangladesh: Awareness, benefits and challenges. *International Journal of Building Pathology and Adaptation*, ahead-of-print. <https://doi.org/10.1108/IJBPA-04-2019-0037>
- Allen, M. (2017). *The SAGE encyclopedia of communication research methods*. SAGE publications.
- Arbulu, R., & Zabelle, T. (2006). Implementing Lean in Construction: How to Succeed. 553–565. <https://iglc.net/Papers/Details/407>
- Ballard, G. (2001). *Cycle Time Reduction In Home Building*.
- Berg, I. L., Lombardo, S., & Lædre, O. (2018). Innovation with Creative Collaborative Practices. 358–369. <https://doi.org/10.24928/2018/0397>
- Bertelsen, S., & Koskela, L. (2004). *Construction Beyond Lean: A New Understanding Of Construction Management*.
- Blayse, A. M., & Manley, K. (2004). Key influences on construction innovation. *Construction Innovation*, 4(3), 143–154. <https://doi.org/10.1108/14714170410815060>
- Bou Hatoum, M., Ammar, A., Nassereddine, H., & Dadi, G. (2022). Preparing Construction Employers for the Gen-Z Workforce: A Case Study (p. 819). <https://doi.org/10.24928/2022/0193>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>

- Castillo, T., Alarcón, L. F., Salvatierra, J., & Alarcón, D. (2015). Analyzing The Interrelation Between Management Practices, Organizational Characteristics And Performance Indicators For Construction Companies.
- Chang, A., & Lee, K.-P. (2004). Nature of Construction Technology. <https://www.semanticscholar.org/paper/Nature-of-Construction-Technology-Chang-Lee/66aa84ae909c1ba8118625fbf977a274d673669f>
- Creswell, J. W. (2013). Qualitative inquiry and research design: Choosing among five approaches (3rd ed). SAGE Publications.
- Davey, C. L., Powell, J. A., Cooper, I., & Hirota, E. (2000). Innovation and Culture Change Within a Medium-Sized Construction Company: Success Through the Process of Action Learning. 8th Annual Conference of the International Group for Lean Construction. <https://iglc.net/Papers/Details/101>
- Etges, B. M. B. da S., & Caten, C. S. ten. (2023). Lean Supporting a Framework for the Construction Innovation Process. 81–91. <https://iglc.net/Papers/Details/2096>
- Freitas, A. A. F., & Heineck, L. F. M. (2012). Technological capability: Evidence from building companies in a lean learning environment.
- Gao, Z., Aslam, M., & Smith, G. (2020). Strategies to Increase Adoption Rate of Lean Construction. EPiC Series in Built Environment, 1, 364–372. <https://doi.org/10.29007/8xzp>
- Gomez, C. P. (2009). An Innovative Self-Assessment Approach For Minimization Of Construction Peculiarities On Lean-Oriented D&B Projects. Th Annual Conference of the International Group for Lean Construction.
- Hamzeh, F. (2011). The Lean Journey: Implementing The Last Planner ® System in Construction. <https://doi.org/10.13140/RG.2.1.3648.7522>
- Harzing, A.-W. (2007). Publish or Perish (Version 8) [Computer software]. <https://harzing.com/resources/publish-or-perish>
- Henrich, G., Abbott, C., & Koskela, L. (2006). Drivers for Innovation in Production Management (pp. 533–541). IGLC. <https://www.hud.ac.uk/news/>
- Hirota, E. H. & Formoso, Carlos T. (2001). Barriers to Management Innovations: Communicating Meanings. https://www.academia.edu/72719868/Barriers_to_Management_Innovations_Communicating_Meanings
- Hunt, R. J., & Gonzalez, V. A. (2018). Innovation in the New Zealand Construction Industry – Diffusion of the Last Planner System. 422–431. <https://iglc.net/Papers/Details/1566>
- Iordanova, I., Valdivieso, F., Filion, C., & Forgues, D. (2020). Schedule Optimization of a Large Hospital Project – 4D Bim Starting With the Demolition (p. 972). <https://doi.org/10.24928/2020/0048>
- Kennedy, Z. A., Daniel, E. I., Egan, M., Sully, T., & Tennant, G. (2023). Exploring a Platform Approach to Improve the Uptake of Offsite Construction in Housebuilding: Evidence From the United Kingdom. 790–801. <https://doi.org/10.24928/2023/0223>
- Koskela, L. (1992). Application of the new production philosophy to construction (Vol. 72). Stanford university Stanford.
- Koskela, L., Howell, G., Ballard, G., & Tommelein, I. (2002). The foundations of lean construction. In Design and Construction. Routledge.
- Koskela, L., & Vrijhoef, R. (2000). The Prevalent Theory Of Construction Is A Hindrance For Innovation.
- Leigard, A., & Pesonen, S. (2010). Defining The Path: A Case Study Of Large Scale Implementation Of Last Planner.
- Leiringer, R. (2001). The Scope for Innovative Thinking Within Public Private Partnerships. 9th Annual Conference of the International Group for Lean Construction. <https://www.iglc.net/Papers/Details/150>

- Leong, M. S., Ward, S., & Koskela, L. (2015). Towards an Operational Definition of Lean Construction Onsite.
- Li, H., Guo, H. L., Li, Y., & Skitmore, M. (2012). From IKEA Model to the Lean Construction Concept: A Solution to Implementation. *International Journal of Construction Management*, 12(4), 47–63. <https://doi.org/10.1080/15623599.2012.10773200>
- Mazzucato, M. (2011). The Entrepreneurial State. Demos
- Poshdar, M., Gonzalez, V., Antunes, R., Ghodrati, N., Katebi, M., Valasiuk, S., & Talebi, S. (2019). Diffusion of Lean Construction in Small to Medium-Sized Enterprises of Housing Sector. <https://doi.org/10.24928/2019/0257>
- QSR International. (2024). NVivo Qualitative Data Analysis Software (Version 14) [Computer software]. <https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home>
- Rogers, E. M., Singhal, A., & Quinlan, M. M. (2014). Diffusion of innovations. In *An integrated approach to communication theory and research* (pp. 432–448). Routledge.
- Roman, B., & Li, G. (2014). A Lean-TRIZ Approach for Improving the Performance of Construction Projects.
- Slaughter, E. S. (1998). Models of construction innovation. *Journal of Construction Engineering and Management*, 124(3), 226–231.
- Stevens, M. (2022). Nine Innovation Barriers in Australian Construction Contracting. 25–35. <https://iglc.net/Papers/Details/1942>
- Sundbo, J. (1995). Three paradigms in innovation theory.
- Tommelein, I. D., & Beeche, G. (2001). De-Coupling Cladding Installation From Other High-Rise Building Trades: A Case Study. The 9th Annual Conference of the International Group for Lean Construction.
- Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. *British Journal of Management*, 14(3), 207–222. <https://doi.org/10.1111/1467-8551.00375>
- Xue, X., Zhang, R., Yang, R., & Dai, J. (2014). Innovation in Construction: A Critical Review and Future Research. *International Journal of Innovation Science*, 6(2), 111–126. <https://doi.org/10.1260/1757-2223.6.2.111>