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INTERNATIONAL GROUP FOR LEAN CONSTRUCTION

Lean Construction 4.0: Exploring the Challenges of Development in the AEC Industry

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What is Lean Construction 4.0?

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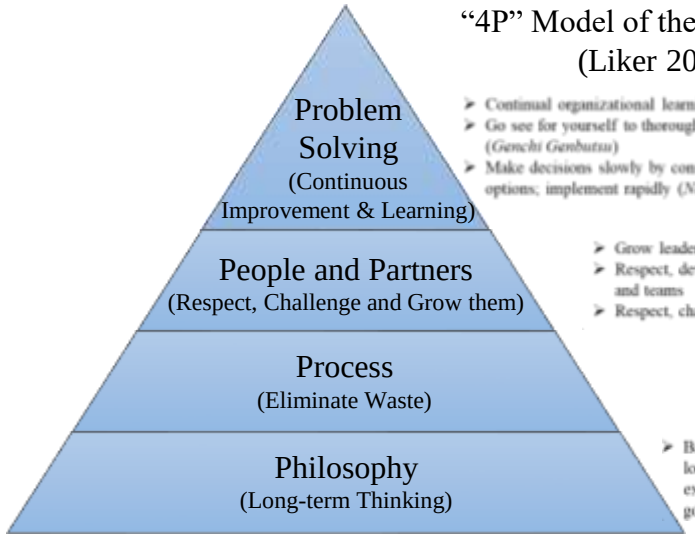


"4P" Model of the Toyota Way (Liker 2004)

- Continual organizational learning through *Kaizen*
- Go see for yourself to thoroughly understand the situation. (*Genchi Genbutsu*)
- Make decisions slowly by consensus, thoroughly considering all options; implement rapidly (*Nemawashi*)
- Grow leaders who live the philosophy
- Respect, develop and challenge your people and teams
- Respect, challenge, and help your suppliers
- Base management decisions on a long-term philosophy, even at the expense of short-term financial goals

Lean Construction

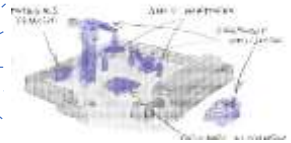
View	Main Principles	Associated Principles
Transformation (Conversion) view	Realize value-adding activities efficiently	1. Decompose the production task; 2. Minimise the costs of all decomposed tasks.
Flow view	Reduce the share of non value-adding activities.	1. Compress Lead Time; 2. Reduce variability; 3. Simplify; 4. Increase transparency; 5. Increase flexibility.
Value Generation View	Improve customer value.	1. Ensure that all requirements get captured; 2. Ensure the flowdown of customer requirements; 3. Take requirement for all deliverables into account; 4. Ensure the capability of the production system; 5. Measure value.

TFV Approach (Koskela 2000)

Synergies between Lean Construction and Industry 4.0 technologies = Lean Construction 4.0

BIM

Physical Twin



Digital Twin

Mixed-Reality

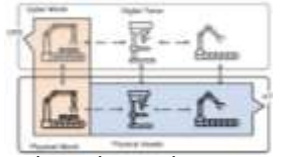
Predictive Analytics & AI

Ind[illegible]) Technologies

Smart Site

Construction Robotics

Additive manufacturing



Cyber Physical Systems

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Why Lean Construction 4.0?

Technologies partially adopted in the Architecture-Engineering-Construction (AEC) industry.

- Machine learning and predictive models (Mansouri et al. 2020)
- Mixed-reality and robotics (Ahmed 2018)
- Computer simulation and modelling (Abdelmegid et al. 2020)
- Cyber-physical Systems (CPS) (Lu et al. 2020)
- Digital twin construction (Sacks et al. 2020)

Why Lean Construction 4.0?

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However, the AEC industry's unwillingness for a widespread adoption of Smart and Digital Technologies has pushed away the opportunity to achieve the "Industry 3.0 transformation", which is an essential pre-condition to adopt an "Industry 4.0" state as in manufacturing (Farmer 2016).

Lean Construction 4.0 - FOUNDATIONS

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People/ Culture

Motivated for Improvement
Proactive Leadership
Promise Based Management
Cross Functional Teams
Competent

Process/Philosophy

Lean Principles
Reduce Waste
Increase Value
Optimize Globally

Technology

Industry 4.0 Technologies
VDC/ BIM
Virtual Reality
Machine Learning
Automation
Etc.

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Value of Lean Construction 4.0 for Both Academia and Industry

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"The essence of management is not techniques and procedures. The essence of management is to make knowledge productive, which is a good starting point for the definition of Lean Management".

Peter Drucker

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Motivation for Construction 4.0

Problem when the triad is ignored:

- Overemphasis on technology
- Inadequate implementation strategies
- Limited and incomplete impacts of Industry 4.0 on project/company results
- Long , slow implementation processes with uncertain results

How Academia can Contribute to LC 4.0?

- Explore the integration between Lean practices and I4.0 technologies (Sanders et al. 2016; Tortorella et al. 2020).
- Develop methodologies to identify how the success of LC 4.0 implementation (process) can impact the performance of projects and companies.
- Develop benchmarking and decision tools to support the choice of the best LC 4.0 implementation strategy.

Lean Construction 4.0 to address Challenges and Opportunities stemming from Industry 4.0 technologies

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Questions for Discussion

- What are the **necessary adjustments** that the Lean Construction community would introduce to Lean Construction 4.0 to cater to future challenges?
- What is the **role of the people-process-technology** triad to revamp the Lean Construction research towards a Lean Construction 4.0 ideal?

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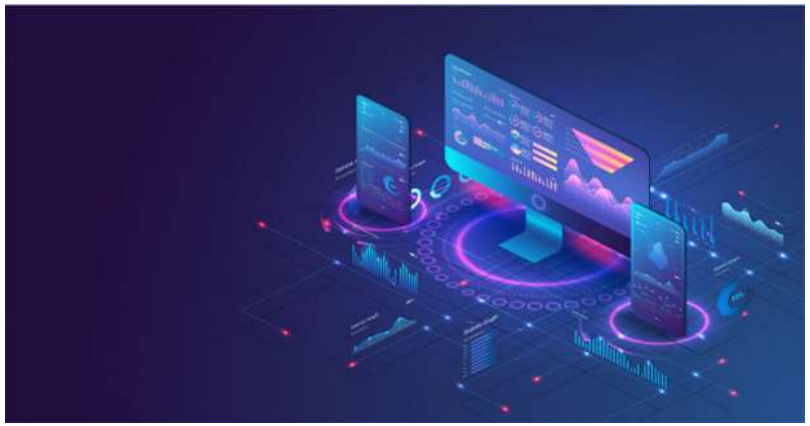
Questions for Discussion

- What **changes** will Industry 4.0 bring into the work of professionals in the AEC industry? What is the role of Lean Construction 4.0 in this?

- What type of **training** will be required from the future workforce to be “up to date” with Lean Construction 4.0 in terms of processes and technologies?



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